Handbook of **Undergraduate Curricula**

The Graduate School
ICAR-Indian Agricultural Research Institute
New Delhi 110012

Handbook of Undergraduate Curricula

The Graduate School
ICAR-Indian Agricultural Research Institute
New Delhi – 110 012

Supervision and guidance
Dr. A. K. Singh
Director & Vice-Chancellor, ICAR-IARI, New Delhi
Dr. Anupama Singh
Joint Director (Education) & Dean, ICAR-IARI, New Delhi

Drafted and compiled by
Dr. T. K. Das
Principal Scientist, Division of Agronomy, IARI, New Delhi
Dr. Debasis Pattanayak
Principal Scientist, NIPB, New Delhi
Dr. Rashmi Singh
Principal Scientist, Agricultural Extension, IARI, New Delhi
Dr. D. K. Singh
Principal Scientist, Agricultural Engineering, IARI, New Delhi
Dr. Roaf Ahmad Parray
Scientist, Agricultural Engineering, IARI, New Delhi

Cover page designed by
Dr. K. K. Vinod
Associate Dean and Principal Scientist, Division of Genetics

The Graduate School team
Mr. Ashok Kumar, Senior Technical Assistant
Mr. Nitin Kumar, Technical Assistant, TGS (IT Cell)
Mr. Praveen Yadav, AAO, TGS-I
Mr. Rahul, AAO, TGS-II

Publication date: February 2024

Published by
The Graduate School, ICAR-Indian Agricultural Research Institute, New Delhi

भा.कृ.अ.प. – भारतीय कृषि अनुसंधान संस्थान, नई दिल्ली–110012 (भारत)
ICAR - INDIAN AGRICULTURAL RESEARCH INSTITUTE
(A DEEMED TO BE UNIVERSITY UNDER SECTION 3 OF UGC ACT, 1956)
NEW DELHI - 110012 (INDIA)

डॉ. अशोक कुमार सिंह, एफ.एन.ए., एफ.एन.ए.एस.सी., एफ.एन.ए.ए.एस.
निदेशक एवं कुलपति
Dr. Ashok Kumar Singh, FNA, FNASc, FNAAS
Director & Vice Chancellor

Phones : 011-2584 2367, 2584 3375
Fax : 011-2584 6420
E-mail : director@iari.res.in
Personal : aks_gene@yahoo.com
Website : www.iari.res.in

Foreword

It is a matter of pleasure to present the Yellow book, The Handbook of UG Course, Curriculum, IARI. This book will serve as a comprehensive guide for undergraduate students enrolled at The Graduate School, ICAR-Indian Agricultural Research Institute (ICAR-IARI). With a history dating back to 1905, Institute is recognized for its commitment to academic excellence and groundbreaking research contributions in agriculture. As the Director of this esteemed institution, I am delighted to introduce the ready reckoner resource book for our UG students enriching programmes of B.Sc. (Hons) Agriculture, B.Tech. Agricultural Engineering, B.Tech. Biotechnology and B.Sc. (Hons) Community Science, offered at The Graduate School, ICAR-IARI, New Delhi. It provides detailed insights into each programme's specific, semester-wise courses, and the intricacies of the examination patterns for the entire duration of the programme.

I encourage our Undergraduate students to regularly refer to the Handbook, embrace the transformative learning experience, and emerge as skilled professionals ready to make a lasting impact in the field of agricultural science and society.

My congratulations to Drs T K Das, Debasis Pattanyak, Rashmi Singh, D K Singh, Roaf Ahmad Parray and The Graduate School of ICAR-IARI for bringing out the document in a very short span of time. My special word of thanks to Dr Anupama Singh, Joint Director (Edu.) & Dean for her vision and guidance to the team assigned with the responsibility.

(AK Singh)

Date: February 9, 2024
Place: New Delhi

भा.कृ.अनु.प.-भारतीय कृषि अनुसंधान संस्थान
नई दिल्ली-110 012 (भारत)
ICAR - INDIAN AGRICULTURAL RESEARCH INSTITUTE
(A Deemed to be University Under Section 3 of UGC Act, 1956)
NEW DELHI-110 012 (India)

डॉ. अनुपमा सिंह
अधिष्ठाता एवं संयुक्त निदेशक (शिक्षा)
Dr. Anupama Singh
Dean & Joint Director (Edu.)

Preface

The present Undergraduate handbook of UG Course christened as Yellow Book contains all the details of course curriculum and assessment plans with examination policy for undergraduate degree requirements. A thorough listing of course curricula of all the UG programmes along with list of books has been updated in the light of the amendments approved by the Academic Council. It is hoped that this yellow book will prove worthy of providing relevant information to the students as well as to the faculty members and motivate young research scholars pursuing their studies, especially in agricultural sciences to strive towards excellence.

I place on record my sincere words of thanks to all stakeholders of IARI involved in bringing out this important publication.

Date: February 9, 2024
Place: New Delhi

(Anupama Singh)

List of Contents

1. INTRODUCTION

Welcome to the comprehensive guide for the Undergraduate Programmmes at ICAR- Indian Agricultural Research Institute (ICAR-IARI), where academic excellence meets a rich legacy of agricultural innovation. The Indian Agricultural Research Institute (ICAR-IARI) stands as India's largest and foremost Institute in the field of research, education and extension/training in agricultural sciences. It has served the cause of science and society with distinction through cutting edge research, generation of appropriate technologies and development of human resources. Originally founded at village Pusa in North Bihar in 1905 by the Government of India and relocated to New Delhi in 1936 after a devastating earthquake in 1934, ICAR-IARI has been a pivotal institution in shaping India's agricultural landscape.

Renowned for its pivotal role in the Green Revolution, ICAR-IARI has been at the forefront of ground-breaking research, contributing significantly to the development of high-yielding, biotic and abiotic stress-tolerant varieties and associated agricultural technologies. Its students constitute the core of the quality human resource in India's agricultural research, education and extension. The Institute's Central Library has a collection of over 6,00,000 documents, receives more than 5000 scientific serials annually from all over the world, and is regarded as the best agro-biological library in South Asia. The library has over 10500 serial files in 40 languages received from more than 90 countries, which form 30% of the total scientific serials available in the country. It has spacious reading halls and a documentation center. The main hub providing email-internet connectivity throughout the Institute is located in the library, which also offers CD-ROM facility and CeRA through the Local Area Network. The present campus of the Institute is a self-contained complex spread over an area of about 500 hectares.

The Institute offers a spectrum of educational degree programs including undergraduate courses like B.Sc.(Hons) Agriculture, B.Tech Agricultural Engineering, B.Tech Biotechnology and B.Sc. (Hons) Community Science. As a Deemed University under the University Grants Commission (UGC) Act of 1956, the Institute provides postgraduate education at the M.Sc., M.Tech., and Ph.D. levels. Additionally, it conducts specialized postgraduate training courses and is engaged in extension education and technology transfer in specific areas. Administratively, ICAR-IARI operates under the aegis of the Indian Council of Agricultural Research (ICAR), an autonomous organization established under the Societies Registration Act, 1860. Recognized for its excellence, the institute has received accreditation from NAEAB (National Accreditation Board) of ICAR and NAAC (National Assessment and Accreditation Council) of UGC. In the NIRF Rankings 2023, ICAR-IARI has achieved the top position in the agriculture and allied categories, affirming its status as a leading institution in the field of agricultural sciences in India. With a distinguished history of scientific contributions and societal impact, ICAR-IARI has been at the forefront of pioneering research, technology development, and human resource development and empowerment.

Aligned with the directives of the New Education Policy (NEP) 2020, ICAR-IARI proudly launched undergraduate degree programmes in four distinct disciplines from the academic year 2022-23. These disciplines include B.Sc. (Hons) Agriculture, B.Tech. Agricultural Engineering, B.Tech. Biotechnology,

and B.Sc. (Hons) Community Science, reflecting our commitment to shaping future leaders in agricultural sciences. In a strategic move, beginning from the session 2023-24, ICAR-IARI has expanded its academic footprint through inclusion of 12 Regional Academic Collaboration Centers. This network of clusters is designated as ICAR-IARI Hubs. Approved by the Academic Council in its 418th meeting, students for the UG programs are admitted through The Graduate School, ICAR-IARI into these hubs. Successful graduates from these regional hubs will receive degrees conferred by The Graduate School, ICAR-IARI during the Annual Convocation held every year in February.

This Yellow Book serves as a comprehensive guide, presenting detailed insights into the program specifics, semester-wise courses, syllabus details, and the intricacies of the course evaluation processes. It is designed to be undergraduate student companion, offering clarity on learning objectives, outcomes, and assessment methodologies. Whether the student is exploring Agriculture, Agricultural Engineering, Community Science, or Biotechnology, this guide serves as a roadmap to navigate his/her academic journey. As the students commence their educational voyage with ICAR-IARI, may this Yellow Book empower them to make informed decisions, traverse their academic pathways, and emerge as a skilled professional ready reckoner to excel in the ever-evolving realm of agriculture and allied sciences.

2. UNDERGRADUATE PROGRAMMES OFFERED

1. ICAR-IARI, New Delhi

ICAR-Indian Agricultural Research Institute, New Delhi	B.Sc. (Hons) Agriculture B.Tech. Agricultural Engineering B.Tech. Biotechnology B.Sc. (Hons) Community Science

2. Regional Academic Collaborators/Hubs

SN	Name of the hub	Name of Nodal Institute and Hub Coordinator	Satellite institutes in cluster	Programme Offered
1.	Hyderabad hub	CRIDA, Director CRIDA	IIRR, IIOR, IIMR, NAARM. DPR, NRC Meat, NBPGR RS, ATARI Total (8)	B.Sc. (Hons.) Agriculture
2.	Baramati hub	NIASM, Director NIASM	DOGR, DFR, NRCG, NRCP, IARI RS, IVRI RS, ATARI Total (7)	B.Sc. (Hons.) Agriculture
3.	Ranchi hub	IIAB, Director IIAB	NISA, RCER RS, NBPGR RS Total (3)	B. Tech. Biotechnology
4.	Cuttack hub	NRRI, Director NRRI	CIFA, IIWM, CIWA, ICFMD, IIHR RS, CTCRI RS, DPR RS, IIPR RS, NBPGR RS Total (9)	B.Sc. (Hons.) Agriculture
5.	Kolkata hub	CRIJAF, Director CRIJAF	NINFET, NBSS&LUP RS, ATARI, CSSRI RS, CIFA RS, KVK North 24 Parganas, KVK Burd-hwan, CIFRI, SRSJAF Total (9)	B.Sc. (Hons.) Agriculture
6.	Shillong hub	RCNEH-Shillong, Director RCNEH	Nil	B.Sc. (Hons.) Agriculture
7.	Lucknow hub	IISR, Director IISR	NBFGR, CSSRI RS, CISH Total (3)	B.Sc. (Hons.) Agriculture
8.	Karnal hub	IIWBR, Director IIWBR	NDRI, IARI RS, SBI RS, NBAGR Total (5)	B.Sc. (Hons.) Agriculture
9.	Raipur hub	NIBSM, Director NIBSM	Nil	B.Sc. (Hons.) Agriculture

10.	Patna hub	RCER-Patna, Director, RCER- Patna	CPRI RS, ATARI Total (2)	B.Sc. (Hons.) Agriculture
11.	Assam hub	IARI-Assam, Director IARI	Nil	B.Sc. (Hons.) Agriculture
12.	Jharkhand hub	IARI-Jharkhand, Director IARI	Nil	B.Sc. (Hons.) Agriculture

3. B.Sc. (Hons) Agriculture

The B.Sc. (Hons.) Agriculture programme curriculum has a total of 185 credit hours including 3 credit hours for remedial courses (Introductory Biology-2/Elemmentary Mathematics-2 and Agric. Heritage-1) and 7 non-credit hours (Human Values & Ethics -1, NSS/NCC/Physical Eduvation & Yoga Practices-4, Educational Tour-2). The curriculum covers almost all the disciplines of agriculture. There are overall 12 elective courses in B.Sc. (Hons.) Ag Programme and each student will have to opt any three (3) courses out of these 12 courses. Three elective courses each of 3 credit hours will be offered during 4th, 5th and 6th semesters of the B.Sc. Agriculture programme. The educational tour will be conducted in the Semester break between IV & V Semester or VI & VII Semester. The 7th semester of the programme is devoted completely for a well-structured Rural Agricultural Work Experience and Agro-industrial Attachment (RAWE &AIA) with 20 credit hours for 20 weeks. The students would be attached with the agro-industries for a period of 3 weeks out of 20 weeks in VII semester to get an experience of the industrial environment and working. The VIII semester is devoted for the modules for skill development and entrepreneurship. A student has to register 20 credit hours opting for any two modules of 10 (0+10) credits each out of 12 modules listed for the development of skill and knowledge on entrepreneurship.

Discipline-wise summary of credit hours

S. No.	Group	Credits Hours
1	Agronomy	21(10+11)
2	Genetics & Plant Breeding	13(7+6)
3	Soil Science & Agricultural Chemistry	8(6+2)
4	Entomology	9(6+3)
5	Agricultural Economics	10(7+3)
6	Agricultural Engineering	8(4+4)
7	Plant Pathology	13(9+4)
8	Horticulture	10(5+5)
9	Food Science	2(2+0)
10	Agricultural Extension	9(6+3)
11	Biochemistry/Physiology/Microbiology/ Environmental Sciences	12(7+5)
12	Statistics, Computer Application and I.P.R.	5(3+2)
13	Animal Production	4(3+1)
14	English	2 (1+1)
15	Remedial Courses	02 (Biol/ Math); 01 (Agriculture)
16	NSS/NCC/Physical Education & Yoga Practices	4(0+4)
17	Human Values and Ethics	1(1+0)
18	Educational Tour	2(0+2)
Total		**126+2(for Bio/Math) + 01(Agri. Heritage) + 7 NC** **126+2+1+7+9 Credits elective**
RAWE + ELP		**20+20**
Grand Total		**145+20+20=185**

NEW COURSES

S. No.	Course Title	Credit Hours
1.	Geoinformatics, Nanotechnology and Precision Farming	2(1+1)
2.	Rainfed Agriculture and Watershed Management	2(1+1)
3.	Problematic Soils and their Management	2(2+0)
4.	Renewable Energy and Green Technology	2(1+1)
5.	Management of Beneficial Insects	2(1+1)
6.	Fundamentals of Horticulture	2(1+1)
7.	Introduction to Forestry	2(1+1)
8.	Agri- Informatics	2(1+1)
9.	Intellectual Property Rights	1(1+0)
10.	Principles of Food Science & Technology	2(2+0)
11.	Communication Skills and Personality Development	2(1+1)
12.	Principles of Integrated Pest & Diseases Management	3(2+1)
13.	Agricultural Heritage	1(1+0)*
14.	Introductory Biology	2(1+1)*
15.	Elementary Mathematics	2(2+0)*
16.	Human Values & Ethics (NG)	1(1+0)**

* Remedial courses ** Non-gradial courses

Elective Courses: A student can select three elective courses out of the following and offer during 4th, 5th and 6th semesters

S. No.	Courses	Credit Hours
1	Agribusiness Management	3(2+1)
2	Agrochemicals	3(2+1)
3	Commercial Plant Breeding	3(1+2)
4	Landscaping	3(2+1)
5	Food Safety and Standards	3(2+1)
6	Biopesticides & Biofertilizers	3(2+1)
7	Protected Cultivation	3(2+1)
8	Micro propagation Technologies	3(1+2)
9	Hi-tech. Horticulture	3(2+1)
10	Weed Management	3(2+1)
11	System Simulation and Agro-advisory	3(2+1)
12	Agricultural Journalism	3(2+1)

Semester-wise distribution of courses

Semester I		
SN	**Course Title**	**Credit Hours**
1	Fundamentals of Horticulture	2(1+1)
2	Fundamentals of Plant Biochemistry and Biotechnology	3(2+1)
3	Fundamentals of Soil Science	3(2+1)
4	Introduction to Forestry	2(1+1)
5	Comprehension & Communication Skills in English	2(1+1)
6	Fundamentals of Agronomy	4(3+1)
7	Introductory Biology*/Elementary Mathematics*	2(1+1)/2(2+0)*
8	Agricultural Heritage*	1(1+0)*
9	Rural Sociology & Educational Psychology	2(2+0)
10	Human Values & Ethics (non gradial)	1(1+0)**
11	NSS/NCC/Physical Education & Yoga Practices**	1(0+1)**
Total ***R: Remedial course; **NC: Non-gradial courses**		**18+03*+02****
Semester II		
S. No.	**Course Title**	**Credit Hours**
1	Fundamentals of Genetics	3(2+1)
2	Agricultural Microbiology	2(1+1)
3	Soil and Water Conservation Engineering	2(1+1)
4	Fundamentals of Crop Physiology	2(1+1)
5	Fundamentals of Agricultural Economics	2(2+0)
6	Fundamentals of Plant Pathology	4(3+1)
7	Fundamentals of Entomology	4(3+1)
8	Fundamentals of Agricultural Extension Education	3(2+1)
9	Communication Skills and Personality Development	2(1+1)
10	NSS/NCC/Physical Education & Yoga Practices**	1(0+1)**
Total ****NC: Non-gradial courses**		**24(16+8)+01****
Semester III		
S. No.	**Course Title**	**Credit Hours**
1	Crop Production Technology – I *(Kharif Crops)*	2(1+1)
2	Fundamentals of Plant Breeding	3(2+1)
3	Agricultural Finance and Cooperation	3(2+1)
4	Agri- Informatics	2(1+1)
5	Farm Machinery and Power	2(1+1)
6	Production Technology for Vegetables and Spices	2(1+1)
7	Environmental Studies and Disaster Management	3(2+1)

8	Statistical Methods	2(1+1)
9	Livestock and Poultry Management	4(3+1)
10	NSS/NCC/Physical Education & Yoga Practices**	1(0+1)**
Total ****NC: Non-gradial courses**		**23(14+9)+01****
Semester IV		
S. No.	**Course Title**	**Credit Hours**
1	Crop Production Technology –II *(Rabi Crops)*	2(1+1)
2	Production Technology for Ornamental Crops, MAP and Landscaping	2(1+1)
3	Renewable Energy and Green Technology	2(1+1)
4	Problematic Soils and their Management	2(2+0)
5	Production Technology for Fruit and Plantation Crops	2(1+1)
6	Principles of Seed Technology	3(1+2)
7	Farming System & Sustainable Agriculture	1(1+0)
8	Agricultural Marketing Trade & Prices	3(2+1)
9	Introductory Agro-meteorology & Climate Change	2(1+1)
10	Elective Course	3 credit
11	NSS/NCC/Physical Education & Yoga Practices**	1(0+1)**
Total ****NC: Non-gradial courses**		**19(11+8)+01**+3 elective**
Semester V		
S. No.	**Course Title**	**Credit Hours**
1	Principles of Integrated Pest and Disease Management	3(2+1)
2	Manures, Fertilizers and Soil Fertility Management	3(2+1)
3	Pests of Crops and Stored Grain and their Management	3(2+1)
4	Diseases of Field and Horticultural Crops and their Management -I	3(2+1)
5	Crop Improvement-I *(Kharif Crops)*	2(1+1)
6	Entrepreneurship Development and Business Communication	2(1+1)
7	Geoinformatics and Nano-technology and Precision Farming	2(1+1)
8	Practical Crop Production – I (*Kharif* crops)	2(0+2)
9	Intellectual Property Rights	1(1+0)
10	Elective Course	3 credit
Total		**21(12+09)+3 elective**
Semester VI		
S. No.	**Course Title**	**Credit Hours**
1	Rainfed Agriculture & Watershed Management	2(1+1)
2	Protected Cultivation and Secondary Agriculture	2(1+1)
3	Diseases of Field and Horticultural Crops and their Management-II	3(2+1)
4	Post-harvest Management and Value Addition of Fruits and Vegetables	2(1+1)
5	Management of Beneficial Insects	2(1+1)

6	Crop Improvement-II *(Rabi crops)*	2(1+1)
7	Practical Crop Production –II (*Rabi* crops)	2(0+2)
8	Principles of Organic Farming	2(1+1)
9	Farm Management, Production & Resource Economics	2(1+1)
10	Principles of Food Science and Nutrition	2(2+0)
11	Elective Course	3 credits
Total		**21(11+10)+3 elective**

Semester VII			
No.	**Rural Agricultural Work Experience and Agro-industrial Attachment (RAWE &AIA)**		
	Activities	**No. of weeks**	**Credit Hours**
1	General orientation & On campus training by different faculties	1	14
2	Village attachment	8	
	Unit attachment in Univ./ College. KVK/ Research Station Attachment	5	
3	Plant clinic	2	02
	Agro-Industrial Attachment	3	04
4	Project Report Preparation, Presentation and Evaluation	1	
Total weeks for RAWE & AIA		**20**	**20**

Agro- Industrial Attachment: The students would be attached with the agro-industries for a period of 3 weeks to get an experience of the industrial environment and working**.**

- Educational tour will be conducted in break between Semester IV & V or Semester VI & VII

RAWE Component-I Village Attachment Training Programme

SN	Activity	Duration
1	Orientation and Survey of Village	1 week
2	Agronomical Interventions	1 week
3	Plant Protection Interventions	1 week
4	Soil Improvement Interventions (Soil sampling and testing)	1 week
5	Fruit and Vegetable production interventions	1 week
6	Food Processing and Storage interventions	1 week
7	Animal Production Interventions	1 week
8	Extension and Transfer of Technology activities	1 week

RAWE Component –II Agro Industrial Attachment

- Students shall be placed in Agro-and Cottage industries and Commodities Boards for 03 weeks.
- Industries include Seed/Sapling production, Pesticides-insecticides, Post harvest-processing- value addition, Agri-finance institutions, etc.

Activities and Tasks during Agro-Industrial Attachment Programme

- Acquaintance with industry and staff
- Study of structure, functioning, objective and mandates of the industry
- Study of various processing units and hands-on trainings under supervision of industry staff
- Ethics of industry
- Employment generated by the industry
- Contribution of the industry promoting environment
- Learning business network including outlets of the industry
- Skill development in all crucial tasks of the industry
- Documentation of the activities and task performed by the students
- Performance evaluation, appraisal and ranking of students

Modules for Skill Development and Entrepreneurship: A student has to register 20 credits opting for two modules of (0+10) credits each (total 20 credits) from the package of modules in the **Semester VIII.**

Semester VIII		
S. No.	**Title of the Module**	**Credits**
1	Production Technology for Bioagents and Biofertilizer	0+10
2	Seed Production and Technology	0+10
3	Mushroom Cultivation Technology	0+10
4	Soil, Plant, Water and Seed Testing	0+10
5	Commercial Beekeeping	0+10
6	Poultry Production Technology	0+10
7	Commercial Horticulture	0+10
8	Floriculture and Landscaping	0+10
9	Food Processing	0+10
10	Agriculture Waste Management	0+10
11	Organic Production Technology	0+10
12	Commercial Sericulture	0+10

NOTE: In addition to above ELP modules other important modules may be given to the students by SAUs

Evaluation of Experiential Learning Programme/ HOT

S. No.	**Parameters**	**Max. Marks**
1.	Project Planning and Writing	10
2.	Presentation	10
3.	Regularity	10
4.	Monthly Assessment	10
5.	Output delivery	10

6.	Technical Skill Development	10
7.	Entrepreneurship Skills	10
8.	Business networking skills	10
9.	Report Writing Skills	10
10.	Final Presentation	10
	Total	**100**

SYLLLABUS

1. AGRONOMY

1. Fundamentals of Agronomy 4(3+1)

Theory

Agronomy and its scope, seeds and sowing, tillage and tilth, crop density and geometry, Crop nutrition, manures and fertilizers, nutrient use efficiency, water resources, soil-plant-water relationship, crop water requirement, water use efficiency, irrigation- scheduling criteria and methods, quality of irrigation water, logging.

Weeds- importance, classification, crop weed competition, concepts of weed management- principles and methods, herbicides- classification, selectivity and resistance, allelopathy. Growth and development of crops, factors affecting growth and development, plant ideotypes, crop rotation and its principles, adaptation and distribution of crops, crop management technologies in problematic areas, harvesting and threshing of crops.

Practical

Identification of crops, seeds, fertilizers, pesticides and tillage implements, study of agro- climatic zones of India, Identification of weeds in crops, Methods of herbicide and fertilizer application, Study of yield contributing characters and yield estimation, Seed germination and viability test, Numerical exercises on fertilizer requirement, plant population, herbicides and water requirement, Use of tillage implements- reversible plough, one way plough, harrow, leveler, seed drill, Study of soil moisture measuring devices, Measurement of field capacity, bulk density and infiltration rate, Measurement of irrigation water.

Suggested Readings:

1. Reddy, Y.T. and Reddy, S.G.H. 2016. Principles of Agronomy. Kalyani Publishers.
2. Reddy, S. R. 2018. Principles of Agronomy. Kalyani Publishers.
3. Reddy, S.R. and Nagamani, C. 2019. Principles of Crop Production. Kalyani Publishers.
4. ICAR 2012. Hand Book of Agriculture. ICAR, New Delhi.

2. Introductory Agrometeorology & Climate Change 2(1+1)

Theory

Meaning and scope of agricultural meteorology; Earth atmosphere- its composition, extent and structure; Atmospheric weather variables; Atmospheric pressure, its variation with height; Wind, types of wind, daily and seasonal variation of wind speed, cyclone, anticyclone, land breeze and sea breeze; Nature and properties of solar radiation, solar constant, depletion of solar radiation, short wave, longwave and thermal

radiation, net radiation, albedo; Atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature, Energy balance of earth; Atmospheric humidity, concept of saturation, vapor pressure, process of condensation, formation of dew, fog, mist, frost, cloud; Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet, and hail, cloud formation and classification; Artificial rainmaking. Monsoon- mechanism and importance in Indian agriculture, Weather hazards - drought, floods, frost, tropical cyclones and extreme weather conditions such as heat-wave and cold-wave. Agriculture and weather relations; Modifications of crop microclimate, climatic normals for crop and livestock production. Weather forecasting- types of weather forecast and their uses. Climate change, climatic variability, global warming, causes of climate change and its impact on regional and national Agriculture.

Practical

Visit of Agrometeorological Observatory, site selection of observatory, exposure of instruments and weather data recording. Measurement of total, shortwave and longwave radiation, and its estimation using Planck's intensity law. Measurement of albedo and sunshine duration, computation of Radiation Intensity using BSS. Measurement of maximum and minimum air temperatures, its tabulation, trend and variation analysis. Measurement of soil temperature and computation of soil heat flux. Determination of vapor pressure and relative humidity. Determination of dew point temperature. Measurement of atmospheric pressure and analysis of atmospheric conditions. Measurement of wind speed and wind direction, preparation of wind rose. Measurement, tabulation and analysis of rain. Measurement of open pan evaporation and evapotranspiration. Computation of PET and AET.

Suggested Readings:

1. HS Mavi. 2019. Introduction to Agrometeorology, 2nd Edition, CBS Publishers & Distributors.
2. Reddy, S.R. and Reddy, D.S. 2007. Agrometeorology. Kalyani Publishers.
3. Mahi and Kingra. 2014. Fundamentals of agrometeorology. Kalyani publishers.
4. Mavi HS and Tupper. 2004. Principles and applications of climate studies in agriculture. CRC Press
5. Varshneya MC and Pillai PB. 2003. Text Book of Agricultural Meteorology. ICAR.

3. Crop Production Technology-I (*Kharif* Crops) 2(1+1)

Theory

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Kharif* crops. Cereals – rice, maize, sorghum, pearl millet and finger millet, pulses- pigeonpea, mungbean and urdbean; oilseeds- groundnut, and soybean; fibre crops- cotton & jute; forage crops-sorghum, cowpea, cluster bean and napier.

Practical

Rice nursery preparation, transplanting of rice, sowing of soybean, pigeonpea and mungbean. maize, groundnut and cotton, effect of seed size on germination and seedling vigour of *kharif* season crops, effect of sowing depth on germination of *kharif* crops, identification of weeds in *kharif* season crops, top dressing

and foliar feeding of nutrients, study of yield contributing characters and yield calculation of *kharif* season crops, study of crop varieties and important agronomic experiments at experimental farm. study of forage experiments, morphological description of *kharif* season crops, visit to research centres of related crops.

Suggested readings:

1. Rajendra Prasad 2012. Textbook of Field Crop Production – Foodgrain Crops Volume I, DKMA, ICAR-KAB I, Pusa, New Delhi.
2. Rajendra Prasad 2012. Textbook of Field Crop Production – Commercial Crops Volume II, DKMA, ICAR-KAB I, Pusa, New Delhi.
3. Singh, C., Singh, P. and Singh, R. 2003. Modern Techniques of Raising Field Crops. Oxford & IBH Publishers Co. Pvt. Ltd.

4. Crop Production Technology-II (*Rabi* crops) 2(1+1)

Theory

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Rabi* crops; cereals –wheat and barley, pulses-chickpea, lentil, peas, oilseeds-rapeseed, mustard and sunflower; sugar crops-sugarcane; medicinal and aromatic crops-mentha, lemon grass and citronella, Forage crops-berseem, lucerne and oat.

Practical

Sowing methods of wheat and sugarcane, identification of weeds in *rabi* season crops, study of morphological characteristics of *rabi* crops, study of yield contributing characters of *rabi* season crops, yield and juice quality analysis of sugarcane, study of important agronomic experiments of *rabi* crops at experimental farms. Study of *rabi* forage experiments, oil extraction of medicinal crops, visit to research stations of related crops.

Suggested readings:

1. Rajendra Prasad 2012. Textbook of Field Crop Production – Foodgrain Crops Volume I, DKMA, ICAR-KAB I, Pusa, New Delhi.
2. Rajendra Prasad 2012. Textbook of Field Crop Production – Commercial Crops Volume II, DKMA, ICAR-KAB I, Pusa, New Delhi.
3. Singh, C., Singh, P. and Singh, R. 2003. Modern Techniques of Raising Field Crops. Oxford & IBH Publishers Co. Pvt. Ltd.

5. Farming System and Sustainable Agriculture 1(1+0)

Theory

Farming System-scope, importance, and concept, Types and systems of farming system and factors affecting types of farming, Farming system components and their maintenance, Cropping system and pattern, multiple cropping system, Efficient cropping system and their evaluation, Allied enterprises and their importance, Tools for determining production and efficiencies in cropping and farming system; Sustainable agriculture-problems and its impact on agriculture, indicators of sustainability, adaptation and mitigation, conservation

agriculture strategies in agriculture, HEIA, LEIA and LEISA and its techniques for sustainability, Integrated farming system-historical background, objectives and characteristics, components of IFS and its advantages, Site specific development of IFS model for different agro-climatic zones, resource use efficiency and optimization techniques, Resource cycling and flow of energy in different farming system, farming system and environment, Visit of IFS model in different agro-climatic zones of nearby states University/ institutes and farmers field.

Suggested Readings:

1. Reddy, S. R. 2016. Farming System and Sustainable Agriculture. Kalyani Publishers.
2. Panda, S.C. 2023. Cropping And Farming Systems. AGROBIOS.
3. Behera, U.K. 2014. A Textbook of Farming Systems. Agrotech Publishing Academy.

6. Practical Crop Production-I *(Kharif Crops)* 2(0+2)

Practical

Crop planning, raising field crops in multiple cropping systems: Field preparation, seed, treatment, nursery raising, sowing, nutrient, water and weed management and management of insect-pests diseases of crops, harvesting, threshing, drying winnowing, storage and marketing of produce. The emphasis will be given to seed production, mechanization, resource conservation and integrated nutrient, insect-pest and disease management technologies. Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of 8-10 students.

Suggested readings:

1. Rajendra Prasad 2012. Textbook of Field Crop Production – Foodgrain Crops Volume I, DKMA, ICAR-KAB I, Pusa, New Delhi.
2. Rajendra Prasad 2012. Textbook of Field Crop Production – Commercial Crops Volume II, DKMA, ICAR-KAB I, Pusa, New Delhi.
3. Singh, C., Singh, P. and Singh, R. 2003. Modern Techniques of Raising Field Crops. Oxford & IBH Publishers Co. Pvt. Ltd.

7. Practical Crop Production-II *(Rabi Crops)* 2(0+2)

Practical

Crop planning, raising field crops in multiple cropping systems: Field preparation, seed, treatment, nursery raising, sowing, nutrient, water and weed management and management of insect-pests diseases of crops, harvesting, threshing, drying winnowing, storage and marketing of produce. The emphasis will be given to seed production, mechanization, resource conservation and integrated nutrient, insect-pest and disease management technologies. Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of 8-10 students.

Suggested readings:

1. Rajendra Prasad 2012. Textbook of Field Crop Production – Foodgrain Crops Volume I, DKMA, ICAR-KAB I, Pusa, New Delhi.

2. Rajendra Prasad 2012. Textbook of Field Crop Production – Commercial Crops Volume II, DKMA, ICAR-KAB I, Pusa, New Delhi.
3. Singh, C., Singh, P. and Singh, R. 2003. Modern Techniques of Raising Field Crops. Oxford & IBH Publishers Co. Pvt. Ltd.

8. Principles of Organic Farming 2(1+1)

Theory

Organic farming, principles and its scope in India; Initiatives taken by Government (central/ state), NGOs and other organizations for promotion of organic agriculture; Organic ecosystem and their concepts; Organic nutrient resources and its fortification; Restrictions to nutrient use in organic farming; Choice of crops and varieties in organic farming; Fundamentals of insect, pest, disease and weed management under organic mode of production; Operational structure of NPOP; Certification process and standards of organic farming; Processing, leveling, economic considerations and viability, marketing and export potential of organic products.

Practical

Visit of organic farms to study the various components and their utilization; Preparation of enrich compost, vermicompost, bio-fertilizers/bio-inoculants and their quality analysis; Indigenous technology knowledge (ITK) for nutrient, insect, pest disease and weed management; Cost of organic production system; Post harvest management; Quality aspect, grading, packaging and handling.

Suggested Readings:

1. Reddy, S. R. 2017. Principles of Organic Farming. Kalyani Publishers.
2. Panda, S.C. 2011. Organic Farming for Sustainable Agriculture. Kalyani Publishers.
3. Palaniappan, S.P. and Annadurai, K. 2004. Organic Farming: Theory and Practice. Scientific Publishers.

9. Geoinformatics, Nano-technology and Precision Farming 2(1+1)

Theory

Precision agriculture: concepts and techniques; their issues and concerns for Indian agriculture; Geo-informatics- definition, concepts, tool and techniques; their use in Precision Agriculture. Crop discrimination and Yield monitoring, soil mapping; fertilizer recommendation using geospatial technologies; Spatial data and their management in GIS; Remote sensing concepts and application in agriculture; Image processing and interpretation; Global positioning system (GPS), components and its functions; Introduction to crop Simulation Models and their uses for optimization of Agricultural Inputs; STCR approach for precision agriculture; Nanotechnology, definition, concepts and techniques, brief introduction about nanoscale effects, nano-particles, nano-pesticides, nano-fertilizers, nano-sensors, Use of nanotechnology in seed, water, fertilizer, plant protection for scaling-up farm productivity.

Practical

Introduction to GIS software, spatial data creation and editing. Introduction to image processing software. Visual and digital interpretation of remote sensing images. Generation of spectral profiles of different

objects. Supervised and unsupervised classification and acreage estimation. Multispectral remote sensing for soil mapping. Creation of thematic layers of soil fertility based on GIS. Creation of productivity and management zones. Fertilizers recommendations based of VRT and STCR techniques. Crop stress (biotic/abiotic) monitoring using geospatial technology. Use of GPS for agricultural survey. Formulation, characterization and applications of nanoparticles in agriculture. Projects formulation and execution related to precision farming.

Suggested Readings:

1. Kumar, P., Patil, V., Kalpana D., Wale, B. and Vishal D. Precision Farming and Geoinformatics. Daya Publishing House. New Delhi.
2. Reddy S.R. 2017. Geoinformatics and Nanotechnology for Precision Farming. Kalyani Publishers.
3. Lillesand TM and Kiefer RW. 1994. Remote Sensing and Image Interpretation. 3rd Ed. Wiley.
4. Nielsen DR and Wendroth O. 2003. Spatial and Temporal Statistics. Catena Verloggmbh.
5. Star J and Esles J. 1990. Geographic Information System: An Introduction. Prentice Hall.

10. Rainfed Agriculture and Watershed Management – (New) 2(1+1)

Theory

Rainfed agriculture: Introduction, types, History of rainfed agriculture and watershed in India; Problems and prospects of rainfed agriculture in India ; Soil and climatic conditions prevalent in rainfed areas; Soil and water conservation techniques, Drought: types, effect of water deficit on physio-morphological characteristics of the plants, Crop adaptation and mitigation to drought; Water harvesting: importance, its techniques, Efficient utilization of water through soil and crop management practices,Management of crops in rainfed areas, Contingent crop planning for aberrant weather conditions, Concept, objective, principles and components of watershed management, factors affecting watershed management.

Practical

Studies on climate classification, studies on rainfall pattern in rainfed areas of the country and pattern of onset and withdrawal of monsoons. Studies on cropping pattern of different rainfed areas in the country and demarcation of rainfed area on map of India. Interpretation of meteorological data and scheduling of supplemental irrigation on the basis of evapo-transpiration demand of crops. Critical analysis of rainfall and possible drought period in the country, effective rainfall and its calculation. Studies on cultural practices for mitigating moisture stress. Characterization and delineation of model watershed. Field demonstration on soil & moisture conservation measures. Field demonstration on construction of water harvesting structures. Visit to rainfed research station/watershed**.**

Suggested Readings:

1. Reddy, S.R. and Reddy, G.P. 2018. Dryland Agriculture. Kalyani Publishers.
2. Reddy TY. 2018. Dryland Agriculture Principles and Practices, Kalyani publishers
3. Das NR. 2007. Tillage and Crop Production. Scientific Publ.
4. Reddy, S. R. 2018. Principles of Agronomy. Kalyani Publishers.
5. Reddy, S.R. and Nagamani, C. 2019. Principles of Crop Production. Kalyani Publishers.

II. GENETICS AND PLANT BREEDING

1. Fundamentals of Genetics 3(2+1)

Theory

Pre and Post Mendelian concepts of heredity, Mendelian principles of heredity. Architecture of chromosome; chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; special types of chromosomes. Chromosomal theory of inheritance- cell cycle and cell division- mitosis and meiosis. Probability and Chi-square. Dominance relationships, Epistatic interactions with example.

Multiple alleles, pleiotropism and pseudoalleles, Sex determination and sex linkage, sex limited and sex influenced traits, Blood group genetics, Linkage and its estimation, crossing over mechanisms, chromosome mapping. Structural and numerical variations in chromosome and their implications, Use of haploids, dihaploids and doubled haploids in Genetics. Mutation, classification, Methods of inducing mutations & CIB technique, mutagenic agents and induction of mutation. Qualitative & Quantitative traits, Polygenes and continuous variations, multiple factor hypothesis, Cytoplasmic inheritance. Genetic disorders. Nature, structure & replication of genetic material. Protein synthesis, Transcription and translational mechanism of genetic material, Gene concept: Gene structure, function and regulation, Lac and Trp operons.

Practical

Study of microscope. Study of cell structure. Mitosis and Meiosis cell division. Experiments on monohybrid, dihybrid, trihybrid, test cross and back cross, Experiments on epistatic interactions including test cross and back cross, Practice on mitotic and meiotic cell division, Experiments on probability and Chi-square test. Determination of linkage and cross-over analysis (through two point test cross and three point test cross data). Study on sex linked inheritance in Drosophila. Study of models on DNA and RNA structures.

Suggested Readings:

1. B.D. Singh. 2023. Fundamental of Genetics. Med Tech Science Press.
2. P.K. Gupta. 2022. Genetics. Rastogi Publishers.
3. Phundan Singh. 2020. Genetics. Kalyani Publishers.

2. Principles of Seed Technology 3(1+2)

Theory

Seed and seed technology: introduction, definition and importance. Deterioration causes of crop varieties and their control; Maintenance of genetic purity during seed production, seed quality; Definition, Characters of good quality seed, different classes of seed. Foundation and certified seed production of important cereals, pulses, oilseeds, fodder and vegetables. Seed certification, phases of certification, procedure for seed certification, field inspection. Seed Act and Seed Act enforcement. Duty and powers of seed inspector, offences and penalties. Seeds Control Order 1983, Varietal Identification through Grow Out Test and Electrophoresis, Molecular and Biochemical test. Detection of genetically modified crops, Transgene contamination in non-GM crops, GM crops and organic seed production. Seed drying, processing and their steps, seed testing for quality assessment, seed treatment, its importance, method of application and seed packing. Seed storage; general principles, stages and factors affecting seed longevity during storage.

Measures for pest and disease control during storage. Seed marketing: structure and organization, sales generation activities, promotional media. Factors affecting seed marketing, Role of WTO and OECD in seed marketing. Private and public sectors and their production and marketing strategies.

Practical

Seed production in major cereals: Wheat, Rice, Maize, Sorghum, Bajra and Ragi. Seed production in major pulses: Urd, Mung, Pigeonpea, Lentil, Gram, Field bean, pea. Seed production in major oilseeds: Soybean, Sunflower, Rapeseed, Groundnut and Mustard. Seed production in important vegetable crops. Seed sampling and testing: Physical purity, germination, viability, etc. Seed and seedling vigour test. Genetic purity test: Grow out test and electrophoresis. Seed certification: Procedure, Field inspection, Preparation of field inspection report. Visit to seed production farms, seed testing laboratories and seed processing plant.

Suggested Readings:

1. Rattan Lal Agarwal. Seed Technology.
2. Agrawal, P.K. 2010. Principles of Seed Technology. ICAR.
3. L.O. Copeland and M.B. McDonald. Principles of Seed Science and Technology.

3. Fundamentals of Plant Breeding 3(2+1)

Theory

Historical development, concept, nature and role of plant breeding, major achievements and future prospects; Genetics in relation to plant breeding, modes of reproductionandapomixes, self-incompatibility andmalesterility- geneticconsequences, cultivar options. Domestication, Acclimatization and Introduction; Centres of origin/ diversity, components of Genetic variation; Heritability and genetic advance; Genetic basis and breeding methods in self- pollinated crops - mass and pure line selection, hybridization techniques and handling of segregating population; Multiline concept. Concepts of population genetics and Hardy-Weinberg Law, Genetic basis and methods of breeding cross pollinated crops, modes of selection; Population improvement Schemes- Ear to row method, Modified Ear to Row, recurrent selection schemes; Heterosis and inbreeding depression, development of inbred lines and hybrids, composite and synthetic varieties; Breeding methods in asexually propagated crops, clonal selection and hybridization; Maintenance of breeding records and data collection; Wide hybridization and pre- breeding; Polyploidy in relation to plant breeding, mutation breeding-methods and uses; Breeding for important biotic and abiotic stresses; Biotechnological tools-DNA markers and marker assisted selection. Participatory plant breeding; Intellectual Property Rights, Patenting, Plant Breeders and & Farmer's Rights.

Practical

Plant Breeder's kit, Study of germplasm of various crops. Study of floral structure of self-pollinated and cross-pollinated crops. Emasculation and hybridization techniques in self- & cross-pollinated crops. Consequences of inbreeding on genetic structure of resulting populations. Study of male sterility system. Handling of segregationpopulations. Methods of calculating mean, range, variance, standard deviation, heritability. Designs used in plant breeding experiments, analysis of Randomized Block Design. To work out the mode of pollination in a given crop and extent of natural out-crossing. Prediction of performance of double cross hybrids.

Suggested Readings:

1. B.D. Singh. 2022. Plant Breeding: Principles and Methods. Med Tech Science Press.
2. Phundan Singh. 2014. Essentials of Plant Breeding. Kalyani Publishers.
3. B. D. Singh. 2018. Plant breeding: principles and methods. Kalyani Publisher.
4. B.D. Singh and A. K. Singh. 2016. Marker assisted plant breeding: principles and practices. Springer, New Delhi.

4. Crop Improvement – I (*Kharif*) 2(1+1)

Theory

Centers of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; fibres; fodders and cash crops; vegetable and horticultural crops; Plant genetic resources, its utilization and conservation, study of genetics of qualitative and quantitative characters; Important concepts of breeding self pollinated, cross pollinated and vegetatively propagated crops; Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Hybrid seed production technology in Maize, Rice, Sorghum, Pearl millet and Pigeonpea, etc. Ideotype concept and climate resilient crop varieties for future.

Practical

Floral biology, emasculation and hybridization techniques in different crop species; viz., Rice, Jute, Maize, Sorghum, Pearl millet, Ragi, Pigeonpea, Urdbean, Mungbean, Soybean, Groundnut, Seasame, Caster, Cotton, Cowpea, Tobacco, Brinjal, Okra and Cucurbitaceous crops. Maintenance breeding of different *kharif* crops. Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods; Study of field techniques for seed production and hybrid seeds production in *Kharif* crops; Estimation of heterosis, inbreeding depression and heritability; Layout of field experiments; Study of quality characters, donor parents for different characters; Visit to seed production plots; Visit to AICRP plots of different field crops.

Suggested Readings:

1. Phundan Singh. 2014. Essentials of Plant Breeding. Kalyani Publishers.
2. B. D. Singh. 2018. Plant breeding: Principles and Methods. Kalyani Publisher.
3. Ali, J. and Wani, S. H. 2021. Rice Improvement: Physiological, Molecular Breeding and Genetic Perspectives. Springers.

5. Crop Improvement – II (*Rabi*) 2(1+1)

Theory

Centers of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; fodder crops and cash crops; vegetable and horticultural crops; Plant genetic resources, its utilization and conservation; study of genetics of qualitative and quantitative characters; Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for

yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Hybrid seed production technology of *rabi* crops. Ideotype concept and climate resilient crop varieties for future.

Practical

Floral biology, emasculation and hybridization techniques in different crop species namely Wheat, Oat, Barley, Chickpea, Lentil, Field pea, Rajma, Horse gram, Rapeseed Mustard, Sunflower, Safflower, Potato, Berseem. Sugarcane, Tomato, Chilli, Onion; Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods; Study of field techniques for seed production and hybrid seeds production in *Rabi* crops; Estimation of heterosis, inbreeding depression and heritability; Layout of field experiments; Study of quality characters, study of donor parents for different characters; Visit to seed production plots; Visit to AICRP plots of different field crops

Suggested Readings:

1. Phundan Singh. 2014. Essentials of Plant Breeding. Kalyani Publishers.
2. B. D. Singh. 2018. Plant breeding: Principles and Methods. Kalyani Publisher.
3. Wuletaw, T. M. S., Sawsan, A. T., Samira, E., Paula, S., Adil, E., Kenza, E., Khaled, E., Sherif, T., Solomon, G. A. and Michael, B. 2019. Wheat Breeding Handbook at ICARDA. ICARDA.

III. SOIL SCIENCE & AGRICULTURAL CHEMISTRY

1. Fundamentals of Soil Science 3(2+1)

Theory

Soil as a natural body, Pedological and edaphological concepts of soil; Soil genesis: soil forming rocks and minerals; weathering, processes and factors of soil formation; Soil Profile, components of soil; Soil physical properties: soil-texture, structure, density and porosity, soil colour, consistence and plasticity; Elementary knowledge of soil taxonomy classification and soils of India; Soil water retention, movement and availability; Soil air, composition, gaseous exchange, problem and plant growth, Soil temperature; source, amount and flow of heat in soil; effect on plant growth, Soil reaction-pH, soil acidity and alkalinity, buffering, effect of pH on nutrient availability; soil colloids inorganic and organic; silicate clays: constitution and properties; sources of charge; ion exchange, cation exchange capacity, base saturation; soil organic matter: composition, properties and its influence on soil properties; humic substances - nature and properties; soil organisms: macro and micro organisms, their beneficial and harmful effects; Soil pollution - behaviour of pesticides and inorganic contaminants, prevention and mitigation of soil pollution.

Practical

Study of soil profile in field. Study of soil sampling tools, collection of representative soil sample, its processing and storage. Study of soil forming rocks and minerals. Determination of soil density, moisture content and porosity. Determination of soil texture by feel and Bouyoucos Methods. Studies of capillary rise phenomenon of water in soil column and water movement in soil. Determination of soil pH and electrical conductivity. Determination of cation exchange capacity of soil. Study of soil map. Determination of soil colour. Demonstration of heat transfer in soil. Estimation of organic matter content of soil.

Suggested Readings:

1. Raymond R. Weil and Nyle C. Brady. 2022. The Nature and Properties of Soils, 15th edition. Pearson Education.
2. ISSS. 2012. Fundamentals of Soil Science. ISSS New Delhi.
3. Das, D.K. 2020. Introductory Soil Science. Kalyani Publishers.
4. T.D. Biswas and S.K. Mukherjee. 2017. Text Book of Soil Science, 2nd Edn. McGraw Hill.
5. Goswami, N.N., Rattan, R.K., Dev, G., Narayanasamy, G., Das, D.K., Sanyal, S.K., Pal, D.K. and Rao, D.L.N. 2009. Fundamentals of Soil Science. Second Edn. Indian Society of Soil Science, New Delhi.

2. Manures, Fertilizers and Soil Fertility Management 3(2+1)

Theory

Introduction and importance of organic manures, properties and methods of preparation of bulky and concentrated manures. Green/leaf manuring. Fertilizer recommendation approaches. Integrated nutrient management.

Chemical fertilizers: classification, composition and properties of major nitrogenous, phosphatic, potassic fertilizers, secondary & micronutrient fertilizers, Complex fertilizers, nano fertilizers Soil amendments, Fertilizer Storage, Fertilizer Control Order. History of soil fertility and plant nutrition. criteria of essentiality. role, deficiency and toxicity symptoms of essential plant nutrients, Mechanisms of nutrient transport to plants, factors affecting nutrient availability to plants. Chemistry of soil nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and micronutrients. Soil fertility evaluation, Soil testing. Critical levels of different nutrients in soil. Forms of nutrients in soil, plant analysis, rapid plant tissue tests. Indicator plants. Methods of fertilizer recommendations to crops. Factor influencing nutrient use efficiency (NUE), methods of application under rainfed and irrigated conditions.

Practical

Introduction of analytical instruments and their principles, calibration and applications, Colorimetry and flame photometry. Estimation of soil organic carbon, Estimation of alkaline hydrolysable N in soils. Estimation of soil extractable P in soils. Estimation of exchangeable K; Ca and Mg in soils . Estimation of soil extractable S in soils.. Estimation of DTPA extractable Zn in soils. Estimation of N in plants. Estimation of P in plants. Estimation of K in plants. Estimation of S in plants.

Suggested Readings:

1. K.S. Yawalkar, J.P. Agarwal, S. Bokde. 2012. Manures and Fertilisers, 12th Edition. Jain Publisher.
2. Havlin, J. L., Tisdale, S. L., Nelson, W. L. and Beaton, J. D. 2016. Soil Fertility and Fertilizers. Pearson Publishers.
3. ISSS. 2012. Fundamentals of Soil Science. ISSS New Delhi.

3. Problematic Soils and their Management (New) 2(2+0)

Theory

Soil quality and health, Distribution of Waste land and problem soils in India. Their categorization based on properties. Reclamation and management of Saline and sodic soils, Acid soils, Acid Sulphate soils, Eroded and Compacted soils, Flooded soils, Polluted soils.

Irrigation water – quality and standards, utilization of saline water in agriculture. Remote sensing and GIS in diagnosis and management of problem soils.

Multipurpose tree species, bio remediation through MPTs of soils, land capability and classification, land suitability classification. Problematic soils under different Agro-ecosystems.

Suggested Readings:

1. ISSS. 2012. Fundamentals of Soil Science. ISSS New Delhi.
2. Das, D.K. 2020. Introductory Soil Science. Kalyani Publishers.
3. Bear FE. 1964. Chemistry of the Soil. Oxford & IBH.
4. Jurinak JJ. 1978. Salt-affected Soils. Department of Soil Science & Biometeorology. Utah State University
5. USDA Handbook No. 60. 1954. Diagnosis and improvement of Saline and Alkali Soils. Oxford & IBH.

IV. ENTOMOLOGY

1. Fundamentals of Entomology 4(3+1)

Theory

Part– I

History of Entomology in India. Major points related to dominance of Insecta in Animal kingdom. Classification of phylum Arthropoda upto classes. Relationship of class Insecta with other classes of Arthropoda. Morphology: Structure and functions of insect cuticle and molting. Body segmentation. Structure of Head, thorax and abdomen. Structure and modifications of insect antennae, mouth parts, legs, Wing venation, modifications and wing coupling apparatus. Structure of male and female genital organ. Metamorphosis and diapause in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretary (Endocrine) and reproductive system, in insects. Types of reproduction in insects. Major sensory organs like simple and compound eyes, chemoreceptor.

Part-II

Insect Ecology: Introduction, Environment and its components. Effect of abiotic factors– temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents. Effect of biotic factors – food competition, natural and environmental resistance.

Part III

Categories of pests. Concept of IPM, Practices, scope and limitations of IPM. Classification of insecticides, toxicity of insecticides and formulations of insecticides. Chemical control- importance, hazards and

limitations. Recent methods of pest control, repellents, anti feed ants, hormones, attractants, gamma radiation. Insecticides Act 1968- Important provisions. Application techniques of spray fluids. Symptoms of poisoning, first aid and antidotes.

Part – IV

Systematics: Taxonomy –importance, history and development and binomial nomenclature. Definitions of Biotype, Sub-species, Species, Genus, Family and Order. Classification of class Insecta upto Orders, basic groups of present day insects with special emphasis to orders and families of Agricultural importance like Orthoptera: Acrididae, Tettigonidae, Gryllidae, Gryllotalpidae; Dictyoptera: Mantidae, Blattidae; Odonata; Isoptera: Termitidae; Thysanoptera:

Thripidae; Hemiptera: Pentatomidae, Coreidae, Cimicidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Lophophidae, Aleurodidae, Pseudococcidae; Neuroptera: Chrysopidae; Lepidoptera: Pieridae, Papiloinidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Saturnidae, Bombycidae; Coleoptera: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae; Hymenoptera: Tenthridinidae, Apidae. Trichogrammatidae, lchneumonidae, Braconidae, Chalcididae; Diptera: Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae,Muscidae, Tephritidae.

Practical

Methods of collection and preservation of insects including immature stages; External features of Grasshopper/Blister beetle; Types of insect antennae, mouthparts and legs; Wing venation, types of wings and wing coupling apparatus. Types of insect larvae and pupae; Dissection of digestive system in insects (Grasshopper); Dissection of male and female reproductive systems in insects (Grasshopper); Study of characters of orders Orthoptera, Dictyoptera, Odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera and their families of agricultural importance. Insecticides and their formulations. Pesticide appliances and their maintenance. Sampling techniques for estimation of insect population and damage.

Suggested Readings:

1. Ragumoorthi, K.N., Balasubramani, V. and Srinivasan M.R. 2017. Insecta An Introducation. A. E. Publications.
2. Ragumoorthi, K.N., Srinivasan M.R. and Balasubramani, V. 2012. Principles of Applied Entomology. A. E. Publications.
3. ICAR 2001: Handbook of Horticulture, ICAR New Delhi.

2. Pests of Crops and Stored Grains and their Management 3(2+1)

Theory

General account on nature and type of damage by different arthropods pests. Scientific name, order, family, host range, distribution, biology and bionomics, nature of damage, and management of major pests and scientific name, order, family, host range, distribution, nature of damage and control practice other important arthropod pests of various field crop, vegetable crop, fruit crop, plantation crops, ornamental crops, spices and condiments. Factors affecting losses of stored grain and role of physical, biological, mechanical and

chemical factors in deterioration of grain. Insect pests, mites, rodents, birds and microorganisms associated with stored grain and their management. Storage structure and methods of grain storage and fundamental principles of grain store management.

Practical

Identification of different types of damage. Identification and study of life cycle and seasonal history of various insect pests attacking crops and their produce: (a) Field Crops; (b) Vegetable Crops; (c) Fruit Crops; (d) Plantation, gardens, Narcotics, spices & condiments. Identification of insect pests and Mites associated with stored grain. Determination of insect infestation by different methods. Assessment of losses due to insects. Calculations on the doses of insecticides application technique. Fumigation of grain store / godown. Identification of rodents and rodent control operations in godowns. Identification of birds and bird control operations in godowns. Determination of moisture content of grain. Methods of grain sampling under storage condition. Visit to Indian Storage Management and Research Institute, Hapur and Quality Laboratory, Department of Food., Delhi. Visit to nearest FCI godowns.

Suggested Readings:

1. B Vasanthraj David and V.V. Ramamurthy. Elements of Economic Entomology.
2. G. S. Dhaliwal and Ramesh Arora. An Introduction to Integrated Pest Management.
3. Ragumoorthi, K.N., Srinivasan M.R. and Balasubramani, V. 2012. Principles of Applied Entomology. A. E. Publications.

3. Management of Beneficial Insects 2(1+1)

Theory

Importance of beneficial Insects, Beekeeping and pollinators, bee biology, commercial methods of rearing, equipment used, seasonal management, bee enemies and disease. Bee pasturage, bee foraging and communication. Insect pests and diseases of honey bee. Role of pollinators in cross pollinated plants.

Types of silkworm, voltinism and biology of silkworm. Mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves. Rearing, mounting and harvesting of cocoons. Pest and diseases of silkworm, management, rearing appliances of mulberry silkworm and methods of disinfection.

Species of lac insect, morphology, biology, host plant, lac production – seed lac, button lac, shellac, lac-products. Identification of major parasitoids and predators commonly being used in biological control.

Insect orders bearing predators and parasitoids used in pest control and their mass multiplication techniques. Important species of pollinator, weed killers and scavengers with their importance.

Practical

Honey bee species, castes of bees. Beekeeping appliances and seasonal management, bee enemies and disease. Bee pasturage, bee foraging and communication. Types of silkworm, voltinism and biology of silkworm. Mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves. Species of lac insect, host plant identification. Identification of other important pollinators, weed killers and scavengers. Visit to research and training institutions devoted to beekeeping, sericulture, lac culture and natural enemies. Identification and techniques for mass multiplication of natural enemies.

Suggested Readings:

1. B Vasanthraj David and V.V. Ramamurthy. Elements of Economic Entomology.
2. G. S. Dhaliwal and Ramesh Arora. An Introduction to Integrated Pest Management.
3. Ragumoorthi, K.N., Srinivasan M.R. and Balasubramani, V. 2012. Principles of Applied Entomology. A. E. Publications.

V. AGRICULTURAL ECONOMICS

1. Fundamentals of Agricultural Economics 2(2+0)

Theory

Economics: Meaning, scope and subject matter, definitions, activities, approaches to economic analysis; micro and macro economics, positive and normative analysis. Nature of economic theory; rationality assumption, concept of equilibrium, economic laws as generalization of human behavior. Basic concepts: Goods and services, desire, want, demand, utility, cost and price, wealth, capital, income and welfare. Agricultural economics: meaning, definition, characteristics of agriculture, importance and its role in economic development. Agricultural planning and development in the country. *Demand:* meaning, law of demand, schedule and demand curve, determinants, utility theory; law of diminishing marginal utility, equi-marginal utility principle. Consumer's equilibrium and derivation of demand curve, concept of consumer surplus. Elasticity of demand: concept and measurement of price elasticity, income elasticity and cross elasticity. Production: process, creation of utility, factors of production, input output relationship. *Laws of returns*: Law of variable proportions and law of returns to scale. *Cost:* concepts, short run and long run cost curves. Supply: Stock v/s supply, law of supply, schedule, supply curve, determinants of supply, elasticity of supply. Market structure: meaning and types of market, basic features of perfectly competitive and imperfect markets. Price determination under perfect competition; short run and long run equilibrium of firm and industry, shut down and break even points. Distribution theory: meaning, factor market and pricing of factors of production. Concepts of rent, wage, interest and profit. *National income:* Meaning and importance, circular flow, concepts of national income accounting and approaches to measurement, difficulties in measurement. Population: Importance, Malthusian and Optimum population theories, natural and socio- economic determinants, current policies and programmes on population control. Money: Barter system of exchange and its problems, evolution, meaning and functions of money, classification of money, supply, general price index, inflation and deflation. Banking: Role in modern economy, types of banks, functions of commercial and central bank, credit creation policy. Agricultural and public finance: meaning, micro v/s macro finance, need for agricultural finance, public revenue and public expenditure. *Tax:* meaning, direct and indirect taxes, agricultural taxation, VAT. *Economic systems:* Concepts of economy and its functions, important features of capitalistic, socialistic and mixed economies, elements of economic planning.

Suggested Readings:

1. Koutsoyiannis A. Modern Micro Economics. Macmillan Press Ltd
2. N. Gregory Mankiw. Principles of Economics, South-Western Pub., 6th edition
3. S. Subba Reddy, N Ragu Ram, T. Neelakanta Sastry and I Bhavani Devi. 2019. Agricultural Economics, Oxford and IBH.
4. V T Raju & D V S Rao. 2006. Economics of Farm Production and Management, Oxford and IBH.

2. Agricultural Finance and Co-Operation 3(2+1)

Theory

Agricultural Finance- meaning, scope and significance, credit needs and its role in Indian agriculture. Agricultural credit: meaning, definition, need, classification. Credit analysis: 4 R's, and 3C's of credits. Sources of agricultural finance: institutional and non-institutional sources, commercial banks, social control and nationalization of commercial banks, Micro financing including KCC. Lead bank scheme, RRBs, Scale of finance and unit cost. An introduction to higher financing institutions – RBI, NABARD, ADB, IMF, world bank, Insurance and Credit Guarantee Corporation of India. Cost of credit. Recent development in agricultural credit. Preparation and analysis of financial statements – Balance Sheet and Income Statement. Basic guidelines for preparation of project reports- Bank norms – SWOT analysis.

Agricultural Cooperation – Meaning, brief history of cooperative development in India, objectives, principles of cooperation, significance of cooperatives in Indian agriculture. Agricultural Cooperation in India- credit, marketing, consumer and multi-purpose cooperatives, farmers' service cooperative societies, processing cooperatives, farming cooperatives, cooperative warehousing; role of ICA, NCUI, NCDC, NAFED.

Practicals

Determination of most profitable level of capital use. Optimum allocation of limited amount of capital among different enterprise. Analysis of progress and performance of cooperatives using published data. Analysis of progress and performance of commercial banks and RRBs using published data. Visit to a commercial bank, cooperative bank and cooperative society to acquire firsthand knowledge of their management, schemes and procedures. Estimation of credit requirement of farm business – A case study. Preparation and analysis of balance sheet – A case study. Preparation and analysis of income statement – A case study. Appraisal of a loan proposal- A case study. Techno-economic parameters for preparation of projects. Preparation of Bankable projects for various agricultural products and its value added products. Seminar on selected topics.

Suggested Readings:

1. Rout, R.K. A Text Book of Agricultural Finance and Cooperation. Kalyani Publishers.
2. Hopkins A Barry, Peter Jo and Baker CB. Financial Management in Agriculture.
3. Murray WG and Nelson AG. 1960. Agricultural Finance. Iowa State University.
4. Moss, C. B. 2013. Agricultural Finance. Routledge Textbooks in Environmental and Agricultural Economics.

3. Agricultural Marketing, Trade and Prices 3(2+1)

Theory

Agricultural Marketing: Conceptsanddefinitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets**;** demand, supply and producer's surplus of agri-commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; product life cycle (PLC) and competitive strategies: Meaning and stages in PLC; characteristics of PLC; strategies in different stages of PLC; pricing

and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – their meaning and merits & demerits; marketing process and functions: Marketing process-concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labeling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel;number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP & DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation & hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; GATT and WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR.

Practical

Plotting and study of demand and supply curves and calculation of elasticities**;** Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions – NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning; Application of principles of comparative advantage of international trade.

Suggested Readings:

1. S.S. Acharya and N.L. Agarwal. 2020. Agricultural Marketing in India. CBS Publishers & Distributors.
2. Richard H Kohls and Joseph N. Uhl: Marketing of Agricultural products by Collier MacMillan International.
3. Acharya SS & Agarawal NL. 1994. Agricultural Prices-Analysis and Policy. Oxford and IBH Publishing company Pvt. Ltd. New Delhi.
4. K. N. Ravi Kumar. 2014. Agricultural Marketing Vol. 2. Astral Publishers.

4. Farm Management, Production and Resource Economics 2(1+1)

Theory

Meaning and concept of farm management, objectives and relationship with other sciences. Meaning and definition of farms, its types and characteristics, factor determining types and size of farms. Principles of farm management: concept of production function and its type, use of production function in decision-making on a farm, factor-product, factor-factor and product- product relationship, law of equi-marginal/or principles of opportunity cost and law of comparative advantage. Meaning and concept of cost, types of costs and

their interrelationship, importance of cost in managing farm business and estimation of gross farm income, net farm income, family labour income and farm business income. Farm business analysis: meaning and concept of farm income and profitability, technical and economic efficiency measures in crop and livestock enterprises. Importance of farm records and accounts in managing a farm, various types of farm records needed to maintain on farm, farm inventory, balance sheet, profit and loss accounts. Meaning and importance of farm planning and budgeting, partial and complete budgeting, steps in farm planning and budgeting-linear programming, appraisal of farm resources, selection of crops and livestock's enterprises. Concept of risk and uncertainty occurs in agriculture production, nature and sources of risks and its management strategies**,** Crop/livestock/machinery insurance weather based crop insurance, features, determinants of compensation. Concepts of resource economics, differences between NRE and agricultural economics, unique properties of natural resources. Positive and negative externalities in agriculture, Inefficiency and welfare loss, solutions, Important issues in economics and management of common property resources of land, water, pasture and forest resources etc.

Practical

Preparation of farm layout. Determination of cost of fencing of a farm. Computation of depreciation cost of farm assets. Application of equi-marginal returns/opportunity cost principle in allocation of farm resources. Determination of most profitable level of inputs use in a farm production process. Determination of least cost combination of inputs. Selection of most profitable enterprise combination. Application of cost principles including CACP concepts in the estimation of cost of crop and livestock enterprises. Preparation of farm plan and budget, farm records and accounts and profit & loss accounts. Collection and analysis of data on various resources in India.

Suggested Readings:

1. V T Raju & D V S Rao. 2006. Economics of Farm Production and Management, Oxford and IBH.
2. EO Heady. Economics of Agricultural Production and resources use.
3. John P Doll and Frank Orazem. Production Economics: Theory with application
4. Heady EO & Dillon JL. 1961. Agricultural Production functions. Kalyani Publishers, Ludhiana, India.

VI. AGRICULTURAL ENGINEERING

1. Introductory Soil and Water Conservation Engineering 2(1+1)

Theory

Introduction to Soil and Water Conservation, causes of soil erosion. Definition and agents of soil erosion, water erosion: Forms of water erosion. Gully classification and control measures. Soil loss estimation by universal Loss Soil Equation. Soil loss measurement techniques. Principles of erosion control: Introduction to contouring, strip cropping. Contour bund. Graded bund and bench terracing. Grassed water ways and their design. Water harvesting and its techniques. Wind erosion: mechanics of wind erosion, types of soil movement. Principles of wind erosion control and its control measures.

Practical

General status of soil conservation in India. Calculation of erosion index. Estimation of soil loss. Measurement of soil loss. Preparation of contour maps. Design of grassed water ways. Design of contour bunds. Design of graded bunds. Design of bench terracing system. Problem on wind erosion.

Suggested Readings:

1. N.N. Basak. Surveying and Levelling Surveying and Levelling. McGraw Hill.
2. R. Suresh. 2020. Soil and water conservation Engineering. Standard Publishers
3. K. Subramanya. 2020. Engineering Hydrology 5/Ed. McGrowHill
4. T P Ojha. 2013. Principles of Agricultural Engineering Vol 2. Jain Bro.

2. Farm Machinery and Power 2(1+1)

Theory

Status of Farm Power in India, Sources of Farm Power, I.C. engines, working principles of I C engines, comparison of two stroke and four stroke cycle engines, Study of different components of I.C. engine, I.C. engine terminology and solved problems, Familiarization with different systems of I.C. engines: Air cleaning, cooling, lubrication ,fuel supply and hydraulic control system of a tractor, Familiarization with Power transmission system : clutch, gear box, differential and final drive of a tractor , Tractor types, Cost analysis of tractor power and attached implement, Familiarization with Primary and Secondary Tillage implement, Implement for hill agriculture, implement for intercultural operations, Familiarization with sowing and planting equipment, calibration of a seed drill and solved examples, Familiarization with Plant Protection equipment, Familiarization with harvesting and threshing equipment.

Practicals

Study of different components of I.C. engine. To study air cleaning and cooling system of engine, Familiarization with clutch, transmission, differential and final drive of a tractor, Familiarization with lubrication and fuel supply system of engine, Familiarization with brake, steering, hydraulic control system of engine, Learning of tractor driving, Familiarization with operation of power tiller, Implements for hill agriculture, Familiarization with different types of primary and secondary tillage implements: mould plough, disc plough and disc harrow . Familiarization with seed- cum-fertilizer drills their seed metering mechanism and calibration, planters and transplanter Familiarization with different types of sprayers and dusters Familiarization with different inter- cultivation equipment, Familiarization with harvesting and threshing machinery.

Suggested Readings:

1. John B Liljedahl. 2004. Tractor and its Power Units. CBS Publishers and Distributions, Delhi.
2. Kepner, Bainer, Barger. 2005. Principles of Farm Machinery 3/Ed. CBS Publishers and Distributions, Delhi.
3. DN Sharma; S. Mukesh. 2010. Farm Machinery Design, Principles and Problems 4/Ed Jain Brothers Publishers, New Delhi.
4. Donnell Hunt. 2013. Farm Power and Machinery Management 10/Ed. Medtech

3. Renewable Energy and Green Technology 2(1+1)

Theory

Classification of energy sources, contribution of these of sources in agricultural sector, Familiarization with biomass utilization for biofuel production and their application, Familiarization with types of biogas plants and gasifiers, biogas, bioalcohol, biodiesel and biooil production and their utilization as bioenergy resource, introduction of solar energy, collection and their application, Familiarization with solar energy gadgets: solar cooker, solar water heater, application of solar energy: solar drying, solar pond, solar distillation, solar photovoltaic system and their application, introduction of wind energy and their application.

Practical

Familiarization with renewable energy gadgets. To study biogas plants, To study gasifier, To study the production process of biodiesel, To study briquetting machine, To study the production process of bio-fuels. Familiarization with different solar energy gadgets. To study solar photovoltaic system: solar light, solar pumping, solar fencing. To study solar cooker, To study solar drying system. To study solar distillation and solar pond.

Suggested Readings:

1. Kumar, N., Singh, H. and Kumar, A. 2021. Renewable Energy and Green Technology: Principles and Practices. CRC Press.
2. V. N. Kishore. 2019. Renewable Energy Engineering and Technology: Principles and Practice. Routledge.
3. I.S. Jha, Subir Sen, et al. 2018. Renewable Energy Technology. New Age International Publishers.

4. Protected Cultivation and Secondary Agriculture 2(1+1)

Theory

Green house technology: Introduction, Types of Green Houses; Plant response to Green house environment, Planning and design of greenhouses, Design criteria of green house for cooling and heating purposes. Green house equipments, materials of construction for traditional and low cost green houses. Irrigation systems used in greenhouses, typical applications, passive solar green house, hot air green house heating systems, green house drying. Cost estimation and economic analysis.

Important Engineering properties such as physical, thermal and aero & hydrodynamic properties of cereals, pulses and oilseed, their application in PHT equipment design and operation. Drying and dehydration; moisture measurement, EMC, drying theory, various drying method, commercial grain dryer (deep bed dryer, flat bed dryer, tray dryer, fluidized bed dryer, recirculatory dryer and solar dryer). Material handling equipment; conveyer and elevators, their principle, working and selection.

Practical

Study of different type of green houses based on shape. Determine the rate of air exchange in an active summer winter cooling system. Determination of drying rate of agricultural products inside green house. Study of green house equipments. Visit to various Post Harvest Laboratories. Determination of Moisture

content of various grains by oven drying & infrared moisture methods. Determination of engineering properties (shape and size, bulk density and porosity of biomaterials). Determination of Moisture content of various grains by moisture meter. Field visit to seed processing plant.

Suggested Readings:

1. Kumar, S. Kumar, A and Kumar, S. 2020. Protected Cultivation and Secondary Agriculture. Lambert Academia Publishing.
2. Deogirikar A A. 2021.Protected Cultivation And Secondary Agriculture. Brillion Publishing.
3. Kumar, S, Saravaiya, S.N. et al. 2021. Precision Farming and Protected Cultivation: Concepts and Applications. CRC Press.

VII. PLANT PATHOLOGY

1. Fundamentals of Plant Pathology 4(3+1)

Theory

Introduction: Importance of plant diseases, scope and objectives of Plant Pathology. History of Plant Pathology with special reference to Indian work. Terms and concepts in Plant Pathology. Pathogenesis. Causes / factors affecting disease development: disease triangle and tetrahedron and classification of plant diseases. Important plant pathogenic organisms, different groups**:** fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa, phanerogamic parasites and nematodes with examples of diseases caused by them. Diseases and symptoms due to abiotic causes.

Fungi: general characters, definition of fungus, somatic structures, types of fungal thalli, fungal tissues, modifications of thallus, reproduction (asexual and sexual). Nomenclature, Binomial system of nomenclature, rules of nomenclature, classification of fungi. Key to divisions, sub-divisions, orders and classes.

Bacteria and mollicutes: general morphological characters. Basic methods of classification and reproduction.

Viruses: nature, structure, replication and transmission. Study of phanerogamic plant parasites.

Nematodes: General morphology and reproduction, classification, symptoms and nature of damage caused by plant nematodes (*Heterodera, Meloidogyne*, *Anguina, Radopholus* etc.)

Growth and reproduction of plant pathogens. Liberation / dispersal and survival of plant pathogens. Types of parasitism and variability in plant pathogens. Pathogenesis. Role of enzymes, toxins and growth regulators in disease development. Defense mechanism in plants**.** Epidemiology: Factors affecting disease development. Principles and methods of plant disease management. Nature, chemical combination, classification, mode of action and formulations of fungicides and antibiotics.

Practical

Acquaintance withvarious laboratory equipmentsandmicroscopy. Collectionandpreservation of disease specimen. Preparation of media, isolation and Koch's postulates. General study of different structures of fungi. Study of symptoms of various plant diseases. Study of representative fungal genera. Staining and identification of plant pathogenic bacteria. Transmission of plant viruses. Study of phanerogamic plant parasites.

Study of morphological features and identification of plant parasitic nematodes. Sampling and extraction of nematodes from soil and plant material, preparation of nematode mounting.

Study of fungicides and their formulations. Methods of pesticide application and their safe use. Calculation of fungicide sprays concentrations**.**

Suggested Readings:

1. Agrios GN. 2005. Plant Pathology. 5th Ed. Academic Press, New York.
2. Heitefuss R and Williams PH. 1976. Physiological Plant Pathology. Springer Verlag, Berlin, New York.
3. Mehrotra RS and Aggarwal A. 2003. Plant Pathology. 2nd Ed. Oxford & IBH, New Delhi.
4. Singh RP. 2012. Plant Pathology 2nd edn. Kalyani Publishers, New Delhi.
5. Singh RS. 2017. Introduction to Principles of Plant Pathology. 5th edn. MedTech, New Delhi.

2. Diseases of Field & Horticultural Crops & their Management-I 3(2+1)

Theory

Symptoms, etiology, disease cycle and management of major diseases of following crops: Field Crops: Rice: blast, brown spot, bacterial blight, sheath blight, false smut, khaira and tungro;Maize: stalk rots, downy mildew, leaf spots; Sorghum: smuts, grain mold and anthracnose, Bajra :downy mildew and ergot; Groundnut: early and late leaf spots, wilt Soybean: Rhizoctonia blight, bacterial spot, seed and seedling rot and mosaic; Pigeonpea: Phytophthora blight, wilt and sterility mosaic; Finger millet: Blast and leaf spot; black & green gram: Cercospora leaf spot and anthracnose, web blight and yellow mosaic; Castor: Phytophthora blight;Tobacco: black shank, black root rot and mosaic. Horticultural Crops: Guava: wilt and anthracnose; Banana: Panama wilt, bacterial wilt, Sigatoka and bunchy top;Papaya: foot rot, leaf curl and mosaic, Pomegranate: bacterial blight; Cruciferous vegetables: Alternaria leaf spot and black rot; Brinjal: Phomopsis blight and fruit rot and Sclerotinia blight; Tomato: damping off, wilt, early and late blight, buck eye rot and leaf curl and mosaic; Okra: Yellow Vein Mosaic; Beans: anthracnose and bacterial blight; Ginger: soft rot; Colocasia: Phytophthora blight; Coconut: wilt and bud rot; Tea: blister blight; Coffee: rust

Practical

Identification and histopathological studies of selected diseases of field and horticultural crops covered in theory. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for Herbarium; Note: Students should submit 50 pressed and well- mounted specimens.

Suggested Readings:

1. Agrios GN. 2005. Plant Pathology. 5th Ed. Academic Press, New York.
2. Singh RS. 2017. Plant Diseases. 10th Ed. Medtech, New Delhi.
3. Tronsmo, A.M., Munk, L., Djurle, A, Tronsmo, A.,Yuen, J. and Collinge, D. B. 2020. Plant Pathology and Plant Diseases. CABI.
4. Singh US, Mukhopadhyay AN, Kumar J and Chaube HS. 1992. Plant Diseases of Internatiobnal Importance. Vol. I. Diseases of Cereals and Pulses. Prentice Hall, Englewood Cliffs, New Jersey.

3. Diseases of Field & Horticultural Crops & their Management-II 3(2+1)

Theory

Symptoms, etiology, disease cycle and management of following diseases: Field Crops: Wheat: rusts, loose smut, karnal bunt, powdery mildew, alternaria blight, and ear cockle; Sugarcane: red rot, smut, wilt, grassy shoot, ratoon stunting and Pokkah Boeng; Sunflower: Sclerotinia stem rot and Alternaria blight; Mustard: Alternaria blight, white rust, downy mildew and Sclerotinia stem rot; Gram: wilt, grey mould and Ascochyta blight; Lentil: rust and wilt; Cotton: anthracnose, vascular wilt, and black arm; Pea: downy mildew, powdery mildew and rust. Horticultural Crops: Mango: anthracnose, malformation, bacterial blight and powdery mildew; Citrus: canker and gummosis; Grape vine: downy mildew, Powdery mildew and anthracnose; Apple: scab, powdery mildew, fire blight and crown gall; Peach: leaf curl. Strawberry: leaf spot Potato: early and late blight, black scurf, leaf roll, and mosaic; Cucurbits: downy mildew, powdery mildew, wilt; Onion and garlic: purple blotch, and Stemphylium blight; Chillies: anthracnose and fruit rot, wilt and leaf curl; Turmeric: leaf spot Coriander: stem gall Marigold: Botrytis blight; Rose: dieback, powdery mildew and black leaf spot.

Practical

Identification and histopathological studies of selected diseases of field and horticultural crops covered in theory. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for herbarium.

Note: Students should submit 50 pressed and well-mounted specimens.

Suggested Readings:

1. Agrios GN. 2005. Plant Pathology. 5th Ed. Academic Press, New York.
2. Singh RS. 2017. Plant Diseases. 10th Ed. Medtech, New Delhi.
3. Tronsmo, A.M., Munk, L., Djurle, A, Tronsmo, A., Yuen, J. and Collinge, D. B. 2020. Plant Pathology and Plant Diseases. CABI.
4. Singh US, Mukhopadhyay AN, Kumar J and Chaube HS. 1992. Plant Diseases of Internatiobnal Importance. Vol. I. Diseases of Cereals and Pulses. Prentice Hall, Englewood Cliffs, New Jersey

4. Principles of Integrated Pest and Disease Management 3(2+1)

Theory

Categories of insect pests and diseases, IPM: Introduction, history, importance, concepts, principles and tools of IPM. Economic importance of insect pests, diseases and pest risk analysis. Methods of detection and diagnosis of insect pest and diseases. Calculation and dynamics of economic injury level and importance of Economic threshold level. Methods of control: Host plant resistance, cultural, mechanical, physical, legislative, biological and chemical control. Ecological management of crop environment. Introduction to conventional pesticides for the insect pests and disease management. Survey surveillance and forecasting of Insect pest and diseases. Development and validation of IPM module. Implementation and impact of IPM (IPM module for Insect pest and disease. Safety issues in pesticide uses. Political, social and legal implication of IPM. Case histories of important IPM programmes. Case histories of important IPM programmes.

Practical

Methods of diagnosis and detection of various insect pests, and plant diseases, Methods of insect pests and plant disease measurement, Assessment of crop yield losses, calculations based on economics of IPM, Identification of biocontrol agents, different predators and natural enemies. Mass multiplication of *Trichoderma, Pseudomonas*, *Trichogramma*, NPV etc. Identification and nature of damage of important insect pests and diseases and their management. Crop (agro- ecosystem) dynamics of a selected insect pest and diseases. Plan & assess preventive strategies (IPM module) and decision making. crop monitoring attacked by insect, pest and diseases . Awareness campaign at farmers fields.

Suggested readings:

1. Gupta VK and Sharma RC. (Eds). 1995. Integrated Disease Management and Plant Health. Scientific Publ., Jodhpur.
2. Fry WE. 1982. Principles of Plant Disease Management. Academic Press, New York.
3. Hewitt HG. 1998. Fungicides in Crop Protection. CABI, Wallington.
4. Nene YL and Thapliyal PN. 1993. Fungicides in Plant Disease Control. Oxford & IBH, New Delhi.
5. Palti J. 1981. Cultural Practices and Infectious Crop Diseases. Springer Verlag, New York.

VIII. HORTICULTURE

1. Fundamentals of Horticulture (NEW) 2(1+1)

Theory

Horticulture - Its definition and branches, importance and scope; horticultural and botanical classification; climate and soil for horticultural crops; Plant propagation-methods and propagating structures; Seed dormancy, Seed germination, principles of orchard establishment; Principles and methods of training and pruning, juvenility and flower bud differentiation; unfruitfulness; pollination, pollinizers and pollinators; fertilization and parthenocarpy; medicinal and aromatic plants; importance of plant bio-regulators in horticulture. Irrigation – methods, Fertilizer application in horticultural crops.

Practical

Identification of garden tools. Identification of horticultural crops. Preparation of seed bed/ nursery bed. Practice of sexual and asexual methods of propagation including micro-propagation. Layout and planting of orchard. Training and pruning of fruit trees. Preparation of potting mixture. Fertilizer application in different crops. Visits to commercial nurseries/orchard.

Suggested readings:

1. Chadha, K.L. 2019. Handbook of Horticulture. ICAR New Delhi.
2. Midmore D. 2015. Principles of Tropical Horticulture. CAB International.
3. Bose TK, Mitra SK and Sanyal D. 2002. Fruits of India – Tropical and Sub-Tropical.3rd Edn. Naya Udyog, Kolkata.
4. Dhillon WS. 2013. Fruit Production in India. Narendra Publ. House, New Delhi.

2. Production Technology for Fruit and Plantation Crops 2(1+1)

Theory

Importance and scope of fruit and plantation crop industry in India; Importance of rootstocks; Production technologies for the cultivation of major fruits-mango, banana, citrus, grape, guava, litchi, papaya, sapota, apple, pear, peach, walnut, almond and; minor fruits- date, ber, pineapple, pomegranate, jackfruit, strawberry, plantation crops-coconut, arecanut, cashew, tea, coffee & rubber.

Practical

Seed propagation. Scarification and stratification of seeds. Propagation methods for fruit and plantation crops. Description and identification of fruit. Preparation of plant bio regulators and their uses, Important pests, diseases and physiological disorders of above fruit and plantation crops, Visit to commercial orchards.

Suggested readings:

1. Chadha, K.L. 2019. Handbook of Horticulture. ICAR New Delhi.
2. Dhillon WS. 2013. Fruit Production in India. Narendra Publ. House, New Delhi.
3. Iyer CPA and Kurian RM. 2006. High Density Planting in Tropical Fruits: Principlesand Practices. IBDC Publishers, New Delhi.
4. Chadha TR. 2011. A Text Book of Temperate Fruits. ICAR, New Delhi
5. Childers NF, Morris JR and Sibbett GS. 1995. Modern Fruit Science: Orchard and Small Fruit Culture. Horticultural Publications, USA.
6. Creasy G and Creasy L. 2018. Grapes. CAB International.
7. Davies FS and Albrigo LG. 1994. Citrus. CAB International.
8. Sharma RR and Krishna H. 2018. Textbook of Temperate Fruits. CBS Publishers and Distributors Pvt. Ltd., New Delhi.
9. Davies FT, Geneve RL and Wilson SB. 2018. Hartmann and Kester's Plant Propagation Principles and Practices. Pearson, USA/ PrenticeHall of India. New Delhi.
10. Joshi P. 2018. Text Book on fruit and plantation crops. Narendra Publishing House, New Delhi
11. Kurian A and Peter KV. 2007. Commercial Crops Technology. New India Publ. Agency.

3. Production Technology for Vegetable and Spices 2(1+1)

Theory

Importance of vegetables & spices in human nutrition and national economy, kitchen gardening, brief about origin, area, climate, soil, improved varieties and cultivation practices such as time of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders, of important vegetable and spices (Tomato, Brinjal, Chilli, Capsicum, Cucumber, Melons, Gourds, Pumpkin, French bean, Peas; Cole crops such as Cabbage, Cauliflower, Knol-khol; Bulb crops such as Onion, Garlic; Root crops such as Carrot, Raddish, Beetroot; Tuber crops such as Potato; Leafy vegetables such as Amaranth, Palak. Perennial vegetables).

Practical

Identification of vegetables & spice crops and their seeds. Nursery raising. Direct seed sowing and transplanting. Study of morphological characters of different vegetables & spices. Fertilizers applications. Harvesting & preparation for market. Economics of vegetables and spices cultivation.

Suggested readings:

1. Chadha, K.L. 2019. Handbook of Horticulture. ICAR New Delhi.
2. Chauhan DVS. (Ed.). 1986. Vegetable production in India. Ram prasad and sons.
3. Fageria MS, Choudhary BR and Dhaka RS. 2000. Vegetable crops: production technology. Vol. II. Kalyani publishers.
4. Gopalakrishanan TR. 2007. Vegetable crops. New India publ. agency.
5. Hazra P. 2019. Vegetable production and technology. New India publishing agency, New Delhi.
6. Hazra P, Chattopadhyay A, Karmakar K and Dutta S. 2011. Modern technology for vegetable production, New India publishing agency, New Delhi, 413p
7. Agarwal S, Sastry EVD and Sharma RK. 2001. Seed Spices: Production, Quality, Export. Pointer Publ.
8. Arya PS. 2003. Spice Crops of India. Kalyani.

4. Production Technology for Ornamental Crops, MAPs and Landscaping 2(1+1)

Theory

Importance and scope of ornamental crops, medicinal and aromatic plants and landscaping. Principles of landscaping. Landscape uses of trees, shrubs and climbers. Production technology of important cut flowers like rose, gerbera, carnation, lilium and orchids under protected conditions and gladiolus, tuberose, chrysanthemum under open conditions. Package of practices for loose flowers like marigold and jasmine under open conditions. Production technology of important medicinal plants like ashwagandha, asparagus, aloe, costus, Cinnamomum, periwinkle, isabgol and aromatic plants like mint, lemongrass, citronella, palmarosa, ocimum, rose, geranium, vetiver. Processing and value addition in ornamental crops and MAPs produce.

Practical

Identification of Ornamental plants. Identification of Medicinal and Aromatic Plants. Nursery bed preparation and seed sowing. Training and pruning of Ornamental plants. Planning and layout of garden. Bed preparation and planting of MAP. Protected structures – care and maintenance. Intercultural operations in flowers and MAP. Harvesting and post harvest handling of cut and loose flowers. Processing of MAP. Visit to commercial flower/MAP unit.

Suggested readings:

1. Bhattacharjee SK. 2018. Advances in Ornamental Horticulture. Pointer Publ., Reprint, 6 vols, pp. 2065.
2. Misra RL and Misra S. 2017. Commercial Ornamental Crops: Cut Flowers. Kruger Brentt Publisher UK Ltd. pp.584.

3. Misra RL and Misra S. 2017. Commercial Ornamental Crops: Traditional and Loose Flowers. Kruger Brentt Publisher UK Ltd.
4. Barche S. 2016. Production technology of spices, aromatic, medicinal and plantation crops. New India Publishing Agency, New Delhi.
5. Farooqi AA, Khan MM and Vasundhara M. 2001. Production Technology of Medicinal and Aromatic Crops. Natural Remedies Pvt. Ltd.
6. Gupta RK. 2010. Medicinal and Aromatic plants. CBS publications.
7. Misra RL and Misra S. 2012. Landscape Gardening. Westville Publ. House, New Delhi, India.
8. Bose TK, Maiti RG, Dhua RS and Das P. 1999. Floriculture and Landscaping. Naya Prokash, Kolkata, India.

5. Post-harvest Management and Value Addition of Fruits and Vegetables 2(1+1)

Theory

Importance of post-harvest processing of fruits and vegetables, extent and possible causes of post harvest losses; Pre-harvest factors affecting postharvest quality, maturity, ripening and changes occurring during ripening; Respiration and factors affecting respiration rate; Harvesting and field handling; Storage (ZECC, cold storage, CA, MA, and hypobaric); Value addition concept; Principles and methods of preservation; Intermediate moisture food- Jam, jelly, marmalade, preserve, candy – Concepts and Standards; Fermented and non-fermented beverages. Tomato products- Concepts and Standards; Drying/ Dehydration of fruits and vegetables – Concept and methods, osmotic drying. Canning -– Concepts and Standards, packaging of products.

Practical

Applications of different types of packaging, containers for shelf life extension. Effect of temperature on shelf life and quality of produce. Demonstration of chilling and freezing injury in vegetables and fruits. Extraction and preservation of pulps and juices. Preparation of jam, jelly, RTS, nectar, squash, osmotically dried products, fruit bar and candy and tomato products, canned products. Quality evaluation of products-physico-chemical and sensory. Visit to processing unit/ industry.

Suggested Readings:

1. Paul Singh R and Heldman DR. 2009. Introduction to Food Engineering (4th Edition), Academic Press.
2. Rao DG. 2010. Fundamentals of Food Engineering, PHI Learning Pvt. Ltd.
3. FAO. 2007. Handling and Preservation of Fruits and Vegetables by Combined Methods for Rural Areas- Technical Manual. FAO Agricultural Services Bulletin 149.
4. Fellows PJ. 2009. Food Processing Technology: Principles and Practice (3rd Edition), Woodhead Publishing.

IX. FOOD SCIENCE & TECHNOLOGY

1. Principles of Food Science and Nutrition 2(2+0)

Theory

Concepts of Food Science (definitions, measurements, density, phase change, pH, osmosis, surface tension, colloidal systems etc.); Food composition and chemistry (water, carbohydrates, proteins, fats, vitamins, minerals, flavours, colours, miscellaneous bioactives, important reactions); Food microbiology (bacteria, yeast, moulds, spoilage of fresh & processed foods, Production of fermented foods); Principles and methods of food processing and preservation (use of heat, low temperature, chemicals, radiation, drying etc.); Food and nutrition, Malnutrition (over and under nutrition), nutritional disorders; Energy metabolism (carbohydrate, fat, proteins); Balanced/ modified diets, Menu planning, New trends in food science and nutrition.

Suggested Readings:

1. Joshi, S.A - Nutrition and dietetics (with Indian Care Studies) Fourth Edition MC Graw Hill Education (India) Pvt. Ltd., New Delhi
2. Mudambi S R, Raja Gopal M V - Fundamentals of Food & Nutrition New Age International Publisher, New Delhi
3. Manay, S.N, Shadaksharaswany M - Food: Facts and Principles New Age International Publisher, 5th Edition
4. Tondon GL, Sidhappa, GS, Lal G. - Preservation of Fruits and Vegetables, ICAR
5. Asrey and Barman - Postharvest Horticultural Principles and Practices. Kalyani Publisher, New Delhi

X. AGRICULTURAL EXTENSION and COMMUNICATION

1. Fundamentals of Agricultural Extension Education 3(2+1)

Theory

Education: Meaning, definition & Types; Extension Education- meaning, definition, scope and process; objectives and principles of Extension Education; Extension Programme planning- Meaning, Process, Principles and Steps in Programme Development. Extension systems in India: extension efforts in pre-independence era (Sriniketan, Marthandam, Firka Development Scheme, Gurgaon Experiment, etc.) and post-independence era (Etawah Pilot Project, Nilokheri Experiment, etc.); various extension/ agriculture development programmes launched by ICAR/ Govt. of India (IADP, IAAP, HYVP, KVK, IVLP, ORP, ND, NATP, NAIP, etc.). New trends in agriculture extension: privatization extension, cyber extension/ e-extension, market-led extension, farmer-led extension, expert systems, etc.

Rural Development: concept, meaning, definition; various rural development programmes launched by Govt. of India. Community Dev.-meaning, definition, concept & principles, Philosophy of C.D. Rural Leadership: concept and definition, types of leaders in rural context; extension administration: meaning and concept, principles and functions. Monitoring and evaluation: concept and definition, monitoring and evaluation of extension programmes; transfer of technology: concept and models, capacity building of

extension personnel; extension teaching methods: meaning, classification, individual, group and mass contact methods, ICT Applications in TOT (New and Social Media), media mix strategies; communication: meaning and definition; Principles and Functions of Communication, models and barriers to communication. Agriculture journalism; diffusion and adoption of innovation: concept and meaning, process and stages of adoption, adopter categories.

Practical

To get acquainted with university extension system. Group discussion- exercise; handling and use of audio visual equipments and digital camera and LCD projector; preparation and use of AV aids, preparation of extension literature – leaflet, booklet, folder, pamphlet news stories and success stories; Presentation skills exercise; micro teaching exercise; A visit to village to understand the problems being encountered by the villagers/ farmers; to study organization and functioning of DRDA and other development departments at district level; visit to NGO and learning from their experience in rural development; understanding PRA techniques and their application in village development planning; exposure to mass media: visit to community radio and television studio for understanding the process of programme production; script writing, writing for print and electronic media, developing script for radio and television.

Suggested Readings:

1. Ray, G.L. 2003. Extension Communication and Management. Kalyani Publishers.
2. ICAR. 2020. Handbook of Agricultural Extension. ICAR New Delhi.
3. Dahama, O.P. and Bhatnagar, O.P. Extension Education and communication for development. Oxford and IBH Publishing Co. Pvt. Ltd.
4. Reddy, A.A. 2001.Extension Education, Baptala Sri Lakshmi Press.

2. Rural Sociology & Educational Psychology 2(2+0)

Theory

Sociology and Rural sociology: Definition and scope, its significance in agriculture extension, Social Ecology, Rural society, Social Groups, Social Stratification, Culture concept, Social Institution, Social Change & Development. Educational psychology: Meaning & its importance in agriculture extension. Behavior: Cognitive, affective, psychomotor domain, Personality, Learning, Motivation, Theories of Motivation, Intelligence.

Suggested Readings:

1. Chitambar, J.B. 2008. Introductory Rural Sociology. New Age International (P) Ltd.
2. Sachdeva, D. R. and Bhushan, V. 2007. An Introduction to Sociology. Kitab Mahal Agency.
3. MacIver R M and Charles H Page. 1949. Society: An Introductory Analysis. Macmillan India Ltd.

3. Entrepreneurship Development and Business Communication 2(1+1)

Theory

Concept of Entrepreneur, Entrepreneurship Development, Characteristics of entrepreneurs; SWOT Analysis & achievement motivation, Government policy and programs and institutions for entrepreneurship development, Impact of economic reforms on Agribusiness/ Agrienterprises, Entrepreneurial Development

Process; Business Leadership Skills; Developing organizational skill (controlling, supervising, problem solving, monitoring & evaluation), Developing Managerial skills, Business Leadership Skills (Communication, direction and motivation Skills), Problem solving skill, Supply chain management and Total quality management, Project Planning Formulation and report preparation; Financing of enterprise, Opportunities for agri- entrepreneurship and rural enterprise.

Practical

Assessing entrepreneurial traits, problem solving skills, managerial skills and achievement motivation, exercise in creativity, time audit through planning, monitoring and supervision, identification and selection of business idea, preparation of business plan and proposal writing, visit to entrepreneurship development institute and entrepreneurs.

Suggested Readings:

1. Koontz, H. and Weihrich, H. 2020. Essentials of Management: An International
2. Pandey, M. and Tewari, D. The Agribusiness Book. IBDC Publishers.
3. Charantimath, P. 2018. Entrepreneurship Development: Small Business Enterprise, Pearson.
4. Nandan H. 2013. Fundamentals of Entrepreneurship. PHI Learning Pvt Ltd India.

4. Communication Skills and Personality Development 2 (1+1)

Theory

Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and nonverbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

Practical

Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations.

Suggested Readings:

1. David K Berlo. The process of Communication: Introduction to Theory and Practice. Thomson Learning.
2. AS Sandhu. 2020. Text book on Agricultural Communication: Process and Methods- Oxford & IBH.
3. Varinder Kumar and Bodh Raj. 2017. Communication skills and personality development- Kalyani Publishers.

XI.BIOCHEMISTRY/ PHYSIOLOGY/ MICROBIOLOGY/ ENVIRONMENTAL SCIENCES

1. Fundamentals of Plant Biochemistry and Biotechnology 3(2+1)

Theory

Importance of Biochemistry. Properties of Water, pH and Buffer. Carbohydrate: Importance and classification. Structures of Monosaccharides, Reducing and oxidizing properties of Monosaccharides, Mutarotation; Structure of Disaccharides and Poly saccharides. Lipid:

Importance and classification; Structures and properties of fatty acids; storage lipids and membrane lipids. Proteins: Importance of proteins and classification; Structures, titration and zwitterions nature of amino acids; Structural organization of proteins. Enzymes: General properties; Classification; Mechanism of action; Michaelis & Menten and Line Weaver Burk equation & plots; Introduction to allosteric enzymes. Nucleic acids: Importance and classification; Structure of Nucleotides, A, B & Z DNA; RNA: Types and Secondary & Tertiary structure. Metabolism of carbohydrates: Glycolysis, TCA cycle, Glyoxylate cycle, Electron transport chain. Metabolism of lipids: Beta oxidation, Biosynthesis of fatty acids.

Concepts and applications of plant biotechnology: Scope, organ culture, embryo culture, cell suspension culture, callus culture, anther culture, pollen culture and ovule culture and their applications; Micro-propagation methods; organogenesis and embryogenesis, Synthetic seeds and their significance; Embryo rescue and its significance; somatic hybridization and cybrids; Somaclonal variation and its use in crop improvement; cryo-preservation; Introduction to recombinant DNA methods: physical (Gene gun method), chemical (PEG mediated) and Agrobacterium mediated gene transfer methods; Transgenics and its importance in crop improvement; PCR techniques and its applications; RFLP, RAPD, SSR; Marker Assisted Breeding in crop improvement; Biotechnology regulations.

Practical

Preparation of solution, pH & buffers, Qualitative tests of carbohydrates and amino acids. Quantitative estimation of glucose/ proteins. Titration methods for estimation of amino acids/lipids, Effect of pH, temperature and substrate concentration on enzyme action, Paper chromatography/ TLC demonstration for separation of amino acids/ Monosaccharides. Sterilization techniques. Composition of various tissue culture media and preparation of stock solutions for MS nutrient medium. Callus induction from various explants. Micro-propagation, hardening and acclimatization. Demonstration on isolation of DNA. Demonstration of gel electrophoresis techniques and DNA finger printing.

Suggested Readings:

1. Voet D, Voet J G & Pratt C M. 2004. Fundamentals of Biochemistry. 2ndEd. NewYork:Wiley.
2. Goodwin,T W & Mercer EI. 1983. Introduction to Plant Biochemistry. Oxford, NewYork. Pergaman Press.
3. Murray RK, DavidB. ,Botham KM & Kennelly PJ. 2012. Harper's Illustrated Biochemistry, Lange Medical Books / Mc.GrawHill.
4. Nelson D L & Cox M M. 2000. Lehninger Principles of Biochemistry, PrenticeHall.

2. Fundamentals of Crop Physiology 2(1+1)

Theory

Introduction to crop physiology and its importance in Agriculture; Plant cell: an Overview; Diffusion and osmosis; Absorption of water, transpiration and Stomatal Physiology; Mineral nutrition of Plants: Functions and deficiency symptoms of nutrients, nutrient uptake mechanisms; Photosynthesis: Light and Dark reactions, C3, C4 and CAM plants; Respiration: Glycolysis, TCA cycle and electron transport chain; Fat Metabolism: Fatty acid synthesis and Breakdown; Plant growth regulators: Physiological roles and agricultural uses, Physiological aspects of growth and development of major crops: Growth analysis, Role of Physiological growth parameters in crop productivity.

Practical

Study of plant cells, structure and distribution of stomata, imbibitions, osmosis, plasmolysis, measurement of root pressure, rate of transpiration, Separation of photosynthetic pigments through paper chromatography, Rate of transpiration, photosynthesis, respiration, tissue test for mineral nutrients, estimation of relative water content, Measurement of photosynthetic CO_2 assimilation by Infra Red Gas Analyser (IRGA).

Suggested readings:

1. Mukherjee S & Ghosh. 1996. Plant Physiology. AK. McGraw Hill.
2. Bhatia K N & Prashar A N. 1990. Plant Physiology. Trueman Book Company.
3. Salisbury F B. & Ross C W. 1992. Plant Physiology. Words worth Publishing Company.

3. Agricultural Microbiology 2(1+1)

Theory

Introduction. Microbial world: Prokaryotic and eukaryotic microbes. Bacteria: cell structure, chemoautotrophy, photo autotrophy, growth. Bacterial genetics: Genetic recombination- transformation, conjugation and transduction, plasmids, transposon. Role of microbes in soil fertility and crop production: Carbon, Nitrogen, Phosphorus and Sulphur cycles. Biological nitrogen fixation- symbiotic, associative and asymbiotic. Azolla, blue green algae and mycorrhiza. Rhizosphere and phyllosphere. Microbes in human welfare: silage production, biofertilizers, biopesticides, biofuel production and biodegradation of agro-waste.

Practical

Introduction to microbiology laboratory and its equipments; Microscope- parts, principles of microscopy, resolving power and numerical aperture. Methods of sterilization. Nutritional media and their preparations. Enumeration of microbial population in soil- bacteria, fungi, actinomycetes. Methods of isolation and purification of microbial cultures. Isolation of *Rhizobium* from legume root nodule. Isolation of *Azotobacter* from soil. Isolation of *Azospirillum* from roots. Isolation of BGA. Staining and microscopic examination of microbes.

Suggested readings:

1. Pelczar MJ, Chan ECS & Kreig N. R. 2023. Microbiology: Concepts and Application. Tata McGraw Hill.

2. Stainier RY, Ingraham JL, Wheelis ML & Painter PR. 2003. General Microbiology. MacMillan.
3. Tauro P, Kapoor KK & Yadav KS. 1996.Introduction to Microbiology. Wiley Eastern.

3. Environmental Studies and Disaster Management 3 (2+1)

Theory

Multidisciplinary nature of environmental studies Definition, scope and importance.

Natural Resources: Renewable and non-renewable resources, Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy resources: Growing energy needs, renewable and non- renewable energy sources, use of alternate energy sources. Case studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. • Role of an individual in conservation of natural resources. • Equitable use of resources for sustainable lifestyles.

Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem. Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

Biodiversity and its conservation: - Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Environmental Pollution: definition, cause, effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.

Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. dies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness.

Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster Management

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion.

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.

Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community –based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

Practical

Pollution case studies. Case Studies- Field work: Visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain, visit to a local polluted site-Urban/Rural/Industrial/ Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc.

Suggested readings:

1. Trivedi RN. 1993. A Text Book of Environmental Sciences. Anmol Publ.
2. Dhaliwal G S & Kukal. 2005. Essentials of Environment Science.Kalyani Publishers.
3. Chauhan, A S. 2009 Environmental Studies. Jain Brothers.
4. Ahluwalia V K & Malhotra S. 2006. Environmental Science. Ane Books India.
5. Sharma, P.D. 2017. Ecology and Environment. Rastogi Publications.
6. Subramanian, R. 2018. Disaster Management. Vikas Publishing House.

4. Introduction to Forestry (New) 2(1+1)

Theory

Introduction – definitions of basic terms related to forestry, objectives of silviculture, forest classification, salient features of Indian Forest Policies. Forest regeneration, Natural regeneration - natural regeneration from seed and vegetative parts, coppicing, pollarding, root suckers; Artificial regeneration – objectives, choice between natural and artificial regeneration, essential preliminary considerations. Crown classification. Tending operations – weeding, cleaning, thinning – mechanical, ordinary, crown and advance thinning. Forest mensuration – objectives, diameter measurement, instruments used in diameter measurement; Non instrumental methods of height measurement - shadow and single pole method; Instrumental methods of height measurement geometric and trigonometric principles, instruments used in height measurement; tree stem form, form factor, form quotient, measurement of volume of felled and standing trees, age determination of

trees. Agroforestry – definitions, importance, criteria of selection of trees in agroforestry, different agroforestry systems prevalent in the country, shifting cultivation, taungya, alley cropping, wind breaks and shelter belts, home gardens. Cultivation practices of two important fast growing tree species of the region.

Practical

Identification of tree-species. Diameter measurements using calipers and tape, diameter measurements of forked, buttressed, fluted and leaning trees. Height measurement of standing trees by shadow method, single pole method and hypsometer. Volume measurement of logs using various formulae. Nursery lay out, seed sowing, vegetative propagation techniques. Forest plantations and their management. Visits of nearby forest based industries.

Suggested Readings:

1. Malcolm Fisher. 2015. Handbook of Forestry. Callisto Référence.
2. Dwivedi AP. 1992. Agroforestry- Principles and Practices. Oxford &IBH.
3. Nair PKR. 1993. An Introduction to Agroforestry. Kluwer Academic Pub.
4. Tejwani KG. 1994. Agroforestry in India. Oxford & IBH Publishing Co. Pvt Ltd.

XII. STATISTICS, COMPUTER APPLICATION AND IPR

1. Statistical Methods 2(1+1)

Theory

Introduction to Statistics and its Applications in Agriculture, Graphical Representation of Data, Measures of Central Tendency & Dispersion, Definition of Probability, Addition and Multiplication Theorem (without proof). Simple Problems Based on Probability. Binomial & Poisson Distributions, Definition of Correlation, Scatter Diagram. Karl Pearson's Coefficient of Correlation. Linear Regression Equations. Introduction to Test of Significance, One sample & two sample test t for Means, Chi-Square Test of Independence of Attributes in 2 ×2 Contingency Table. Introduction to Analysis of Variance, Analysis of One Way Classification. Introduction to Sampling Methods, Sampling versus Complete Enumeration, Simple Random Sampling with and without replacement, Use of Random Number Tables for selection of Simple Random Sample.

Practical

Graphical Representation of Data. Measures of Central Tendency (Ungrouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Central Tendency (Grouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Dispersion (Ungrouped Data). Measures of Dispersion (Grouped Data). Moments, Measures of Skewness & Kurtosis (Ungrouped Data). Moments, Measures of Skewness & Kurtosis (Grouped Data). Correlation & Regression Analysis. Application of One Sample t-test. Application of Two Sample Fisher's t-test. Chi-Square test of Goodness of Fit. Chi-Square test of Independence of Attributes for 2 ×2 contingency table. Analysis of Variance One Way Classification. Analysis of Variance Two Way Classification. Selection of random sample using Simple Random Sampling.

Suggested Readings:

Freud J E & Perles B M. 2006. Modern Elementary Statistics.12thEd. Pearson India.

1. Kapoor V K. 2003. Problems and Solutions in Statistics.7thEdition. Sultan Chand.
2. Snedecor G W. & Cochran W G. 1989. Statistical Methods. Iowa State University Press.

2. Agri-Informatics 2(1+1)

Theory

Introduction to Computers, Operating Systems, definition and types, Applications of MS- Office for document creation & Editing, Data presentation, interpretation and graph creation, statistical analysis, mathematical expressions, Database, concepts and types, uses of DBMS in Agriculture, World Wide Web (WWW): Concepts and components. Introduction to computer programming languages, concepts and standard input/output operations. e-Agriculture, concepts and applications, Use of ICT in Agriculture. Computer Models for understanding plant processes. IT application for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone Apps in Agriculture for farm advises, market price, postharvest management etc; Geospatial technology for generating valuable agri-information. Decision support systems, concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc for supporting Farm decisions. Preparation of contingent crop-planning using IT tools.

Practical

Study of Computer Components, accessories, practice of important DOS Commands. Introduction of different operating systems such as windows, Unix/ Linux, Creating, Files & Folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific Document. MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data. MS-ACCESS: Creating Database, preparing queries and reports, demonstration of Agri-information system. Introduction to World Wide Web (WWW). Introduction of programming languages. Hands on Crop Simulation Models (CSM) such as DSSAT/Crop-Info/CropSyst/ Wofost; Computation of water and nutrient requirements of crop using CSM and IT tools. Introduction of Geospatial Technology for generating valuable information for Agriculture. Hands on Decision Support System. Preparation of contingent crop planning.

Suggested Readings:

1. Maidasani D. 2016. Learning Computer Fundamentals, MSOffice andInternet & Web Technology. 3rd edition, Laxmi Publications.
2. Kumar A. 2015. Computer Basics with Office Automation. I K International Publishing House Pvt Ltd.
3. Rajaraman V & Adabala N. 2015. Fundamentals of Computers. PHI

4. Intellectual Property Rights 1(1+0)

Theory

Introduction and meaning of intellectual property, brief introduction to GATT, WTO, TRIPs and WIPO, Treaties for IPR protection: Madrid protocol, Berne Convention, Budapest treaty, etc. Types of Intellectual Property and legislations covering IPR in India:-Patents, Copyrights, Trademark, Industrial design, Geographical indications, Integrated circuits, Trade secrets. Patents Act 1970 and Patent system in India,

patentability, process and product patent, filing of patent, patent specification, patent claims, Patent opposition and revocation, infringement, Compulsory licensing, Patent Cooperation Treaty, Patent search and patent database.

Origin and history including a brief introduction to UPOV for protection of plant varieties, Protection of plant varieties under UPOV and PPV&FR Act of India, Plant breeders rights, Registration of plant varieties under PPV&FR Act 2001, breeders, researcher and farmers rights. Traditional knowledge-meaning and rights of TK holders.

Convention on Biological Diversity, International treaty on plant genetic resources for food and agriculture (ITPGRFA). Indian Biological Diversity Act, 2002 and its salient features, access and benefit sharing.

Suggested Readings:

1. Singh B D. 2007. Biotechnology: Expanding Horizon. Kalyani Publishers.
2. Intellectual Property India. 2019. Ministry of Commerce and Industry, Government of India. https://ipindia.gov.in/manual-patents.htm
3. World Intellectual Property Organization. www.wipo.org
4. DBT. Intellectual Property Guidelines. 2023. Ministry of Science and Technology, Government of India. https://dbtindia.gov.in/sites/default/files/uploadfiles/DBT%20IP%20Guidelines%202023%20final.pdf
5. DBT. 2019. Ministry of Science and Technology, Government of India. https://dbtindia.gov.in/guidelines-biosafety

XIII. ANIMAL PRODUCTION

1. Livestock & Poultry Management 4 (3+1)

Theory

Role of livestock in the national economy. Reproduction in farm animals and poultry. Housing principles, space requirements for different species of livestock and poultry. Management of calves, growing heifers and milch animals. Management of sheep, goat and swine. Incubation, hatching and brooding. Management of growers and layers. Important Indian and exotic breeds of cattle, buffalo, sheep, goat, swine and poultry. Improvement of farm animals and poultry. Digestion in livestock and poultry. Classification of feedstuffs. Proximate principles of feed. Nutrients and their functions. Feed ingredients for ration for livestock and poultry. Feed supplements and feed additives. Feeding of livestock and poultry. Introduction of livestock and poultry diseases. Prevention (including vaccination schedule) and control of important diseases of livestock and poultry.

Practical

External body parts of cattle, buffalo, sheep, goat, swine and poultry. Handling and restraining of livestock. Identification methods of farm animals and poultry. Visit to IDF and IPF to study breeds of livestock and poultry and daily routine farm operations and farm records. Judging of cattle, buffalo and poultry. Culling of livestock and poultry. Planning and layout of housing for different types of livestock. Computation of rations

for livestock. Formulation of concentrate mixtures. Clean milk production, milking methods. Hatchery operations, incubation and hatching equipments. Management of chicks, growers and layers. Debeaking, dusting and vaccination. Economics of cattle, buffalo, sheep, goat, swine and poultry production.

Suggested readings:

1. Banerjee GC. 2019. Text Book of Animal Husbandry. Oxford and IBH.
2. ICAR. 1962. Handbook of Animal Husbandry. ICAR Publication.
3. Parsad Jagdish. 2023. Poultry Production and Management. Kalyani Publishers.
4. Sastry NSR & Thomas CK. 2023. Dairy Bovine Production. Kalyani Publishers.
5. Singh RA. 2018. Poultry Production. Kalyani Publishers.
6. Thomas CK & Sastry NSR. 2013. Livestock Production Management. Kalyani Publisher.

XIV. LANGUAGE

1. Comprehension and Communication Skills in English 2(1+1)

Theory

War Minus Shooting- The sporting Spirit. A Dilemma- A layman looks at science Raymond B. Fosdick. You and Your English – Spoken English and broken English G.B. Shaw. Reading Comprehension, Vocabulary- Antonym, Synonym, Homophones, Homonyms, often confused words. Exercises to Help the students in the enrichment of vocabulary based on TOEFL and other competitive examinations. Functional grammar: Articles, Prepositions, Verb, Subject verb Agreement, Transformation, Synthesis, Direct and Indirect Narration. Written Skills: Paragraph writing, Precise writing, Report writing and Proposal writing. The Style: Importance of professional writing. Preparation of Curriculum Vitae and Job applications. Synopsis Writing. Interviews: kinds, Importance and process.

Practical

Listening Comprehension: Listening to short talks lectures, speeches (scientific, commercial and general in nature). Oral Communication: Phonetics, stress and intonation, Conversation practice. Conversation: rate of speech, clarity of voice, speaking and Listening, politeness &Reading skills: reading dialogues, rapid reading, intensive reading, improving reading skills. Mock Interviews: testing initiative, team spirit, leadership, intellectual ability. Group Discussions.

Suggested readings:

1. Shah, A. 2018. Handbook of Communication Skills & English Grammar. Prabhat.
2. Mishra, R. and Rao, R. 2019. A Textbook of English and Communication Skills. Macmillan Education.
3. Kumar, S. and Lata, P. 2015. Communication Skills. Oxford University Press.
4. Gupta, S C. 2012. Comprehensive English Grammar & Composition. Arihant.

XV. REMEDIAL COURSES

1. Agricultural Heritage (New Course) 1(1+0)

Theory

Introduction of Indian agricultural heritage; Ancient agricultural practices, Relevance of heritage to present day agriculture; Past and present status of agriculture and farmers in society; Journey of Indian agriculture and its development from past to modern era; Plant production and protection through indigenous traditional knowledge; Crop voyage in India and world; Agriculture scope; Importance of agriculture and agricultural resources available in India; Crop significance and classifications; National agriculture setup in India; Current scenario of Indian agriculture; Indian agricultural concerns and future prospects.

Suggested readings:

1. Choudhary, S.L., Sharma, G.S. and Nene, Y.L. 2000. Ancient and medievel history of Indian agriculture and its relevance to sustainable agriculture in the 21st century.
2. Proceedings of the sumemr school held from 28 May to 17 June 1999. Rajasthan College of Agriculture, Udaipur, India
3. Nene, Y.L. and Choudhary, S.L. 2002. Agricultural heritage of India. Asian Agri –History foundation, Secundrabad.
4. Randhawa, M.S., 1980 – 86. A histroy of Agriculture in India. Vol. I, II, III and IV. Indian council of Agricultural Research, New Delhi.
5. Raychaudhuri, S.P. 1964. Agriculture in ancient India. Indian council of Agricultural Research, New Delhi.

2. Introductory Biology (New) 2(1+1)

Theory

Introduction to the living world, diversity and characteristics of life, origin of life, Evolution and Eugenics. Binomial nomenclature and classification Cell and cell division. Morphology of flowing plants. Seed and seed germination. Plant systematic- viz; Brassicaceae, Fabaceae and Poaceae. Role of animals in agriculture.

Practical

Morphology of flowering plants – root, stem and leaf and their modifications. Inflorence, flower and fruits. Cell, tissues & cell division. Internal structure of root, stem and leaf. Study of specimens and slides. Description of plants - Brassicaceae, Fabaceae and Poaceae.

Suggested readings:

1. Bendre A & Kumar A. 2022. Textbook of Practical Botany. Vol. 2, 7th Ed., Rastogi Publications.
2. Bendre AM & Pande PC. 2009. Introduction to Botany. Rastogi publications.
3. Dutta AC. 1995. A Class Book of Botany, 16th Edition. Oxford University Press.
4. Bhatia KN &Tyagi MP. 2024. Trueman's Elementary Biology. Trueman Book Company, Vol. 1 & 2.
5. Dhami PS & Mahindru RC. A Text Book of Biology for 10+2. Pradeep Publications., Vol. 1 & 2.

3. Elementary Mathematics (New) 2(2+0)

Theory

Straight lines : Distance formula, section formula (internal and external division), Change of axes (only origin changed), Equation of co-ordinate axes, Equation of lines parallel to axes, Slope-intercept form of equation of line, Slope-point form of equation of line, Two point form of equation of line, Intercept form of equation of line, Normal form of equation of line, General form of equation of line, Point of intersection of two st. lines, Angles between two st. lines, Parallel lines, Perpendicular lines, Angle of bisectors between two lines, Area of triangle and quadrilateral. Circle: Equation of circle whose centre and radius is known, General equation of a circle, Equation of circle passing through three given points, Equation of circle whose diameters is line joining two points (x_1, y_1) & (x_2,y_2), Tangent and Normal to a given circle at given point (Simple problems), Condition of tangency of a line y = mx + c to the given circle x2 + y2 = a2. Differential Calculus: Definition of function, limit and continuity, Simple problems on limit, Simple problems on continuity, Differentiation of xn , ex , sin x & cos x from first principle, Derivatives of sum, difference, product and quotient of two functions, Differentiation of functions of functions (Simple problem based on it), Logarithmic differentiation (Simple problem based on it), Differentiation by substitution method and simple problems based on it, Differentiation of Inverse Trigonometric functions. Maxima and Minima of the functions of the form y=f (x) (Simple problems based on it). Integral Calculus: Integration of simple functions, Integration of Product of two functions, Integration by substitution method, Definite Integral (simple problems based on it), Area under simple well-known curves (simple problems based on it). Matrices and Determinants: Definition of Matrices, Addition, Subtraction, Multiplication, Transpose and Inverse up to 3rd order, Properties of determinants up to 3rd order and their evaluation**.**

Suggested readings:

1. NCERT. 2019. Mathematics of Class XI. NCERT India.
2. Sharma RD. 2023. Mathematics of Class XI. Dhanpat Rai Publisher., Vol. 1 & 2.
3. NCERT. 2012. Mathematics of Class XII. NCERT India., Pt. 1 & 2.
4. Sharma RD. 2014. Mathematics of Class XII. Dhanpat Rai Publisher, Vol. 1 &2

XVI. NON-GRADIAL COURSES

1. NSS/NCC/Physical Education & Yoga Practices 2(0+2)

Theory

Course aims at evoking social consciousness among students through various activities viz., working together, constructive and creative social work, to be skilful in executing democratic leadership, developing skill in programme development to be able for self employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Following activities are to be taken up under the NSS course:

- Introduction and basic components of NSS: Orientation
- NSS programmes and activities
- Understanding youth

- Community mobilisation
- Social harmony and national integration
- Volunteerism and shramdan
- Citizenship, constitution and human rights
- Family and society
- Importance and role of youth leadership
- Life competencies
- Youth development programmes
- Health, hygiene and sanitation
- Youth health, lifestyle, HIV AIDS and first aid
- Youth and yoga
- Vocational skill development
- Issues related environment
- Disaster management
- Entrepreneurship development
- Formulation of production oriented project
- Documentation and data reporting
- Resource mobilization
- Additional life skills
- Activities directed by the Central and State Government

All the activities related to the National Service Scheme course is distributed under four different courses viz., National Service Scheme I, National Service Scheme II, National Service Scheme III and National Service Scheme IV each having one credit load. The entire four courses should be offered continuously for two years. A student enrolled in NSS course should put in at least 60 hours of social work in different activities in a semester other than five regular one day camp in a year and one special camp for duration of 7 days at any semester break period in the two year. Different activities will include orientation lectures and practical works. Activities directed by the Central and State Government have to be performed by all the volunteers of NSS as per direction.

SYLLABUS

Semester I

Course Title: National Service Scheme I

Introduction and basic components of NSS:

Orientation: history, objectives, principles, symbol, badge; regular programmes under NSS,

organizational structure of NSS, code of conduct for NSS volunteers, points to be considered by NSS volunteers awareness about health

NSS programmes and activities

Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analysing guiding financial patterns of scheme, youth programme/ schemes of GOI, coordination with different agencies and maintenance of diary

Understanding youth

Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change

Community mobilisation

Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilisation involving youth-adult partnership

Social harmony and national integration

Indian history and culture, role of youth in nation building, conflict resolution and peace- building

Volunteerism and shramdan

Indian tradition of volunteerism, its need, importance, motivation and constraints; shramdan as part of volunteerism

Citizenship, constitution and human rights

Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information

Family and society

Concept of family, community (PRIs and other community based organisations) and society

Semester II

Course Title: National Service Scheme II

Importance and role of youth leadership

Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership

Life competencies

Definition and importance of life competencies, problem-solving and decision-making, inter personal communication

Youth development programmes

Development of youth programmes and policy at the national level, state level and voluntary sector; youth-focused and youth-led organisations

Health, hygiene and sanitation

Definition needs and scope of health education; role of food, nutrition, safe drinking water, water born diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programmes and reproductive health.

Youth health, lifestyle, HIV AIDS and first aid

Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid

Youth and yoga

History, philosophy, concept, myths and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method

Semester III

Course Title: National Service Scheme III

Vocational skill development

To enhance the employment potential and to set up small business enterprises skills of volunteers, a list of 12 to 15 vocational skills will be drawn up based on the local conditions and opportunities. Each volunteer will have the option to select two skill-areas out of this list

Issues related environment

Environmental conservation, enrichment and sustainability, climatic change, natural resource management (rain water harvesting, energy conservation, forestation, waste land development and soil conservations) and waste management

Disaster management

Introduction and classification of disaster, rehabilitation and management after disaster; role of NSS volunteers in disaster management.

Entrepreneurship development

Definition, meaning and quality of entrepreneur; steps in opening of an enterprise and role of financial and support service institution.

Formulation of production-oriented project

Planning, implementation, management and impact assessment of project

Documentation and data reporting

Collection and analysis of data, documentation and dissemination of project reports

Semester IV

Course Title: National Service Scheme IV

Youth and crime

Sociological and psychological factors influencing youth crime, cyber crime, pear mentoring in preventing crime and awareness for juvenile justice

Civil/self defence

Civil defence services, aims and objectives of civil defence; needs and training of self defence

Resource mobilisation

Writing a project proposal of self fund units (SFUs) and its establishment

Additional life skills

Positive thinking, self confidence and esteem, setting life goals and working to achieve them, management of stress including time management.

Suggested readings for NSS:

1. MoYAS. 2006. National Service Scheme Manual (Revised). Ministry of Youth Affairs & Sports, Government of India, New Delhi. https://www.nss.gov.in/sites/default/files/manualNss2006.pdf

National Cadet Corps Credit hours: 2(0+2)

Semester I: National Cadet Corps

1. Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
2. Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
3. Sizing, numbering, forming in three ranks, open and close order march and dressing.
4. Saluting at the halt, getting on parade, dismissing and falling out.
5. Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear.
6. Turning on the march and wheeling. Saluting on the march.
7. Marking time, forward march and halt.
8. Changing step, formation of squad and squad drill.
9. Command and control, organization, badges of rank, honours and awards
10. Nation Building- cultural heritage, religions, traditions and customs of India. National integration.
11. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizen.
12. Leadership traits, types of leadership. Character/personality development.
13. Civil defense organization, types of emergencies, fire fighting, protection,
14. Maintenance of essential services, disaster management, aid during development projects.
15. Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
16. Structure and function of human body, diet and exercise, hygiene and sanitation.
17. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health.

18. Adventure activities
19. Basic principles of ecology, environmental conservation, pollution and its control.
20. Precaution and general behaviour of girl cadets, prevention of untoward incidents, vulnerable parts of the body, self defense.

Semester II: National Cadet Corps

1. Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms.
2. Shoulder from the order and vice-versa, present from the order and vice-versa.
3. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa.
4. Guard mounting, guard of honour, Platoon/Coy Drill.
5. Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning and sight setting.
6. Loading, cocking and unloading. The lying position and holding.
7. Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight.
8. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing.
9. Characteristics of Carbine and LMG.
10. Introduction to map, scales and conventional signs. Topographical forms and technical terms.
11. The grid system. Relief, contours and gradients. Cardinal points and finding north. Types of bearings and use of service protractor.
12. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map.
13. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
14. Field defenses obstacles, mines and mine lying. Bridging, waterman ship
15. Field water supplies, tracks and their construction.
16. Nuclear, Chemical and Biological Warfare (NCBW)
17. Judging distance. Description of ground and indication of landmarks.
18. Recognition and description of target. Observation and concealment. Field signals. Section formations.
19. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill.
20. Types of communication, media, latest trends and developments.

Suggested readings for NCC:

1. Cadet's Handbook. Common Subjects SD / SW. The DG NCC, New Delhi. https://indiancc.nic.in/cadets-handbook/

Physical Education and Yoga Practices Credit hours: 2(0+2) (0+2)

Semester I: Physical Education and Yoga Practices

1. Teaching of skills of Football – demonstration, practice of the skills, correction, involvement in game situation (For girls teaching of Tennikoit)
2. Teaching of different skills of Football – demonstration, practice of the skills, correction, involvement in game situation (For girls teaching of Tennikoit)
3. Teaching of advance skills of Football – involvement of all the skills in game situation with teaching of rules of the game
4. Teaching of skills of Basketball – demonstration, practice of the skills, correction of skills, involvement in game situation
5. Teaching of skills of Basketball – demonstration, practice of the skills, involvement in game situation
6. Teaching of skills of Basketball – involvement of all the skills in game situation with teaching of rule of the game
7. Teaching of skills of Kabaddi – demonstration, practice of the skills, correction of skills, involvement in game situation
8. Teaching of skills of Kabaddi – demonstration, practice of the skills, correction of skills, involvement in game situation
9. Teaching of advance skills of Kabaddi – involvement of all the skills in game situation with teaching of rule of the game
10. Teaching of skills of Ball Badminton – demonstration, practice of the skills, correction of skills, involvement in game situation
11. Teaching of skills of Ball Badminton – involvement of all the skills in game situation with teaching of rule of the game
12. Teaching of some of Asanas – demonstration, practice, correction and practice
13. Teaching of some more of Asanas – demonstration, practice, correction and practice
14. Teaching of skills of Table Tennis – demonstration, practice of skills, correction and practice and involvement in game situation
15. Teaching of skills of Table Tennis – demonstration, practice of skills, correction and practice and involvement in game situation
16. Teaching of skills of Table Tennis – involvement of all the skills in game situation with teaching of rule of the game
17. Teaching – Meaning, Scope and importance of Physical Education
18. Teaching – Definition, Type of Tournaments
19. Teaching – Physical Fitness and Health Education
20. Construction and laying out of the track and field (*The girls will have Tennikoit and Throw Ball).

Semester II: Physical Education and Yoga Practices

1. Teaching of skills of Hockey – demonstration practice of the skills and correction.
2. Teaching of skills of Hockey – demonstration practice of the skills and correction. And involvement of skills in games situation
3. Teaching of advance skills of Hockey – demonstration practice of the skills and correction. Involvement of all the skills in games situation with teaching of rules of the game
4. Teaching of skills of Kho-Kho – demonstration practice of the skills and correction.
5. Teaching of skills of Kho-Kho – demonstration practice of the skills and correction. Involvement of the skills in games situation
6. Teaching of advance skills of Kho-Kho – demonstration practice of the skills and correction. Involvement of all the skills in games situation with teaching of rules of the game
7. Teaching of different track events – demonstration practice of the skills and correction.
8. Teaching of different track events – demonstration practice of the skills and correction.
9. Teaching of different track events – demonstration practice of the skills and correction with competition among them.
10. Teaching of different field events – demonstration practice of the skills and correction.
11. Teaching of different field events – demonstration practice of the skills and correction.
12. Teaching of different field events – demonstration practice of the skills and correction.
13. Teaching of different field events – demonstration practice of the skills and correction with competition among them.
14. Teaching of different asanas – demonstration practice and correction.
15. Teaching of different asanas – demonstration practice and correction.
16. Teaching of different asanas – demonstration practice and correction.
17. Teaching of different asanas – demonstration practice and correction.
18. Teaching of weight training – demonstration practice and correction.
19. Teaching of circuit training – demonstration practice and correction.
20. Teaching of calisthenics – demonstration practice and correction.

Note: 1) Compulsory Uniform: Half pants, Tee Shirts, Shoes and socks all white (Girls will have white Tee Shirt and Track pants) 2) The games mentioned in the practical may be inter changed depending on the season and facilities.

Suggested readings for Physical Education and Yoga practices:

1. NAAC. 2021. Manual for Yoga Higher Education Institutional Accreditation. National Assessment and Accreditation Council, Bengaluru. http://naac.gov.in/images/docs/Manuals/Yoga_University_manual_as_on_11-11-21.pdf

Course title: Human Value and Ethics 1(1+0)

Theory

Values and Ethics-An Introduction. Goal and Mission of Life. Vision of Life. Principles and Philosophy. Self Exploration. Self Awareness. Self Satisfaction. Decision Making. Motivation. Sensitivity. Success. Selfless Service. Case Study of Ethical Lives. Positive Spirit. Body, Mind and Soul. Attachment and Detachment. Spirituality Quotient. Examination.

Suggested readings:

1. GaurRR, Sangal R & Bagaria GP. 2019. A Foundation Course in Human Values and Professional Ethics. ExcelBooks.
2. Mathur S S. 2010. Education forValues,Environment and Human Rights. RSA International.
3. Sharma R A. 2011. Human Values and Education-Axiology, Inculcation and Research. R. Lall Book Depot.
4. Sharma R P & SharmaM. 2011. Value Education and Professional Ethics. Kanishka Publishers.
5. Srivastava S. 2011. Human Values and Professional Ethics. S K Kataria & Sons.

Course Title: Educational Tour 2 (0+2)

ELECTIVE COURSES

1. Agri-business Management 3 (2+1)

Theory

Transformation of agriculture into agribusiness, various stakeholders and components of agribusiness systems. Importance of agribusiness in the Indian economy and New Agricultural Policy. Distinctive features of Agribusiness Management: Importance and needs of agro-based industries, Classification of industries and types of agro based industries. Institutional arrangement, procedures to set up agro based industries. Constraints in establishing agro-based industries. Agri-value chain: Understanding primary and support activities and their linkages. Business environment: PEST & SWOT analysis. Management functions: Roles & activities, Organization culture. Planning, meaning, definition, types of plans. Purpose or mission, goals or objectives, Strategies, polices procedures, rules, programs and budget. Components of a business plan, Steps in planning and implementation. Organization staffing, directing and motivation. Ordering, leading, supervision, communications, control. Capital Management and Financial management of Agribusiness. Financial statements and their importance. Marketing Management: Segmentation, targeting & positioning. Marketing mix and marketing strategies. Consumer behaviour analysis, Product Life Cycle (PLC). Sales & Distribution Management. Pricing policy, various pricing methods. Project Management definition, project cycle, identification, formulation, appraisal, implementation, monitoring and evaluation. Project Appraisal and evaluation techniques.

Practical

Study of agri-input markets: Seed, fertilizers, pesticides. Study of output markets: grains, fruits, vegetables, flowers. Study of product markets, retails trade commodity trading, and value added products. Study of

financing institutions- Cooperative, Commercial banks, RRBs, Agribusiness Finance Limited, NABARD. Preparations of projects and Feasibility reports for agribusiness entrepreneur. Appraisal/evaluation techniques of identifying viable project- Non-discounting techniques. Case study of agro-based industries. Trend and growth rate of prices of agricultural commodities. Net present worth technique for selection of viable project. Internal rate of return.

Suggested readings:

1. Harold Koontz & Heinz Weihrich. 2010. Essentials of Management: An International.
2. Mukesh Pandey & DeepaliTewari. The Agribusiness Book. IBDC Publishers.
3. Nandan H. 2013. Fundamentals of Entrepreneurship. PHI Learning Pvt Ltd India.
4. Philip Kotler, Kavin Lane Keller, Abraham Koshy & Mithileshwar Jha. 2022. Marketing Management, Pearson
5. Poornima Charantimath. 2018. Entrepreneurship Development: Small Business Enterprise, Pearson
6. Stephans P Robbins & Mary Coulter. 2003. Management. Pearson Education.

2. Agrochemicals 3 (2+1)

Theory

An introduction to agrochemicals, their type and role in agriculture, effect on environment, soil, human and animal health, merits and demerits of their uses in agriculture, management of agrochemicals for sustainable agriculture.

Herbicides-Major classes, properties and important herbicides. Fate of herbicides.

Fungicides - Classification – Inorganic fungicides - characteristics, preparation and use of sulfur and copper, Mode of action-Bordeaux mixture and copper oxychloride.

Organic fungicides- Mode of action- Dithiocarbamates-characteristics, preparation and use of Zineb and maneb.

Systemic fungicides- Benomyl, carboxin, oxycarboxin, Metalaxyl, Carbendazim, characteristics and use. Introduction and classification of insecticides: inorganic and organic insecticides Organochlorine, Organophosphates, Carbamates, Synthetic pyrethroids Neonicotinoids, Biorationals, Insecticide Act and rules, Insecticides banned, withdrawn and restricted use, Fate of insecticides in soil & plant. IGRs Biopesticides, Reduced risk insecticides, Botanicals, plant and animal systemic insecticides their characteristics and uses.

Fertilizers and their importance. Nitrogenous fertilizers: Feedstocks and Manufacturing of ammonium sulphate, ammonium nitrate, ammonium chloride, urea. Slow release N-fertilizers. Phosphatic fertilizers: feedstock and manufacturing of single superphosphate. Preparation of bone meal and basic slag. Potassic fertilizers: Natural sources of potash, manufacturing of potassiumchloride, potassium sulphate and potassium nitrate.

Mixed and complex fertilizers: Sources and compatibility–preparation of major, secondary and micronutrient mixtures. Complex fertilizers: Manufacturing of ammonium phosphates, nitrophosphates and NPK

complexes. Fertilizer control order. Fertilizer logistics and marketing.

Plant bio-pesticides for ecological agriculture, Bio-insect repellent.

Practical

Sampling of fertilizers and pesticides. Pesticides application technology to study about various pesticides appliances. Quick tests for identification of common fertilizers. Identification of anion and cation in fertilizer. Calculation of doses of insecticides to be used. To study and identify various formulations of insecticide available kin market. Estimation of nitrogen in Urea. Estimation of water soluble P_2O_5 and citrate soluble P_2O_5 in single super phosphate. Estimation of potassium in Muraite of Potash/ Sulphate of Potash by flame photometer. Determination of copper content in copper oxychloride. Determination of sulphur content in sulphur fungicide. Determination of thiram. Determination of ziram content.

Suggested readings:

1. K.S. Yawalkar, J.P. Agarwal, S. Bokde. 2012. Manures and Fertilisers, 12th Edition. Jain Publisher.
2. Havlin, J. L., Tisdale, S. L., Nelson, W. L. and Beaton, J. D. 2016. Soil Fertility and Fertilizers. Pearson Publishers
3. Kearnay PC and Kaufman DD. 1975. Herbicides: Chemistry, Degradation and Mode of Action. Vols. I, II. Marcel Dekker.
4. Matolcsy G, Nadasy M and Andriska V. 1989. Pesticide Chemistry, Volume 32 (1st Edition) G. eBook ISBN: 9780080874913, Elsevier Science, pp 805
5. Cremlyn RJ. 1990. Pesticides: Preparation and Mode of Action. Wiley
6. Kramer WK and Ulrich Schirmer. 2007. Modern Crop Protection Compounds. Wiley-vch Verlag Gmbh.
7. ICAR Institute/SAU. Practical Manual on Agrochemicals for Weed and Crop Management

3. Commercial Plant Breeding 3(1+2)

Theory

Types of crops and modes of plant reproduction. Line development and maintenance breeding in self- and cross-pollinated crops (A/B/R and two line system) for development of hybrids and seed production. Genetic purity test of commercial hybrids. Advances in hybrid seed production of maize, rice, sorghum, pearl millet, castor, sunflower, cotton pigeon pea, Brassica etc. Quality seed production of vegetable crops under open and protected environment. Alternative strategies for the development of the line and cultivars: haploid inducer, tissue culture techniques and biotechnological tools. IPR issues in commercial plant breeding: DUS testing and registration of varieties under PPV & FR Act. Variety testing, release and notification systems in India. Principles and techniques of seed production, types of seeds, quality testing in self and cross pollinated crops.

Practical

Floral biology in self and cross pollinated species, selfing and crossing techniques. Techniques of seed production in self and cross pollinated crops using A/B/R and two line system. Learning techniques in hybrid seed production using male-sterility in field crops. Understanding the difficulties in hybrid

seed production, Tools and techniques for optimizing hybrid seed production. Concept of rouging in seed production plot. Concept of line its multiplication and purification in hybrid seed production. Role of pollinators in hybrid seed production. Hybrid seed production techniques in sorghum, pearl millet, maize, rice, rapeseed-mustard, sunflower, castor, pigeon pea, cotton and vegetable crops. Sampling and analytical procedures for purity testing and detection of spurious seed. Seed drying and storage structure in quality seed management. Screening techniques during seed processing viz., grading and packaging. Visit to public private seed production and processing plants.

Suggested readings:

1. B.D. Singh. 2022. Plant Breeding: Principles and Methods. Med Tech Science Press.
2. Phundan Singh. 2014. Essentials of Plant Breeding. Kalyani Publishers.
3. B. D. Singh. 2018. Plant breeding: principles and methods. Kalyani Publisher.
4. B.D. Singh and A. K. Singh. 2016. Marker assisted plant breeding: principles and practices. Springer, New Delhi.

4. Landscaping 3(2+1)

Theory

Importance and scope of landscaping. Principles of landscaping, garden styles and types, terrace gardening, vertical gardening, garden components, adornments, lawn making, rockery, water garden, walk-paths, bridges, other constructed features etc. gardens for special purposes. Trees: selection, propagation, planting schemes, canopy management, shrubs and herbaceous perennials: selection, propagation, planting schemes, architecture. Climber and creepers: importance, selection, propagation, planting, Annuals: selection, propagation, planting scheme, Other garden plants: palms, ferns, grasses and cacti succulents. Pot plants: selection, arrangement, management. Bio-aesthetic planning: definition, need, planning; landscaping of urban and rural areas, Peri-urban landscaping, Landscaping of schools, public places like bus station, railway station, townships, river banks, hospitals, play grounds, airports, industries, institutions. Bonsai: principles and management, lawn: establishment and maintenance. CAD application.

Practical

Identification of trees, shrubs, annuals, pot plants; Propagation of trees, shrubs and annuals, care and maintenance of plants, potting and repotting, identification of tools and implements used in landscape design, training and pruning of plants for special effects, lawn establishment and maintenance, layout of formal gardens, informal gardens, special type of gardens (sunken garden, terrace garden, rock garden) and designing of conservatory and lathe house. Use of computer software, visit to important gardens/ parks/ institutes.

Suggested readings:

1. Bose TK, Chowdhury B and Sharma SP. 2011. Tropical Garden Plants in Colour. Hort. and Allied Publ.
2. Bose TK, Maiti RG, Dhua RS and Das P. 1999. Floriculture and Landscaping. Naya Prokash, Kolkata, India.

3. Grewal HS and Singh P. 2014. Landscape Designing and Ornamental Plants. Kalyani Publishers, New Delhi.
4. Lauria A and Victor HR. 2001. Floriculture-Fundamentals and Practices.Agrobios Publ., Jodhpur.
5. Misra RL and Misra S. 2012. Landscape Gardening. Westville Publ. House, New Delhi, India.
6. Nambisan KMP. 1992. Design Elements of Landscape Gardening. Oxford & IBH Publ. Co., New Delhi, India.
7. Randhawa GS and Mukhopadhyay A. 1986. Floriculture in India. Allied Publ.
8. Sabina GT and Peter KV. 2008. Ornamental Plants for Gardens. New India Publ. Agency, New Delhi, India.
9. Singh A and Dhaduk BK. 2015. A Colour Handbook: Landscape Gardening. New India Publ. Agency, New Delhi, India

5. Food Safety and Standards 3(2+1)

Theory

Food Safety – Definition, Importance, Scope and Factors affecting Food Safety. Hazards and Risks, Types of hazards - Biological, Chemical, Physical hazards. Management of hazards - Need. Control of parameters. Temperature control. Food storage. Product design. Hygiene and Sanitation in Food Service Establishments- Introduction. Sources of contamination and their control. Waste Disposal. Pest and Rodent Control. Personnel Hygiene. Food Safety Measures. Food Safety Management Tools- Basic concepts. PRPs, GHPs, GMPs, SSOPs etc. HACCP. ISO series. TQM concept and need for quality, components of TQM, Kaizen. Risk Analysis. Accreditation and Auditing, Water Analysis, Surface Sanitation and Personal Hygiene. Food laws and Standards- Indian Food Regulatory Regime, FSSA. Global Scenario CAC. Other laws and standards related to food. Recent concerns- New and Emerging Pathogens. Packaging, Product labeling and Nutritional labeling. Genetically modified foods\ transgenics. Organic foods. Newer approaches to food safety. Recent Outbreaks. Indian and International Standards for food products.

Practical

Water quality analysis physico-chemical and microbiological. Preparation of different types of media. Microbiological Examination of different food samples. Assessment of surface sanitation by swab/rinse method. Assessment of personal hygiene. Biochemical tests for identification of bacteria. Scheme for the detection of food borne pathogens. Preparation of plans for Implementation of FSMS - HACCP, ISO: 22000.

Suggested readings:

1. Joshi, S.A - Nutrition and dietetics (with Indian Care Studies) Fourth Edition MC Graw Hill Education (India) Pvt. Ltd., New Delhi
2. Mudambi S R, Raja Gopal M V - Fundamentals of Food & Nutrition New Age International Publisher, New Delhi
3. Manay , S.N, Shadaksharaswany M - Food: Facts and Principles New Age International Publisher, 5th Edition
4. Tondon GL, Sidhappa, GS, Lal G. - Preservation of Fruits and Vegetables, ICAR
5. Asrey and Barman - Postharvest Horticultural Principles and Practices Kalyani Publisher, New Delhi

6. Biopesticides & Biofertilizers 3(2+1)

Theory

History and concept of biopesticides. Importance, scope and potential of biopesticide. Definitions, concepts and classification of biopesticides viz. pathogen, botanical pesticides, and biorationales. Botanicals and their uses. Mass production technology of bio-pesticides. Virulence, pathogenicity and symptoms of entomopathogenic pathogens and nematodes. Methods of application of biopesticides. Methods of quality control and Techniques of biopesticides. Impediments and limitation in production and use of biopesticide.

Biofertilizers - Introduction, status and scope. Structure and characteristic features of bacterial biofertilizers- *Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium* and *Frankia*; Cynobacterial biofertilizers- *Anabaena*, *Nostoc*, Hapalosiphon and fungal biofertilizers- AM mycorrhiza and ectomycorhiza. Nitrogen fixation -Free living and symbiotic nitrogen fixation. Mechanism of phosphate solubilization and phosphate mobilization, K solubilization. Production technology: Strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid biofertiizers. FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers, sets etc. Biofertilizers -Storage, shelf life, quality control and marketing. Factors influencing the efficacy of biofertilizers.

Practical

Isolation and purification of important biopesticides: *Trichoderma Pseudomonas, Bacillus, Metarhyzium* etc. and its production. Identification of important botanicals. Visit to biopesticide laboratory in nearby area. Field visit to explore naturally infected cadavers. Identification of entomopathogenic entities in field condition. Quality control of biopesticides. Isolation and purification of *Azospirillum , Azotobacter, Rhizobium*, P-solubilizers and cyanobacteria. Mass multiplication and inoculums production of biofertilizers. Isolation of AM fungi -Wet sieving method and sucrose gradient method. Mass production of AM inoculants.

Suggested readings:

1. Basics of Organic Farming: by Mamta Bansal. Kindle Edition.
2. The Complete book of Organic farming and products of organic compost: NPCS Board of consultants and Engineers.
3. ABC of Organic Farming: Amitava Rakshit and H.B. Singh. Jain Brothers
4. S.R. Reddy. Principles of Organic Farming: Kalyani Publisher.
5. G. S. Dhaliwal and Ramesh Arora. An Introduction to Integrated Pest Management.

7. Protected Cultivation 3(2+1)

Theory

Protected cultivation- importance and scope, Status of protected cultivation in India and World types of protected structure based on site and climate. Cladding material involved in greenhouse/ poly house. Greenhouse design, environment control, artificial lights, Automation. Soil preparation and management, Substrate management. Types of benches and containers. Irrigation and fertigation management. Propagation and production of quality planting material of horticultural crops. Greenhouse cultivation of important horticultural crops – rose, carnation, chrysanthemum, gerbera, orchid, anthurium, lilium, tulip, tomato, bell pepper, cucumber, strawberry, pot plants, etc. Cultivation of economically important medicinal and aromatic plants. Off-season production of flowers and vegetables. Insect pest and disease management.

Practical

Raising of seedlings and saplings under protected conditions, use of protrays in quality planting material production, Bed preparation and planting of crop for production, Inter cultural operations, Soil EC and pH measurement, Regulation of irrigation and fertilizers through drip, fogging ad misting.

Suggested readings:

1. Kumar, S. Kumar, A and Kumar, S. 2020. Protected Cultivation and Secondary Agriculture. Lambert Academia Publishing.
2. Deogirikar A A. 2021.Protected Cultivation And Secondary Agriculture. Brillion Publishing.
3. Kumar, S, Saravaiya, S.N. et al. 2021. Precision Farming and Protected Cultivation: Concepts and Applications. CRC Press.

8. Micro propagation Technologies 3(1+2)

Theory

Introduction, History, Advantages and limitations; Types of cultures (seed, embryo, organ, callus, cell), Stages of micropropagation, Axillary bud proliferation (Shoot tip and meristem culture, bud culture),Organogenesis (callus and direct organ formation), Somatic embryogenesis, cell suspension cultures, Production of secondary metabolites, Somaclonal variation, Cryopreservation

Practical

Identification and use of equipments in tissue culture Laboratory, Nutrition media composition, sterilization techniques for media, containers and small instruments, sterilization techniques for

explants, Preparation of stocks and working solution, Preparation of working medium, Culturing of explants: Seeds, shoot tip and single node, Callus induction, Induction of somatic embryos regeneration of whole plants from different explants, Hardening procedures.

Suggested readings:

1. Debergh PC & Zimmerman RH. 1991. Micropropagation: Technology and Application. Kluwer Academic.
2. George EF, Hall MA &Klerk GJD. 2007. Plant Propagation by Tissue Culture. Volume

9. Hi-tech. Horticulture 3(2+1)

Theory

Introduction & importance; Nursery management and mechanization; micro propagation of horticultural crops; Modern field preparation and planting methods, Protected cultivation: advantages, controlled conditions, method and techniques, Micro irrigation systems and its components; EC, pH based fertilizer scheduling, canopy management, high density orcharding, Components of precision farming: Remote sensing, Geographical Information System (GIS), Differential Geo-positioning System (DGPS), Variable Rate applicator (VRA), application of precision farming in horticultural crops (fruits, vegetables and ornamental crops); mechanized harvesting of produce.

Practical

Types of polyhouses and shade net houses, Intercultural operations, tools and equipments identification and application, Micro propagation, Nursery-protrays, micro-irrigation, EC, pH based fertilizer scheduling, canopy management, visit to hi-tech orchard/nursery.

Suggested readings:

1. Kumar, S. Kumar, A and Kumar, S. 2020. Protected Cultivation and Secondary Agriculture. Lambert Academia Publishing.
2. Deogirikar A A. 2021.Protected Cultivation And Secondary Agriculture. Brillion Publishing.
3. Kumar, S, Saravaiya, S.N. et al. 2021. Precision Farming and Protected Cultivation: Concepts and Applications. CRC Press.
4. Kumar, P., Patil, V., Kalpana D., Wale, B. and Vishal D. Precision Farming and Geoinformatics. Daya Publishing House. New Delhi.
5. Reddy S.R. 2017. Geoinformatics and Nanotechnology for Precision Farming. Kalyani Publishers.
6. Lillesand TM and Kiefer RW. 1994. Remote Sensing and Image Interpretation. 3rd Ed. Wiley.
7. Nielsen DR and Wendroth O. 2003. Spatial and Temporal Statistics. Catena Verloggmbh.
8. Star J and Esles J. 1990. Geographic Information System: An Introduction. Prentice Hall.

10. Weed Management 3(2+1)

Theory

Introduction to weeds, characteristics of weeds their harmful and beneficial effects on ecosystem. Classification, reproduction and dissemination of weeds. Herbicide classification, concept of adjuvant, surfactant, herbicide formulation and their use. Introduction to mode of action of herbicides and selectivity. Allelopathy and its application for weed management. Bio-herbicides and their application in agriculture. Concept of herbicide mixture and utility in agriculture. Herbicide compatibility with agro-chemicals and their application. Integration of herbicides with non chemical methods of weed management. Herbicide Resistance and its management.

Practical

Techniques of weed preservation. Weed identification and their losses study. Biology of important weeds. Study of herbicide formulations and mixture of herbicide. Herbicide and agro- chemicals study. Shift of weed flora study in long term experiments. Study of methods of herbicide application, spraying equipments. Calculations of herbicide doses and weed control efficiency and weed index.

Suggested readings:

1. Das TK. 2008. *Weed Science: Basics and Applications*, Jain Brothers (New Delhi).
2. Chauhan B and Mahajan G. 2014. *Recent Advances in Weed Management*. Springer.
3. Fennimore, Steven A and Bell, Carl. 2014. *Principles of Weed Control*, 4th Ed, California Weed Sci. Soc.

4. Gupta OP. 2007. *Weed Management*: *Principles and Practices*, 2nd Ed.
5. Jugulan, Mithila (ed). 2017. *Biology, Physiology and Molecular Biology of Weeds*. CRC Press
6. Monaco TJ, Weller SC and Ashton FM. 2014. *Weed Science Principles and Practices*, Wiley
7. Powles SB and Shaner DL. 2001. Herbicide Resistance and World Grains, CRC Press.
8. Walia US. 2006. *Weed Management*, Kalyani.

11. System Simulation and Agroadvisory 3(2+1)

Theory

System Approach for representing soil-plant-atmospheric continuum, system boundaries, Crop models, concepts & techniques, types of crop models, data requirements, relational diagrams. Evaluation of crop responses to weather elements; Elementary crop growth models; calibration, validation, verification and sensitivity analysis. Potential and achievable crop production- concept and modelling techniques for their estimation. Crop production in moisture and nutrients limited conditions; components of soil water and nutrients balance. Weather forecasting, types, methods, tools & techniques, forecast verification; Value added weather forecast, ITK for weather forecast and its validity; Crop-Weather Calendars; Preparation of agro-advisory bulletin based on weather forecast. Use of crop simulation model for preparation of Agro-advisory and its effective dissemination.

Practical

Preparation of crop weather calendars. Preparation of agro-advisories based on weather forecast using various approaches and synoptic charts. Working with statistical and simulation models for crop growth. Potential & achievable production; yield forecasting, insect & disease forecasting models. Simulation with limitations of water and nutrient management options. Sensitivity analysis of varying weather and crop management practices. Use of statistical approaches in data analysis and preparation of historical, past and present meteorological data for medium range weather forecast. Feedback from farmers about the agroadvisory.

Suggested readings:

1. Datta SC. 2008. *Theory and Principles of Simulation Modeling in Soil-Plant System*. Capital Publishing Company, New Delhi.
2. Frame J and Thornley JHM. 1984. *Mathematical Models in Agriculture—A Quantitative approach to problems in agriculture and related science*. Butterworth and Co. Ltd.
3. Freud PJ and Minton PD. 1979. *Regression Methods—A tool for data Analysis*. Marcel Dekker Inc., New York.
4. Frissel MJ and Reinger P. 1974. *Simulation of Accumulation and Leaching in Sils*. Oxford and IBM Pub. Co., New Delhi.
5. Hanks J and Richie JT. (Eds.). 1991. *Modeling Plant and Soil System*. Agronomy Bulletin No. 31, ASA, SSSA Madison, Wisconsin, USA.

12. Agricultural Journalism 3(2+1)

Theory

Agricultural Journalism: The nature and scope of agricultural journalism characteristics and training of the agricultural journalist, how agricultural journalism is similar to and different from other types of journalism. Newspapers and magazines as communication media: Characteristics; kinds and functions of newspapers and magazines, characteristics of newspaper and magazine readers. Form and content of newspapers and magazines: Style and language of newspapers and magazines, parts of newspapers and magazines. The agricultural story: Types of agricultural stories, subject matter of the agricultural story, structure of the agricultural story. Gathering agricultural information: Sources of agricultural information, interviews, coverage of events, abstracting from research and scientific materials, wire services, other agricultural news sources. Writing the story: Organizing the material, treatment of the story, writing the news lead and the body, readability measures. Illustrating agricultural stories: Use of photographs, use of artwork (graphs, charts, maps, etc.), writing the captions. Editorial mechanics: Copy reading, headline and title writing, proofreading, lay outing.

Practical

Practice in interviewing. Covering agricultural events. Abstracting stories from research and scientific materials and from wire services. Writing different types of agricultural stories. Selecting pictures and artwork for the agricultural story. Practice in editing, copy reading, headline and title writing, proofreading, layouting. Testing copy with a readability formula. Visit to a publishing office.

Suggested readings:

1. Arvind Kumar. 1999. The Electronic Media Anmol Publications, New Delhi.
2. Bhatt,S.C. 2007. Broadcast Journalism Basic Principles. Har Anand Publications, Delhi
3. Bhatnagar, R. 2001. Print media and Broadcast Journalism. Indian Publisher Distributors, Delhi
4. Katyal, V.P. 2007. Fundamentals of Media Ethics. Cyber Tech Publishers, New Delhi.

4. B.Tech. Agricultural Engineering

The B.Tech. Agricultural Engineering programme curriculum has a total of 182 credit hours including two skill development trainings (I & II) each of five weeks during the summer break after IV & VI Semester, respectively with a credit load of 0+5. In addition, there will be Industrial attachment of 10 weeks and On-Campus Experiential Learning Program of 12 weeks each with a credit load of 0+10 credit hours during Semester VII. During the Semester VIII will be exposed to project planning and report writing of 12 weeks with a weightage of 0+10 credit hours. Educational tour will be conducted in break between IV & V Semester or VI & VII Semester.

Titles and Credit Hours of B. Tech. Agricultural Engineering Degree Programme

S. No.	Department with number of courses and Course title	Credit Hours
Dept. of Basic Engineering & Applied Sciences		**75(45+30)**
A.)	**Basic Engineering (18)**	**44(25+19)**
1	Surveying and Levelling	3(1+2)
2	Engineering Mechanics	3(2+1)
3	Strength of Materials	2(1+1)
4	Design of Structures	2(1+1)
5	Fluid Mechanics and Open Channel Hydraulics	3(2+1)
6	Building Construction and Cost Estimation	2(2+0)
7	Soil Mechanics	2(1+1)
8	Engineering Drawing	2(0+2)
9	Workshop Technology and Practice	3(1+2)
10	Heat and Mass Transfer	2(2+0)
11	Machine Design	2(2+0)
12	Auto CAD Applications	2(0+2)
13	Thermodynamics, Refrigeration and Air Conditioning	3(2+1)
14	Theory of Machines	2(2+0)
15	Electrical Machines and Power Utilization	3(2+1)
16	Applied Electronics and Instrumentation	3(2+1)
17	Computer Programming and Data Structures	3(1+2)
18	Web Designing and Internet Applications	2(1+1)
B.)	**Applied Sciences (11)**	**31(20+11)**
1	Principles of Agronomy	3(2+1)
2	Principles of Soil Science	3(2+1)
3	Principles of Horticultural Crops and Plant Protection	2(1+1)
4	Engineering Physics	3(2+1)
5	Engineering Chemistry	3(2+1)
6	Engineering Mathematics-I	3(2+1)
7	Engineering Mathematics-II	3(2+1)
8	Engineering Mathematics-III	3(2+1)
9	Communication Skills and Personality Development	2(1+1)
10	Entrepreneurship Development and Business Management	3(2+1)
11	Environmental Science and Disaster Management	3(2+1)

Dept. of Soil and Water Conservation Engineering (4)		**10(6+4)**
1	Watershed Hydrology	2(1+1)
2	Soil and Water Conservation Engineering	3(2+1)
3	Water Harvesting and Soil Conservation Structures	3(2+1)
4	Watershed Planning and Management	2(1+1)
Dept. of Irrigation and Drainage Engineering (4)		**10(6+4)**
1	Irrigation Engineering	3(2+1)
2	Drainage Engineering	2(1+1)
3	Groundwater, Wells and Pumps	3(2+1)
4	Sprinkler and Micro Irrigation Systems	2(1+1)
Dept. of Farm Machinery and Power Engineering (5)		**14(8+6)**
1	Farm Machinery and Equipment-I	3(2+1)
2	Farm Machinery and Equipment-II	3(2+1)
3	Tractor and Automotive Engines	3(2+1)
4	Tractor Systems and Controls	3(2+1)
5	Tractor and Farm Machinery Operation and Maintenance	2(0+2)
Dept. of Processing and Food Engineering (5)		**13(8+5)**
1	Engineering Properties of Agricultural Produce	2(1+1)
2	Agricultural Structures and Environmental Control	3(2+1)
3	Post Harvest Engineering of Cereals, Pulses and Oil Seeds	3(2+1)
4	Post Harvest Engineering of Horticultural Crops	2(1+1)
5	Dairy and Food Engineering	3(2+1)
Dept. of Renewable Energy Engineering (3)		**9(6+3)**
1	Fundamentals of Renewable Energy Sources	3(2+1)
2	Renewable Power Sources	3(2+1)
3	Bio-energy Systems: Design and Applications	3(2+1)
Elective Courses (Any 3 courses)		**9 (6+3)**
1	Floods and Control Measures	3(2+1)
2	Wasteland Development	3(2+1)
3	Information Technology for Land and Water Management	3(2+1)
4	Remote Sensing and GIS Applications	3(2+1)
5	Management of Canal Irrigation System	3(2+1)
6	Minor Irrigation and Command Area Development	3(2+1)

7	Precision Farming Techniques for Protected Cultivation	3(2+1)
8	Water Quality and Management Measures	3(2+1)
9	Landscape Irrigation Design and Management	3(2+1)
10	Plastic Applications in Agriculture	3(2+1)
11	Mechanics of Tillage and Traction	3(2+1)
12	Farm Machinery Design and Production	3(2+1)
13	Human Engineering and Safety	3(2+1)
14	Tractor Design and Testing	3(2+1)
15	Hydraulic Drives and Controls	3(2+1)
16	Precision Agriculture and System Management	3(2+1)
17	Food Quality and Control	3(2+1)
18	Food Plant Design and Management	3(2+1)
19	Food Packaging Technology	3(2+1)
20	Development of Processed Products	3(2+1)
21	Process Equipment Design	3(2+1)
22	Photovoltaic Technology and Systems	3(2+1)
23	Waste and By-products Utilization	3(2+1)
24	Artificial Intelligence	3(3+0)
25	Mechatronics	3(2+1)
	Total course work Credit Hours (140)	**140(85+55)**

	Educational tour (During first week of January)	**2(0+2)**
	One-year Student READY (Rural and Entrepreneurship Awareness Development Yojana) programme	**40(0+40)**
	8-weeks Skill Development Trainings (I and II, each of 4-weeks) during semester break after IVth and VIth semester	10(0+10)
	10- weeks Industrial Attachment/ Internship	10(0+10)
	10- weeks Experiential Learning On campus	10(0+10)
	20-weeks Project Planning and Report Writing	10(0+10)
	Total Credit Hours Load of B. Tech. (Agricultural Engineering)	**182(85+97)**

Semester-wise Course Programme

S. No.	Course No.	Title of the Course	Credit Hours
Semester I			
1.	AS-111	Engineering Mathematics-I	3(2+1)
2.	AS-112	Engineering Physics	3(2+1)
3.	AS-113	Engineering Chemistry	3(2+1)
4.	AS-114	Principles of Soil Science	3(2+1)
5.	BE-111	Surveying and Levelling	3(1+2)
6.	BE-112	Engineering Mechanics	3(2+1)
7.	BE-113	Engineering Drawing	2(0+2)
8.	BE-114	Heat and Mass Transfer	2(2+0)
		Total	**22(13+9)**
Semester II			
1.	AS-125	Engineering Mathematics-II	3(2+1)
2.	AS-126	Environmental Science and Disaster Management	3(2+1)
3.	AS-127	Entrepreneurship Development and Business Management	3(2+1)
4.	BE-125	Fluid Mechanics and Open Channel Hydraulics	3(2+1)
5.	BE-126	Strength of Materials	2(1+1)
6.	BE-127	Workshop Technology and Practices	3(1+2)
7.	BE-128	Theory of Machines	2(2+0)
8.	BE-129	Web Designing and Internet Applications	2(1+1)
		Total	**21(13+8)**
Semester III			
1.	AS-218	Principles of Horticultural Crops and Plant Protection	2(1+1)
2.	AS-219	Principles of Agronomy	3(2+1)
3.	AS-210	Communication Skills and Personality Development	2(1+1)
4.	AS-211	Engineering Mathematics-III	3(2+1)
5.	BE-210	Soil Mechanics	2(1+1)
6.	BE-211	Design of Structures	2(1+1)
7.	BE-212	Machine Design	2(2+0)
8.	BE-213	Thermodynamics, Refrigeration and Air Conditioning	3(2+1)
9.	BE-214	Electrical Machines and Power Utilization	3(2+1)
		Total	**22(14+8)**
Semester IV			
1	BE-225	Building Construction and Cost Estimation	2(2+0)
2	BE-226	Auto CAD Applications	2(0+2)
3	BE-227	Applied Electronics and Instrumentation	3(2+1)

4	FMPE-221	Tractor and Automotive Engines	3(2+1)
5	PFE-221	Engineering Properties of Agricultural Produce	2(1+1)
6	SWCE-221	Watershed Hydrology	2(1+1)
7	IDE-221	Irrigation Engineering	3(2+1)
8.	IDE-222	Sprinkler and Micro Irrigation Systems	2(1+1)
9.	REE-221	Fundamentals of Renewable Energy Sources	3(2+1)
		Total	**22(13+9)**
Skill Development Training-I Summer break June-July after 4th Semester (Student READY)			
Semester V			
1.	FMPE-312	Tractor Systems and Controls	3(2+1)
2.	FMPE-313	Farm Machinery and Equipment-I	3(2+1)
3.	PFE-312	Agricultural Structures and Environmental Control	3(2+1)
4.	PFE-313	Post Harvest Engineering of Cereals, Pulses and Oil Seeds	3(2+1)
5.	SWCE-312	Soil and Water Conservation Engineering	3(2+1)
6.	SWCE-313	Watershed Planning and Management	2(1+1)
7.	IDE-313	Drainage Engineering	2(1+1)
8.	REE-312	Renewable Power Sources	3(2+1)
9.	CAE-311	Skill Development Training-I (Student READY) Registration only	5(0+5)
		Total	**27(14+13)**
Semester VI			
1.	BE-328	Computer Programming and Data Structures	3(1+2)
2.	FMPE-324	Farm Machinery and Equipment-II	3(2+1)
3.	PFE-324	Post Harvest Engineering of Horticultural Crops	2(1+1)
4.	SWCE-324	Water Harvesting and Soil Conservation Structures	3(2+1)
5.	IDE-324	Groundwater, Wells and Pumps	3(2+1)
6.	FMPE-325	Tractor and Farm Machinery Operation and Maintenance	2(0+2)
7.	PFE-325	Dairy and Food Engineering	3(2+1)
8.	REE-323	Bio-energy Systems: Design and Applications	3(2+1)
		Total	**22(12+10)**
Skill Development Training-II in Summer break June-July after 6th Semester (Student READY)			

Semester VII Student READY (Rural and Entrepreneurship Awareness Development Yojana)			
1.	CAE-412	10- weeks Industrial Attachment /Internship (Student READY)	10(0+10)
2.	CAE-413	10- weeks Experiential Learning On campus (Student READY)	10(0+10)
3.	CAE-414	Skill Development Training-II (Student READY) Registration only	5(0+5)
4.	CAE-415	Educational Tour (Registration only)	2 (0+2)
		Total	**27(0+27)**
		Educational tour during winter/January break	
Semester VIII Student READY (Rural and Entrepreneurship Awareness Development Yojana)			
1.	DEPT-42X(E)	Elective course	3(2+1)
2.	DEPT-42Y(E)	Elective course	3(2+1)
3.	DEPT-42Z(E)	Elective course	3(2+1)
4.	CAE-415	Project Planning and Report Writing (Student READY)	10(0+10)
		Total	19(6+13)
		Grand Total I to VIII semesters	182(85+97)

SYLLLABUS

Department of Basic Engineering and Applied Sciences 73 (44+29)

A) Basic Engineering 44(25+19)

i) Civil Engineering Section 17(10+7)

1. Surveying and Levelling (1+2)

Theory

Surveying: Introduction, classification and basic principles, Linear measurements. Chain surveying. Cross staff survey, Compass survey. Planimeter, Errors in measurements, their elimination and correction. Plane table surveying. Levelling, Leveling difficulties and error in leveling, Contouring, Computation of area and volume. Theodolite traversing. Introduction to setting of curves. Total station, Electronic Theodolite. Introduction to GPS survey

Practical

Chain survey of an area and preparation of map; Compass survey of an area and plotting of compass survey; Plane table surveying; Levelling. L section and X sections and its plotting; Contour survey of an area and preparation of contour map; Introduction of software in drawing contour; Theodolite surveying; Ranging by Theodolite, Height of object by using Theodolite; Setting out curves by Theodolite; Minor instruments. Use of total station.

Suggested Readings

- Punmia, B C 1987. Surveying (Vol.I). Laxmi Publications, New Delhi.
- Arora K R 1990. Surveying(Vol.I), Standard Book House, Delhi.
- Kanetkar T P 1993. Surveying and Levelling. Pune Vidyarthi Griha, Prakashan, Pune.

2. Engineering Mechanics 3 (2+1)

Theory

Basic concepts of Engineering Mechanics. Force systems, Centroid, Moment of inertia, Free body diagram and equilibrium of forces. Frictional forces Analysis of simple framed structures using methods of joints, methods of sections and graphical method. Simple stresses. Shear force and bending moment diagrams. Stresses in beams. Torsion. Analysis of plane and complex stresses.

Practical

Problems on composition and resolution of forces, moments of a force, couples, transmission of a couple, resolution of a force into a force & a couple; Problems relating to resultant of; Co- planer force system, collinear force system, concurrent force system, co-planer concurrent force system, co-planer non-concurrent force system, Non-coplaner concurrent force system, Non-coplaner non-concurrent force system, system of couples in space; Problems relating to centroids of composite areas; Problems on moment of inertia, polar moment of inertia, radius of gyration, polar radius of gyration of composite areas; Equilibrium of

concurrent – co-planer and non concurrent – co-planer force systems; Problems involving frictional forces; Analysis of simple trusses by method of joints and method of sections; Analysis of simple trusses by graphical method; Problems relating to simple stresses and strains; Problems on shear force and bending moment diagrams; Problems relating to stresses in beams; Problems on torsion of shafts; Analysis of plane and complex stresses.

Suggested Readings

- Sundarajan V 2002. Engineering Mechanics and Dynamics. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Timoshenko S and Young D H 2003. Engineering Mechanics. McGraw Hill Book Co., New Delhi.
- Prasad I B 2004. Applied Mechanics. Khanna Publishers, New Delhi.
- Prasad I B 2004. Applied Mechanics and Strength of Materials. Khanna Publishers, New Delhi.
- Bansal R K 2005. A Text Book of Engineering Mechanics. Laxmi Publishers, New Delhi.

3. Strength of Materials 2(1+1)

Theory

Slope and deflection of beams using integration techniques, moment area theorems and conjugate beam method. Columns and Struts. Riveted and welded connections. Stability of masonry dams. Analysis of statically intermediate beams. Propped beams. Fixed and continuous beam analysis using superposition, three moment equation and moment distribution methods.

Practical

To perform the tension test on metal specimen (M.S., C.I.), to observe the behaviour of materials under load, to calculate the value of E, ultimate stress, permissible stress, percentage elongation etc. and to study its fracture; To perform the compression test on; Concrete cylinders &cubes, C.I., M.S. & Wood specimens and to determine various physical and mechanical properties; To perform the bending test on the specimens; M.S. Girder, Wooden beam, Plain concrete beams & R.C.C. beam, and to determine the various physical and mechanical properties; To determine Young's modulus of elasticity of beam with the help of deflection produced at centre due to loads placed at centre & quarter points; To study the behaviour of materials (G.I. pipes, M.S., C.I.) under torsion and to evaluate various elastic constants; To study load deflection and other physical properties of closely coiled helical spring in tension and compression; To perform the Rockwell, Vicker's and Brinell's Hardness tests on the given specimens; To perform the Drop Hammer Test, Izod Test and Charpay's impact tests on the given specimens; To determine compressive & tensile strength of cement after making cubes and briquettes; To measure workability of concrete (slump test, compaction factor test); To determine voids ratio & bulk density of cement, fine aggregates and coarse aggregates; To determine fatigue strength of a given specimen; To write detail report emphasizing engineering importance of performing tension, compression, bending, torsion, impact and hardness tests on the materials.

Suggested Readings

- Khurmi R.S. 2001. Strength of Materials S. Chand & Co., Ltd., New Delhi.
- Junarkar S.B. 2001.Mechanics of Structures (Vo-I). Choratar Publishing House, Anand.
- Ramamrutham S. 2003. Strengths of Materials. Dhanpat Rai and Sons, Nai Sarak, New Delhi.

4. Design of Structures 2(1+1)

Theory

Loads and use of BIS Codes. Design of connections. Design of structural steel members in tension, compression and bending. Design of steel roof truss. Analysis and design of singly and doubly reinforced sections, Shear, Bond and Torsion. Design of Flanged Beams, Slabs, Columns, Foundations, Retaining walls and Silos.

Practical

Design and drawing of single reinforced beam, double reinforced beam, Design and drawing of steel roof truss; Design and drawing of one way, two way slabs, Design and drawing of RCC building; Design and drawing of Retaining wall. To measure workability of cement by slump test

Suggested Readings

- Junarkar, S.B. 2001. Mechanics of Structures Vol. I Charotar Publishing Home, Anand.
- Khurmi R. S. 2001. Strength of materials. S. Chand & Company Ltd., 7361, Ram Nagar, New Delhi – 110055.
- Kumar Sushil 2003. Treasure of R.C.C. Design. R.K. Jain. 1705-A, Nai Sarak , Delhi-110006, P.B.1074.

5. Fluid Mechanics and Open Channel Hydraulics 3(2+1)

Theory

Properties of fluids: Ideal and real fluid. Pressure and its measurement, Pascal's law, pressure forces on plane and curved surfaces, centre of pressure, buoyancy, meta centre and meta centric height, condition of floatation and stability of submerged and floating bodies; Kinematics of fluid flow: Lagrangian and Eulerian description of fluid motion, continuity equation, path lines, streak lines and stream lines, stream function, velocity potential and flow net. Types of fluid flow, translation, rotation, circulation and vorticity, Vortex motion; Dynamics of fluid flow, Bernoulli's theorem, venturimeter, orifice meter and nozzle, siphon; Laminar flow: Stress strain relationships, flow between infinite parallel plates both plates fixed, one plate moving, discharge, average velocity; Laminar and turbulent flow in pipes, general equation for head loss Darcy, Equation, Moody's diagram, Minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic gradient and energy gradient; Flow through orifices (Measurement of Discharge, Measurement of Time),Flow through Mouthpieces, Flow over Notches , Flow over weirs, Chezy's formula for loss of head in pipes, Flow through simple and compound pipes, Open channel design and hydraulics: Chezy's formula, Bazin's formula, Kutter's Manning's formula, Velocity and Pressure profiles in open channels, Hydraulic jump; Dimensional analysis and similitude: Rayleigh's method and Buckingham's `Pi' theorem, types of similarities, dimensional analysis, dimensionless numbers. Introduction to fluid machinery.

Practical

Study of manometers and pressure gauges; Verification of Bernoulli's theorem; Determination of coefficient of discharge of venturi-meter and orifice meter; Determination of coefficient of friction in pipeline;

Determination of coefficient of discharge for rectangular and triangular notch; Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice; Determination of coefficient of discharge for mouth piece; Measurement of force exerted by water jets on flat and hemi-spherical vanes; Determination of meta-centric height; Determination of efficiency of hydraulic ram; Performance evaluation of Pelton and Francis turbine; Study of current meter; Velocity distribution in open channels and determination of Manning's coefficient of rugosity.

Suggested Readings

- Khurmi, R .S. 1970. A Text Book of Hydraulics, Fluid Mechanics and Hydraulic Machines S. Chand & Company Limited, New Delhi.
- Modi P M and Seth S.M.1973. Hydraulics and Fluid Mechanics. Standard Book House, Delhi.
- Chow V T 1983. Open Channel Hydraulics. McGraw Hill Book Co., New Delhi.
- LalJagadish 1985. Fluid Mechanics and Hydraulics. Metropolitan Book Co.Pvt. Ltd., New Delhi.

6. Building Construction and Cost Estimation 2(2+0)

Theory

Building Materials: Rocks, Stones, Bricks Properties and varieties of Tiles, Lime, Cement, Concrete, Sand. Glass, Rubber, Plastics, iron, Steel, Aluminium, Copper, Nickle. Timber. Building components: Lintels, Arches, stair cases, Different types of floors, Finishing: Damp Proofing and water proofing, Plastering, pointing, white washing and distempering – Painting, Building design, Design procedures, Technology, building construction, Types of agricultural buildings and related needs, application of design theory and practice to the conservation, sloped and flat roof buildings, construction economics: Preliminary estimates, Detailed Estimates of Buildings source of cost information, use of cost analyses for controlling design, Factors affecting building costs; cost evaluation of design and planning alternatives for building and estate development, Measurement and pricing, Economic methods for evaluating investments in buildings and building systems: cost-in-use, benefit-to-costs and savings-to-investment ratios, rate of return, net benefits, payback

Suggested Readings

- Punmia B.C. Ashok Kumar Jain and Arun Kumar Jain. Building Construction. Laxmi Publications (P) ltd., New Delhi.
- Duggal S K. Building material. New Age International Publishers.
- Sane Y.S. Planning and Designing of Buildings.
- Rangwala S C. 1994. Engineering Materials. Charotar Publishing House, Anand.
- Dutta B.N. 2000. Estimating and Costing. UBS publishers.

7. Soil Mechanics 2(1+1)

Theory

Introduction of soil mechanics, field of soil mechanics, phase diagram, physical and index properties of soil, classification of soils, effective and neutral stress, elementary concept of Boussinesq and Wester guards

analysis, new mark influence chart. Seepage Analysis; Quick condition-two dimensional flow-Laplace equation, Velocity potential and stream function, Flow net construction. Shear strength, Mohr stress circle, theoretical relationship between principle stress circle, theoretical relationship between principal stress, Mohr coulomb failure theory, effective stress principle. Determination of shear parameters by direct shear test, triangle test & vane shear test. Numerical exercise based on various types of tests. Compaction, composition of soils standard and modified protector test, abbot compaction and Jodhpur mini compaction test field compaction method and control. Consolidation of soil: Consolidation of soils, one dimensional consolidation spring analogy, Terzaghi's theory, Laboratory consolidation test, calculation of void ratio and coefficient of volume change, Taylor's and Casagrande's method, determination of coefficient of consolidation. Earth pressure: plastic equilibrium in soils, active and passive states, Rankine's theory of earth pressure, active and passive earth pressure for cohesive soils, simple numerical exercises. Stability of slopes: introduction to stability analysis of infinite and finite slopes friction circle method, Taylor's stability number.

Practical

Determination of water content of soil; Determination of specific gravity of soil; Determination of field density of soil by core cutter method; Determination of field density by sand replacement method; Grain size analysis by sieving (Dry sieve analysis); Grain size analysis by hydrometer method; Determination of liquid limit by Casagrande's method; Determination of liquid limit by cone penetrometer and plastic limit; Determination of shrinkage limit; Determination of permeability by constant head method; Determination of permeability by variable head method; Determination of compaction properties by standard proctor test; Determination of shear parameters by Direct shear test; Determination of unconfined compressive strength of soil; Determination of shear parameters by Tri-axial test; Determination of consolidation properties of soils.

Suggested Readings

- Punmia B C, Jain A K and Jain A K. 2005. Soil Mechanics and Foundations. Laxmi Publications (P) Ltd. New Delhi.
- Ranjan Gopal and Rao A S R. 1993. Basic and Applied Soil Mechanics. Welley Easters Ltd., New Delhi.
- Singh Alam. 1994. Soil Engineering Vol. I. CBS Publishers and Distributions, Delhi.

ii) Mechanical Engineering Section 16(9+7)

1. Engineering Drawing 2(0+2)

Practical

Introduction of drawing scales; First and third angle methods of projection. Principles of orthographic projections; References planes; Points and lines in space and traces of lines and planes; Auxiliary planes and true shapes of oblique plain surface; True length and inclination of lines; Projections of solids (Change of position method, alteration of ground lines); Section of solids and Interpenetration of solid surfaces; Development of surfaces of geometrical solids; Isometric projection of geometrical solids. Preparation of working drawing from models and isometric views. Drawing of missing views. Different methods of dimensioning. Concept of sectioning. Revolved and oblique sections. Sectional drawing of simple machine

parts. Types of rivet heads and riveted joints. Processes for producing leak proof joints. Symbols for different types of welded joints. Nomenclature, thread profiles, multi start threads, left and right hand threads. Square headed and hexagonal nuts and bolts. Conventional representation of threads. Different types of lock nuts, studs, machine screws, cap screws and wood screws. Foundation bolts. Forms of screw threads, representation of threads, Bolts- headed centre, stud screws, set screws, butt, hexagonal and square; keys-types, taper, rank taper, hollow saddle etc.

Suggested Readings

- Bhat N D. 2010. Elementary Engineering Drawing. Charotar Publishing House Pvt. Ltd., Anand.
- Bhatt N D and Panchal V M. 2013. Machine Drawing. Charotar Publishing House Pvt. Ltd., Anand.
- Narayana K L and Kannaiah P. 2010. Machine Drawing. Scitech Publications (India) Pvt. Ltd., Chennai.

2. Workshop Technology and Practice 3(1+2)

Theory

Introduction to various carpentry tools, materials, types of wood and their characteristics and Processes or operations in wood working; Introduction to Smithy tools and operations; Introduction to welding, types of welding, Oxyacetylene gas welding, types of flames, welding techniques and equipment. Principle of arc welding, equipment and tools. Casting processes; Classification, constructional details of center lathe, Main accessories and attachments. Main operations and tools used on center lathes. Types of shapers, Constructional details of standard shaper. Work holding devices, shaper tools and main operations. Types of drilling machines. Constructional details of pillar types and radial drilling machines. Work holding and tool holding devices. Main operations. Twist drills, drill angles and sizes. Types and classification. Constructional details and principles of operation of column and knee type universal milling machines. Plain milling cutter. Main operations on milling machine.

Practical

Preparation of simple joints: Cross half Lap joint and T-Halving joint; Preparation of Dovetail joint, Mortise and tenor joint; Jobs on Bending, shaping etc.; Jobs on Drawing, Punching, Rivetting. Introduction to tools and measuring instruments for fitting; Jobs on sawing, filing and right angle fitting of MS Flat; Practical in more complex fitting job; Operations of drilling,, reaming, and threading with tap and dies; Introduction to tools and operations in sheet metal work; Making different types of sheet metal joints using G.I. sheets. Introduction to welding equipment, processes tools, their use and precautions; Jobs on ARC welding – Lap joint, butt joint; T-Joint and corner joint in Arc welding; Gas welding Practice – Lab, butt and T-Joints; Introduction to metal casting equipment, tools and their use; Mould making using one-piece pattern and two pieces pattern; Demonstration of mould making using sweep pattern, and match plate patterns; Introduction to machine shop machines and tools; Demonstration on Processes in machining and use of measuring instruments; Practical jobs on simple turning, step turning; Practical job on taper turning, drilling and threading; Operations on shaper and planer, changing a round MS rod into square section on a shaper; Demonstration of important operations on a milling machine, making a plot, gear tooth forming and indexing; Any additional job.

Suggested Readings

- Hazra, Choudari S K and Bose S K. 1982. Elements of Workshop technology (Vol. I and II). Media Promoters and Publishers Pvt. Ltd., Mumbai.
- Chapman W A J. 1989. Workshop Technology (Part I and II). Arnold Publishers (India) Pvt. Ltd., AB/9 Safdarjung Enclave, New Delhi.
- Raghuwamsi B S. 1996. A Course in Workshop Technology (Vol. I and II). Dhanpat Rai and Sons, 1682 Nai Darak, New Delhi.

3. Heat and Mass Transfer 2(2+0)

Theory

Concept, modes of heat transfer, thermal conductivity of materials, measurement. General differential equation of conduction. One dimensional steady state conduction through plane and composite walls, tubes and spheres with and without heat generation. Electrical analogy. Insulation materials. Fins, Free and forced convection. Newton's law of cooling, heat transfer coefficient in convection. Dimensional analysis of free and forced convection. Useful non dimensional numbers. Equation of laminar boundary layer on flat plate and in a tube. Laminar forced convection on a flat plate and in a tube. Combined free and forced convection. Introduction. Absorptivity, reflectivity and transmissivity of radiation. Black body and monochromatic radiation, Planck's law, Stefan- Boltzman law, Kirchoff 's law, grey bodies and emissive power, solid angle, intensity of radiation. Radiation exchange between black surfaces, geometric configuration factor. Heat transfer analysis involving conduction, convection and radiation by networks. Types of heat exchangers, fouling factor, log mean temperature difference, heat exchanger performance, transfer units. Heat exchanger analysis restricted to parallel and counter flow heat exchangers. Steady state molecular diffusion in fluids at rest and in laminar flow, Flick's law, mass transfer coefficients. Reynold's analogy.

Suggested Readings

- Geankoplis C.J. 1978. Transport Port Processes and Unit Operations. Allyn and Bacon Inc., Newton, Massachusetts.
- Holman J P. 1989. Heat Transfer. McGraw Hill Book Co., New Delhi.
- Incropera F P and De Witt D P. 1980. Fundamentals of Heat and Mass Transfer. John Wiley and Sons, New York.
- Gupta C P and Prakash R. 1994. Engineering Heat Transfer. Nem Chand and Bros., Roorkee.

4. Machine Design 2(2+0)

Theory

Meaning of design, Phases of design, design considerations. Common engineering materials and their mechanical properties. Types of loads and stresses, theories of failure, factor of safety, selection of allowable stress. Stress concentration. Elementary fatigue and creep aspects. Cotter joints, knuckle joint and pinned joints, turnbuckle. Design of welded subjected to static loads. Design of threaded fasteners subjected to direct static loads, bolted joints loaded in shear and bolted joints subjected to eccentric loading. Design of shafts under torsion and combined bending and torsion. Design of keys. Design of muff, sleeve, and rigid flange couplings. Design of helical and leaf springs. Design of flat belt and V-belt drives and pulleys.

Design of gears. Design of screw motion mechanisms like screw jack, lead screw, etc. Selection of anti-friction bearings.

Suggested Readings

- Jain R K. 2013. Machine Design. Khanna Publishers, 2-B Nath Market, Nai Sarak, New Delhi.
- Khurmi R S and Gupta J K. 2014. A Text Book of Machine Design. S. Chand & Company Ltd., New Delhi.

5. Auto CAD Applications 2(0+2)

Practical

Application of computers for design. CAD- Overview of CAD window – Explanation of various options on drawing screen. Study of draw and dimension tool bar. Practice on draw and dimension tool bar. Study of OSNAP, line thickness and format tool bar. Practice on OSNAP, line thickness and format tool bar. Practice on mirror, offset and array commands. Practice on trim, extend, chamfer and fillet commands. Practice on copy, move, scale and rotate commands. Drawing of 2 D- drawing using draw tool bar. Practice on creating boundary, region, hatch and gradient commands. Practice on Editing polyline- PEDIT and Explode commands. Setting of view ports for sketched drawings. Printing of selected view ports in various paper sizes. 2D- drawing of machine parts with all dimensions and allowances- Foot step bearing and knuckle joint. Sectioning of foot step bearing and stuffing box. Drawing of hexagonal, nut and bolt and other machine parts. Practice on 3-D commands- Extrusion and loft. Practice on 3-D commands-on sweep and press pull. Practice on 3-D Commands- revolving and joining. Demonstration on CNC machine and simple problems.

Suggested Readings

- Rao P.N.. 2002. CAD/CAM Principles and Applications. McGraw-Hill Education Pvt. Ltd., New Delhi.
- Sareen Kuldeep and Chandan Deep Grewal. 2010. CAD/CAM Theory and Practice. S.Chand & Company Ltd., New Delhi.
- Zeid Ibrahim. 2011. Mastering CAD/CAM with Engineering. McGraw-Hill Education Pvt. Ltd., New Delhi.
- Lee Kunwoo. 1999. Principles of CAD/CAM/CAE Systems. Addison Vesley Longman, Inc.

6. Thermodynamics, Refrigeration and Air Conditioning 3(2+1)

Theory

Thermodynamics properties, closed and open system, flow and non-flow processes, gas laws, laws of thermodynamics, internal energy. Application of first law in heating and expansion of gases in non-flow processes. First law applied to steady flow processes. Carnot cycle, Carnot theorem. Entropy, physical concept of entropy, change of entropy of gases in thermodynamics process. Otto, diesel and dual cycles. Principles of refrigeration, - units, terminology, production of low temperatures, air refrigerators working on reverse Carnot cycle and Bell Coleman cycle. Vapour refrigeration-mechanism, P-V,P-S,P-H diagrams, vapor compression cycles, dry and wet compression, super cooling and sub cooling. Vapour absorption

refrigeration system. Common refrigerants and their properties. Design calculations for refrigeration system. Cold storage plants. Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychometric chart and its use, elementary psychometric process. Air conditioning – principles –Type and functions of air conditioning, physiological principles in air conditioning, air distribution and duct design methods, fundamentals of design of complete air conditioning systems – humidifiers and dehumidifiers – cooling load calculations, types of air conditioners – applications.

Practical

Tutorials on thermodynamic air cycles, Study and application of P V and T S chart in refrigeration, P H chart (or) Mollier diagram in refrigeration, Numerical on air refrigeration cycle systems, Numerical on vapour compression cycle refrigeration system, Study of domestic water cooler, Study of domestic household refrigerator, Study of absorption type solar refrigeration system, Study cold storage for fruit and vegetables, Freezing load and time calculations for food materials, Determination of refrigeration parameters using refrigeration tutor – II, Numerical on design of air conditioning systems, Study of window air conditioner, Study on repair and maintenance of refrigeration and air-conditioning systems. Visit to chilling or ice making and cold storage plants.

Suggested Readings

- Kothandaraman C P Khajuria P R and Arora S C. 1992. A Course in Thermodynamics and Heat Engines. Dhanpet Rai and Sons, 1682 Nai Sarak, New Delhi.
- Khurmi R S. 1992. Engineering Thermodynamics. S Chand and Co. Ltd., Ram Nagar, New Delhi.
- Mathur M L and Mehta F S. 1992. Thermodynamics and Heat Power Engineering. Dhanpat Rai and Sons 1682 Nai Sarak, New Delhi.
- Ballney P. L. 1994. Thermal Engineering. Khanna Publishers, New Delhi.
- Nag P K.1995. Engineering Thermodynamics. Tata McGraw Hill Publishing Co.Ltd., 12/4 Asaf Ali Raod, New Delhi.

7. Theory of Machines 2(2+0)

Theory

Elements, links, pairs, kinematics chain, and mechanisms. Classification of pairs and mechanisms. Lower and higher pairs. Four bar chain, slider crank chain and their inversions. Determination of velocity and acceleration using graphical (relative velocity and acceleration) method. Instantaneous centers. Types of gears. Law of gearing, velocity of sliding between two teeth in mesh. Involute and cycloidal profile for gear teeth. Spur gear, nomenclature, interference and undercutting. Introduction to helical, spiral, bevel and worm gear. Simple, compound, reverted, and epicyclic trains. Determining velocity ratio by tabular method. Turning moment diagrams, coefficient of fluctuation of speed and energy, weight of flywheel, flywheel applications. Belt drives, types of drives, belt materials. Length of belt, power transmitted, velocity ratio, belt size for flat and V belts. Effect of centrifugal tension, creep and slip on power transmission, Chain drives. Types of friction, laws of dry friction. Friction of pivots and collars. Single disc, multiple disc, and cone clutches. Rolling friction, anti friction bearings. Types of governors. Constructional details and anal-

ysis of Watt, Porter, Proell governors. Effect of friction, controlling force curves. Sensitiveness, stability, hunting, iso-chronism, power and effort of a governor. Static and dynamic balancing. Balancing of rotating masses in one and different planes.

Suggested Readings

- Bevan Thomas. 1984. Theory of Machines. CBS Publishers and Distributors, Delhi.
- Ballaney P L. 1985. Theory of Machines. Khanna Publishers, 2-B Nath Market, Nai Sarak, New Delhi.
- Rao J S and Dukkipatti R V. 1990. Mechanisms and Machine Theory. Wiley astern Ltd., New Delhi.
- Lal Jagdish. 1991. Theory of Mechanisms and Machines. Metropolitan Book Co. Pvt.Ltd., 1 Netaji Subash Marg, New Delhi..
- Rattan S B. 1993. Theory of Machines. Tata McGraw Hill Publishing Co. Ltd., 12/4 Asaf Ali Road, New Delhi.
- Khurmi R S and Gupta J K. 1994. Theory of Machines. Eurasia Publishing House Pvt. Ltd., Ram Nagar, New Delhi.

iii) Electrical and Computer Engineering Section 11(6+5)

1. Electrical Machines and Power Utilization 3(2+1)

Theory

Electro motive force, reluctance, laws of magnetic circuits, determination of ampere-turns for series and parallel magnetic circuits, hysteresis and eddy current losses, Transformer: principle of working, construction of single phase transformer, EMF equation, phasor diagram on load, leakage reactance, voltage regulation, power and energy efficiency, open circuit and short circuit tests, principles, operation and performance of DC machine (generator and motor), EMF and torque equations, armature reaction, commutation, excitation of DC generator and their characteristics, DC motor characteristics, starting of shunt and series motor, starters, speed control methods-field and armature control, polyphase induction motor: construction, operation, phasor diagram, effect of rotor resistance, torque equation, starting and speed control methods, single phase induction motor: double field revolving theory, equivalent circuit, characteristics, phase split, shaded pole motors, various methods of three phase power measurement; power factor, reactive and apparent power, Concept and analysis of balanced poly-phase circuits; Series and parallel resonance.

Practical

To obtain load characteristics of d.c. shunt/series /compound generator; To study characteristics of DC shunt/ series motors; To study d.c. motor starters; To Perform load-test on 3 ph. induction motor & to plot torque V/S speed characteristics; To perform no-load & blocked –rotor tests on 3 ph. Induction motor to obtain equivalent ckt. parameters & to draw circle diagram; To study the speed control of 3 ph. induction motor by cascading of two induction motors, i.e. by feeding the slip power of one motor into the other motor; To study star- delta starters physically and (a) to draw electrical connection diagram (b) to start the 3 ph. induction motor using it. (c) to reverse the direction of 3 ph. I.M.; To start a 3-phase slip –ring induction motor by inserting different levels of resistance in the rotor ckt. and to plot torque –speed characteristics; To

perform no load & blocked –rotor test on 1 ph. induction motor & to determine the parameters of equivalent ckt. drawn on the basis of double revolving field theory; To perform load –test on 1 ph. induction motor & plot torque –speed characteristics; To study power consumed in a three-phase circuit; Two lights in series controlled by one switch; Two lights in parallel controlled by one switch.

Suggested Readings

- Thareja B L & Theraja AK. 2005. A text book of Electrical Technology. Vol. I S. Chand & Company LTD., New Delhi.
- Theraja B L & Theraja AK 2005. A text book of Electrical Technology. Vol. II S.Chand & Company LTD., New Delhi.
- Vincent Del Toro. 2000. Electrical Engineering Fundamentals. Prentice-Hall of India Private LTD., New Delhi.
- Anwani M L. 1997. Basic Electrical Engineering. Dhanpat Rai & Co.(P) LTD. New Delhi.

2. Applied Electronics and Instrumentation 3(2+1)

Theory

Semiconductors. p—n junction. V—I characteristics of p—n junction. diode as a circuit element. rectifier. clipper. damper, voltage multiplier, capacitive filter. diode circuits for OR &AND (both positive and negative logic), bipolar junction transistor: operating point. classification (A.B & C) of amplifier. various biasing methods (fixed. self potential divider). h-parameter model of a transistor. analysis of small signal. CE amplifier. phase shift oscillator, analysis of differential amplifier using transistor. ideal OP-AMP characteristics. linear and non-linear applications of OP-AMP (adder. subtractor. integrator, active rectifier. comparator. differentiator. differential, instrumentation amplifier and oscillator). zener diode voltage regulator. transistor series regulator. current limiting. OP-AMP voltage regulators. Basic theorem of Boolean algebra. Combinational logic circuits(basic gates. SOP rule and Kmap). binary ladder D/A converter, successive approximation A/D converter, generalized instrumentation, measurement of displacement. temperature. velocity, force and pressure using potentiometer. resistance thennometer. thermocouples. Bourclen tube. LVDT. strain gauge and tacho-generator.

Practical

To study V-I characteristics of p-n junction diode: To study half wave. full wave and bridge rectifier: To study transistor characteristics in CE configurations: To design and study fixed and self bias transistor: To design and study potential divider bias transistor: To study a diode as clipper and clamper: To study a OP-AMP IC 741 as inverting and non- inverting amplifier: To study a OP-AMP IC 741 as differentiator and integrator to study a differential amplifier using two transistor: To study a OP-AMP IC 741 as differential amplifier: To study a zener regulator circuit: To study a OP-AMP IC 741 as a active rectifier: To study a OP-AMP IC 741 as a comparator: To familiarize with various types of transducers.

Suggested Readings

- Mehta V K. Principles of Electronics. S. Chand and Co., New Delhi.
- Shaney A K. Measurement of Electronics and Electronic Instrumentation. Khanna Publications.

- Roy Chowdary. Integrated Electronics. John Wiley International.
- Kumar Anand. Digital Electronics. A. PHI.
- Gupta Sanjeev, Sonthosh Gupta. Electronic Devices and Circuits. Danapath Rai Publications.

3. Computer Programming and Data Structures 3(1+ 2)

Theory

Introduction to high level languages, Primary data types and user defined data types, Variables, typecasting, Operators, Building and evaluating expressions, Standard library functions, Managing input and output, Decision making, Branching, Looping, Arrays, User defined functions, passing arguments and returning values, recursion, scope and visibility of a variable, String functions, Structures and union, Pointers, Stacks, Push/Pop operations, Queues, Insertion and deletion operations, Linked lists.

Practical

Familiarizing with Turbo C IDE; Building an executable version of C program; Debugging a C program; Developing and executing simple programs; Creating programs using decision making statements such as if, go to & switch; Developing program using loop statements while, do & for; Using nested control structures; Familiarizing with one and two dimensional arrays; Using string functions; Developing structures and union; Creating user defined functions; Using local, global & external variables; Using pointers; Implementing Stacks; Implementing push/pop functions; Creating queues; Developing linked lists in C language; Insertion/Deletion in data structures.

Suggested Readings

- Rajaraman V. 1985. Computer Oriented Numerical Methods. Prentice Hall of India. Pvt. Ltd., New Delhi.
- Balagurusamy E. 1990. Programming in 'C'. Tata McGraw Hill Publishing Co. Ltd., 12/4 Asaf Ali Road, New Delhi.
- Rajaraman V. 1995. Computer Programming in 'C'. Prentice Hall of India Pvt.Ltd., New Delhi.
- Bronson G and Menconi S. 1995. A First Book of 'C' Fundamentals of 'C' Programming. Jaico Publishing House, New Delhi
- Sahni S.. Data Structures, Algorithms and Applications in C++. University press (India) Pvt Ltd / Orient Longman Pvt. Ltd.
- Michael T. Goodrich, R. Tamassia and D Mount. Data structures and Algorithms in C++. Wiley Student Edition, John Wiley and Sons.
- Mark Allen Weiss. Data Structures and Algorithm Analysis in C++. Pearson Education.
- Augenstein, Langsam and Tanenbaum. Data structures using C and C++. PHI/Pearson Education.
- Drozdek Adam. Data Structures and Algorithms in C++. Vikas Publishing House / Thomson International Student Edition.
- Agarwal, Ajay. The Complete Reference Guide: Data Structure through C. ISBN: 8178840448; Publisher: Cyber Tech Publications.

4. Web Designing and Internet Applications 2(1+1)

Theory

Basic principles in developing a web designing, Planning process, Five Golden rules of web designing, Designing navigation bar, Page design, Home Page Layout, Design Concept. Basics in Web Design, Brief History of Internet, World Wide Web , creation of a web site, Web Standards, Audience requirement. Introduction to Java Script, variables & functions, Working with alert, confirm and prompt, Connectivity of Web pages with databases; Project.

Practical

FLASH: Animation concept FPS, Understanding animation for web, Flash interface, Working with tools, DREAM WEAVER :Exploring Dreamweaver Interface, Planning & Setting Web Site Structure, Working with panels, Understanding and switching views, Using property inspector, Formatting text, JAVA SCRIPT: Working with alert, confirm and prompt, Understanding loop, arrays, Creating rollover image, Working with operator, GIF ANIMATION: Learning to use FTP, Setting FTP, Uploading of site, Using Control panel, FTP UPLOADING SITE: Understanding gif animation interface, Knowing GIf file format, Creating basic web banners, Creating web banners with effects, Creating animated web buttons.

Suggested Readings

- Jennifer Niederst Robbins. Developing web design latest edition.
- Frain and Ben. Responsive Web Design with HTML5..
- Nicholas c.Zakas. Java Script for Web Developers.
- George Q. Huang, K. L Mak. Internet Applications in Product Design and Manufacturing. ISBN:3540434658.

B) Applied Sciences 31(20+11)

i) Principles of Agronomy 3(2+1)

Theory

Introduction and scope of agronomy. Classification of crops, Effect of different weather parameters on crop growth and development. Principles of tillage, tilth and its characteristics. Crop seasons. Methods, time and depth of sowing of major field crops. Methods and time of application of manures and fertilizers. Organic farming-Sustainable agriculture. Soil water plant relationship, crop coefficients, water requirement of crops and critical stages for irrigation, weeds and their control, crop rotation, cropping systems, Relay cropping and mixed cropping.

Practical

Identification of crops and their varieties, seeds, manures, fertilizers and weeds; Fertilizer application methods; Different weed control methods; Practice of ploughing, Practice of Puddling, Practice of sowing.

Suggested Readings

- William L Donn. 1965. Meteorology. McGraw-Hill Book Co. New York.
- Arnon L. 1972. Crop Production in Dry Regions. Leonard Hill Publishing Co. London.

- Yawalkar K S and Agarwal J P. 1977. Manures and Fertilizers. Agricultural Horticultural Publishing House, Nagpur.
- Gupta O P. 1984. Scientific Weed Management in the Tropics and Sub- Tropics. Today and Tomorrow's Printers and Publishers. New Delhi.
- Rao V S. 1992. Principles of Weed Science. Oxford and IBH Publishing Co. Ltd. New Delhi.
- Reddy Yellamanda T and Shankar Reddy G H. 1995. Principles of Agronomy. Kalyani Publishers Ludhiana.

ii) Principles of Soil Science 3(2+1)

Theory

Nature and origin of soil; soil forming rocks and minerals, their classification and composition, soil forming processes, classification of soils – soil taxonomy orders; important soil physical properties; and their importance; soil particle distribution; soil inorganic colloids – their composition, properties and origin of charge; ion exchange in soil and nutrient availability; soil organic matter – its composition and decomposition, effect on soil fertility; soil reaction – acidic, saline and sodic soils; quality or irrigation water; essential plants nutrients – their functions and deficiency symptoms in plants; important inorganic fertilizers and their reactions in soils. Use of saline and sodic water for crop production, Gypsum requirement for reclamation of sodic soils and neutralising RSC; Liquid fertilisers and their solubility and compatibility.

Practical

Identification of rocks and minerals; Examination of soil profile in the field; Collection of Soil Sample; Determination of bulk density; particle density and porosity of soil; Determination of organic carbon of soil; Determination of Nitrogen, Determination of Phosphorus and Determination of Potassium; Identification of nutrient deficiency symptoms of crops in the field; Determination of gypsum requirement of sodic soils; Determination of water quality parameters.

Suggested Readings

- Brady Nyle C and Ray R Well. 2002. Nature and properties of soils. Pearson Education Inc., New Delhi.
- Indian Society of Soil Science. 1998. Fundamentals of Soil Science. IARI, New Delhi.
- Sehgal J.. A. Textbook of Pedology Concepts and Applications. Kalyani Publishers, New Delhi.
- Hillel D. 1982. Introduction to Soil Physics. Academic Press, London.

ii) Principles of Horticultural Crops and Plant Protection 2(1+1)

Theory

Scope of horticultural. Soil and climatic requirements for fruits, vegetables and floriculture crops, improved varieties, Criteria for site selection, layout and planting methods, nursery raising, commercial varieties/ hybrids, sowing and planting times and methods, seed rate and seed treatment for vegetable crops; macro and micro propagation methods, plant growing structures, pruning and training, crop coefficients, water requirements and critical stages, fertilizer application, fertigation, irrigation methods, harvesting, grading

and packaging, post harvest practices, Garden tools, management of orchard, Extraction and storage of vegetables seeds. Major pests and diseases and their management in horticulture crops.

Practical

Judging maturity time for harvesting of crop; Study of seed viability and germination test; Identification and description of important fruits, flowers and vegetable crops; Study of different garden tools; Preparation of nursery bed; Practices of pruning and training in some important fruit crops, visit to commercial greenhouse/ polyhouse; cultural operations for vegetable crops (sowing, fertilizer application, mulching, irrigation and weed control); seed extraction techniques; identification of important pests and diseases and their control.

Suggested Readings

- Bansal. P.C. 2008. Horticulture in India. CBS Publishers and Distributors, New Delhi.
- Saraswathy, S., T.L. Preethi, S. Balasubramanyan, J. Suresh, N. Revathy and S. Natarajan. 2007. Postharvest management of Horticultural Crops. Agrobios Publishers, Jodhpur.
- Arjunan, G., Karthikeyan, G, Dinakaran, D. and Raguchander, T. 1999. Diseases of Horticultural Crops. AE Publications, Coimbatore.
- Sharma Neeta and Mashkoor Alam. 1997. Postharvest diseases of Horticultural crops. International Book publishing Co. UP.

iv) Engineering Physics 3(2+1)

Theory

Dia, Para and ferromagnetism-classification. Langevin theory of dia and paramagnetism. Adiabatic demagnetization. Weiss molecular field theory and ferromagnetism. Curie-Weiss law. Wave particle quality, de-Broglie concept, uncertainty principle. Wave function. Time dependent and time independent Schrodinger wave equation, Qualitative explanation of Zeeman effect, Stark effect and Paschan Back effect, Raman spectroscopy. Statement of Bloch's function. Bands iii solids, velocity of Bloch's electron and effective mass. Distinction between metals. insulators and semiconductors. Intrinsic and extrinsic semiconductors, law of mass action. Determination of energy gap in semiconductors. Donors and acceptor levels. Superconductivity, critical magnetic field. Meissner effect. Isotope effect. Type-I and II superconductors, Josephson's effect DC and AC, Squids. Introduction to high Tc superconductors. Spontaneous and stimulated emission, Einstein A and B coefficients. Population inversion, He-Ne and Ruby lasers. Ammonia and Ruby masers, Holography-Note. Optical fiber. Physical structure. basic theory. Mode type, input output characteristics of optical fiber and applications. Illumination: laws of illumination, luminous flux, luminous intensity, candle power, brightness.

Practical

To find the frequency of A.C. supply using an electrical vibrator; To find the low resistance using Carey Foster bridge without calibrating the bridge wire; To determine dielectric constant of material using De Sauty's bridge; To determine the value of specific charge (e/m) for electrons by helical method; To study the induced e.m.f. as a function of velocity of the magnet; To obtain hysteresis curve (B-H curve) on a C.R.O. and to determine related magnetic quantities; To study the variation of magnetic field with distance along the axis of a current carrying circular coil and to detuning the radius of the coil; To determine the energy

band gap in a semiconductor using a p-n Junction diode; To determine the slit width from Fraunhofer diffraction pattern using laser beam; To find the numerical aperture of optical fiber: To set up the fiber optic analog and digital link; To study the phase relationships in L.R. circuit; To study LCR circuit; To study the variations of thermo emf of a copper-constantan thermo-couple with temperature; To find the wave length of light by prism.

Suggested Readings

- Brijlal and Subrahmanyam. Text Book of optics. S. Chand and Co., New Delhi.
- Sarkar Subir Kumar. Optical State Physics and Fiber Optics. S. Chand and Co., New Delhi.
- Gupta S L, Kumar V Sharma R C. Elements of Spectroscopy. Pragati Prakasam, Meeruth.
- Saxena B S and Gupta R C. Solid State Physics. Pragati Prakasam, Meeruth.
- Srivastava B N. Essentials of Quantum Mechanics. Pragati Prakasam, Meeruth.
- Vasudeva D N. Fundamentals of Magnetism and Electricity. S. Chand and Co., New Delhi.

v. Engineering Chemistry 3(2+1)

Theory

Phase rule and its application to one and two component systems. Fuels: classification. calorific value. Colloids: classification. properties. Corrosion: causes. types and method of prevention. Water: temporary and permanent hardness. disadvantages of hard water, scale and sludge formation in boilers, boiler corrosion. Analytical methods like thermo-gravimetric. polarographic analysis. nuclear radiation. detectors and analytical applications of radioactive materials. Enzymes and their use in the manufacturing of ethanol and acetic acid by fermentation methods. Principles of food chemistry. Introduction to lipids, proteins, carbohydrates, vitamins, food preseltators, colouring and flavouring reagents of food. Lubricants: properties. mechanism. classification and tests. Polymers. types of polymerization. properties. uses and methods for the determination of molecular weight of polymers. Introduction to IR spectroscopy.

Practical

Determination of temporary and permanent hardness of water by EDTA method: Estimation of chloride in water: Estimation of dissolved oxygen in water: Determination of BOD in water sample: Determination of COD in water sample: Estimation of available chlorine in bleaching powder: Determination of viscosity of oil: Estimation of activity of water sample: Estimation of alkalinity of water sample: Determination of carbonate and non- carbonate hardness by soda reagent: Determination of coagulation of water and chloride ion content: Determination of specific rotation of an optically active compound: Determination of Xnax and verification of Beer Lambert Law: Determination of calorific value of fuel: Identification of functional groups (alcohol, aldelyde, ketones, carboxylic acid and amide) by IR: Chromatographic analysis: Determination of molar refraction of organic compounds.

Suggested Readings

- Jain P L and Jain M. 1994. Engineering Chemistry. Danpat Rai publishing company Pvt. Ltd., Delhi.
- Bahl B S, Arun Bahl and Tuli B D. 2007. Essentials of Physical Chemistry. S. Chand and Co. Ltd., Delhi.

vi. Engineering Mathematics – I 3(2+1)

Theory

Matrices: Elementary transformations, rank of a matrix, reduction to normal form, Gauss- Jordon method to find inverse of a matrix, Eigen values and Eigen vectors, Cayley-Hamilton theorem, linear transformation, orthogonal transformations, diagonalisation of matrices, quadratic forms. PAQ form, Echelon form, Solution of linear equations, nature of rank, using Cayley-Hamilton theorem to find inverse of A. Differential calculus: Taylor's and Maclaurin's expansions; indeterminate form; curvature, function of two or more independent variables, partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivatives, maxima and minima. Integral calculus: volumes and surfaces of revolution of curves; double and triple integrals, change of order of integration, application of double and triple integrals to find area and volume. Vector calculus: Differentiation of vectors, scalar and vector point functions, vector differential operator Del, Gradient of a scalar point function, Divergence and Curl of a vector point function and their physical interpretations, identities involving Del, second order differential operator; line, surface and volume integrals, Stoke's, divergence and Green's theorems (without proofs).

Practical

Tutorials on rank of a matrix, reduction to normal form, consistency and solution of linear equations, eigen values and eigen vectors, Cayley-Hamilton theorem, diagonalization of matrices, quadratic forms; Taylor's and Maclaurin's expansion, indeterminate form, curvature, tracing of curves, partial differentiation, maxima and minima, volume and surface of revolution, multiple integrals, Beta and Gama functions, differentiation of vectors, gradient, divergence and curl of a vector point function, line, surface and volume integrals, Stoke's divergence and Green's Theorems.

Suggested Readings

- Narayan Shanti. 2004. Differential Calculus. S. Chand and Co. Ltd. New Delhi.
- Narayan Shanti. 2004. Integral Calculus. S. Chand and Co. Ltd. New Delhi.
- Grewal B S. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi.
- Narayan Shanti. 2004. A Text Book of Vector. S. Chand and Co. Ltd. New Delhi.

vii. Engineering Mathematics – II 3(2+1)

Theory

Ordinary differential equations: Exact and Bernoulli's differential equations, equations reducible to exact form by integrating factors, equations of first order and higher degree, Clairaut's equation, Differential equations of higher orders, methods of finding complementary functions and particular integrals, method of variation of parameters, Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients, series solution techniques, Bessel's and Legendre's differential equations. Functions of a Complex variable: Limit, continuity and analytic function, Cauchy-Riemann equations, Harmonic functions. Infinite series and its convergence, periodic functions, Fourier series, Euler's formulae, Dirichlet's conditions, functions having arbitrary period, even and odd functions, half range series, Harmonic analysis. Fourier Sine and Cosine Series, Fourier series for function having period 2L, Elimination of one and two arbitrary function. Partial differential equations: Formation of partial

differential equations Higher order linear partial differential equations with constant coefficients, solution of non-linear partial differential equations, Charpit's method, application of partial differential equations (one dimensional wave and heat flow equations, Laplace Equation.

Practical

Tutorials on solution of ordinary differential equations of first and higher orders. Series solutions of differential equations. Bessel's and Legendre's differential equations, Convergence of infinite series. Fourier series, harmonic analysis, analytical functions, Cauchey-Riemann equations, harmonic functions, Solution of partial differential equations, Application of partial differential equations.

Suggested Readings

- Narayan Shanti. 2004. A Text Book of Matrices. S. Chand and Co. Ltd. New Delhi.
- Grewal B S. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi.
- Ramana B V. 2008. Engineering Mathematics. Tata McGraw-Hill. New Delhi.

viii. Engineering Mathematics – III 3(2+1)

Theory

Numerical analysis and Laplace transformation: finite difference, various difference operators and their relationships. factorial notation, interpolation with equal integrals. Newton's forward and backward interpolation formula. Bessel's and Stirling's difference interpolation formulae. Interpolation with unequal intervals. Newton's divided difference formula. Lagrange's interpolation formula. numerical differentiations, numerical integrations, difference equations and their solutions, numerical solutions of ordinary differential equations by Picard's Taylor's series. Fuller's and modified Fuller's methods. Runga-Kutta method; Laplace transformation and its applications to the solutions of ordinary and simultaneous differential equations. Testing of Hypothesis-Level of Significance-Degrees of freedom-Statistical errors, Large sample test (Z-test), Small sample test t-test (One tailed, two tailed and Paired tests), Testing of Significance through variance (F-test), Chi -Square test, contingency table, Correlation, Regression.

Practical

Interpolation, Numerical differentiation and integration solutions of difference equations, numerical solution of ordinary differential equations of first order and first degree, Laplace and inverse Laplace transformations and their application to solution of ordinary and simultaneous differential equations. Problems on One Sample, Two sample Z-tests when Population S.D. is known and unknown, Problems on one sample, Two sample and paired t-test Chi-Square test – 2x2 and m x n, Calculation of Correlation coefficient and its testing, Contingency Table and F-test.

Suggested Readings

- Chandel SRS. A Hand book of Agricultural Statistics. Achal Praskasam Masndir, Kanpur.
- Agrawal B L. Basic Statistics. Wiley Eastern Ltd. New Age International Ltd.
- Nageswara Rao G. Statistics for Agricultural Sciences. BS Publications.

- Rangaswamy R. A Text Book of Agricultural Statistics. New Age Int. publications Ltd.
- Gupta S.C. Fundamental Applied Statistics.

ix. Communication Skills and Personality Development 2(1+1)

Theory

Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precis writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

Practical

Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precis writing, summarizing, abstracting; individual and group presentations.

Suggested Readings

- Balasubramanian T. 1989. A Text book of Phonetics for Indian Students. Orient Longman, New Delhi.
- Balasubrmanyam M. 1985. Business Communication. Vani Educational Books, New Delhi.
- Naterop, Jean, B. and Rod Revell. 1997. Telephoning in English. Cambridge University Press, Cambridge.
- Mohan Krishna and Meera Banerjee. 1990. Developing Communication Skills. Macmillan India Ltd. New Delhi.
- Krishnaswamy,. N and Sriraman, T. 1995. Current English for Colleges. Macmillan India Ltd. Madras.
- Narayanaswamy V R. 1979. Strengthen your writing. Orient Longman, New Delhi.
- Sharma R C and Krishna Mohan. 1978. Business Correspondence. Tata Mc Graw Hill publishing Company, New Delhi.

x Entrepreneurship Development and Business Management 3(2+1)

Theory

Entrepreneurship, management – Management functions – planning- Organizing -Directing – motivation – ordering – leading – supervision-Communication and control – Capital – Financial management – importance of financial statements – balance sheet – profit and loss statement, Analysis of financial statements – liquidity ratios – leverage ratios, Coverage ratios – turnover ratios – profitability ratios, Agro-based industries – Project – project cycle – Project appraisal and evaluation techniques – undiscounted measures – payback period – proceeds per rupee of outlay, Discounted measures – Net Present Value (NPV) – Benefit-Cost Ratio (BCR) – Internal Rate of Return (IRR) – Net benefit investment ratio (N / K ratio) – sensitivity analysis-Importance of agribusiness in Indian economy International trade-WTO agreements –

Provisions related to agreements in agricultural and food commodities. Agreements on agriculture (AOA) – Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS). Development (ED): Concept of entrepreneur and entrepreneurship Assessing overall business environment in Indian economy– Entrepreneurial and managerial characteristics- Entrepreneurship development Programmes (EDP)- Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development- Globalization and the emerging business entrepreneurial environment- Managing an enterprise: Importance of planning, budgeting, monitoring evaluation and follow-up managing competition. Role of ED in economic development of a country- Overview of Indian social, political systems and their implications for decision making by individual entrepreneurs- Economic system and its implications for decision making by individual entrepreneurs- Social responsibility of business. Morals and ethics in enterprise management- SWOT analysis- Government schemes and incentives for promotion of entrepreneurship. Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors- Venture capital (VC), contract farming (CF) and joint ventures (JV), public-private partnerships (PPP)- Overview of agricultural engineering industry, characteristics of Indian farm machinery industry.

Practical

Preparation of business – Strengths Weaknesses Opportunities and Threats (SWOT) analysis, Analysis of financial statements (Balance Sheet, Profit loss statement). Compounding and discounting, Break-even analysis Visit to agro-based industries – I, Visit to agro-based industries II Study of Agro-industries Development Corporation , Ratio analysis – I, Ratio analysis – II, Application of project appraisal technique – I(Undiscounted measures), Application of project appraisal technique – II(Discounted Measures), Formulation of project feasibility reports – Farm Machinery Project proposals as entrepreneur – individual and group - Presentation of project proposals in the class.

Suggested Readings

- Harsh, S.B., Conner, U.J. and Schwab, G.D. 1981. Management of the Farm Business. Prentice Hall Inc., New Jersey.
- Joseph, L. Massie. 1995. Essentials of Management. Prentice Hall of India Pvt. Ltd., New Delhi.
- Omri Rawlins, N. 1980. Introduction to Agribusiness. Prentice Hall Inc., New Jersey
- Gittenger Price, J. 1989. Economic Analysis of Agricultural Projects. John Hopkins University, Press, London.
- Thomas W Zimmer and Norman M Scarborough. 1996. Entrepreneurship. Prentice-Hall, New Jersey.
- Mark J Dollinger. 1999. Entrepreneurship Strategies and Resources. Prentice-Hall, Upper Saddal Rover, New Jersey.
- Khanka S S. 1999. Entrepreneurial Development. S. Chand and Co. New Delhi.
- Mohanty S K. 2007. Fundamentals of Entrepreneurship. Prentice Hall India Ltd., New Delhi.

xi. Environmental Science and Disaster Management (2+1)

Theory

Environmental Studies: Scope and importance. Natural Resources: Renewable and non- renewable resources Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles. Ecosystems: Concept, Structure, function, Producers, consumers, decomposers, Energy flow, ecological succession, food chains, food webs, ecological pyramids. Introduction, types, characteristic features, structure and function of the forest, grassland, desert and aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity and its conservation:- Introduction, definition, genetic, species & ecosystem diversity and bio-geographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Environmental Pollution: definition, cause, effects and control measures of a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Social Issues and the Environment from Unsustainable to Sustainable development, Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. dies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster Management*:* Natural Disasters and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion. Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents. Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

Practical

Case Studies and Field work. Visit to a local area to document environmental assets river/forest/grassland/ hill/mountain, Visit to a local polluted site-Urban/ Rural/ Industrial/ Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc. Expected impact of climate change on agricultural production and water resources, Mitigation Strategies, Economics of climate change. Disaster Management introduction, Natural and Manmade Disaster Studies, Informatics for Disaster Management, Quantitative Techniques for Disaster Management Environmental Impact Assessment (EIA) and Disaster Management Disaster Management Policy Environmental Modelling.

Suggested Readings

- Bharucha Erach. 2005. Text Book of Environmental Studies for Undergraduate Courses. University Grants Commission, University Press, Hyderabad.
- Sharma J P. 2003. Introduction to Environment Science. Lakshmi Publications.
- Chary Manohar and Jaya Ram Reddy. 2004. Principles of Environmental Studies. BS Publishers, Hyderabad.
- Kaul S N, Ashuthosh Gautam. 2002. Water and Waste Water Analysis. Days Publishing House, Delhi.
- Gupta P K. 2004. Methods in Environmental Analysis – Water. Soil and Air. Agro bios, Jodhpur.
- Climate change.1995: Adaptation and mitigation of climate change-Scientific Technical Analysis Cambridge University Press, Cambridge.
- Sharma, R.K. & Sharma, G. 2005. Natural Disaster. APH Publishing Corporation, New Delhi.
- Husain Majid. 2013. Environment and Ecology: Biodiversity, Climate Change and Disaster Management. online book.

2. Department of Soil and Water Conservation Engineering 10(6+4)

a. Watershed Hydrology 2(1+1)

Theory

Hydrologic cycle, precipitation and its forms, rainfall measurement and estimation of mean rainfall, frequencyanalysisofpointrainfall. Masscurve, hyetograph, depth-area-durationcurvesand intensity-duration-frequency relationship. Hydrologic processes-Interception, infiltration -factors influencing, measurement and indices. Evaporation - Estimation and measurement. Runoff - Factors affecting, measurement, stage - discharge rating curve, estimation of peak runoff rate and volume, Rational method, Cook's method and SCS curve number method. Geomorphology of watersheds – Linear, aerial and relief aspects of watersheds-stream order, drainage density and stream frequency. Hydrograph - Components, base flow separation, unit hydrograph theory, S-curve, synthetic hydrograph, applications and limitations. Stream gauging - discharge rating curves, flood peak, design flood and computation of probable flood. Flood routing – channel and reservoir routing. Drought – classification, causes and impacts, drought management strategy.

Practical

Visit to meteorological observatory and study of different instruments. Design of rain gauge network. Exercise on intensity - frequency - duration curves. Exercise on depth - area - duration and double mass curves. Analysis of rainfall data and estimation of mean rainfall by different methods. Exercise on frequency analysis of hydrologic data and estimation of missing data, test for consistency of rainfall records. Exercise on computation of infiltration indices. Computation of peak runoff and runoff volume by Cook's method and rational formula. Computation of runoff volume by SCS curve number method. Study of stream gauging instruments - current meter and stage level recorder. Exercise on geomorphic parameters of watersheds. Exercise on runoff hydrograph. Exercise on unit hydrograph. Exercise on synthetic hydrograph. Exercise on flood routing.

Suggested Readings

- Chow, V.T., D.R. Maidment and L.W. Mays. 2010. Applied Hydrology, McGraw Hill Publishing Co., New York.
- Jaya Rami Reddy, P. 2011. A Text Book of Hydrology. University Science Press, New Delhi.
- Linsley, R.K., M.A. Kohler, and J.L.H. Paulhus. 1984. Hydrology for Engineers. McGraw-Hill Publishing Co., Japan.
- Mutreja, K.N. 1990. Applied Hydrology. Tata McGraw-Hill Publishing Co., New Delhi.
- Raghunath, H.M. 2006. Hydrology: Principles Analysis and Design. Revised 2nd Edition, New Age International (P) Limited Publishers, New Delhi.
- Subramanya, K. 2008. Engineering Hydrology. 3rd Edition, Tata McGraw-Hill Publishing Co., New Delhi.
- Suresh, R. 2005. Watershed Hydrology. Standard Publishers Distributors, Delhi.
- Varshney, R.S. 1986. Engineering Hydrology. Nem Chand and Brothers, Roorkee, U.P.

b. Soil and Water Conservation Engineering 3(2+1)

Theory

Soil erosion - Introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion. Water erosion - Mechanics and forms - splash, sheet, rill, gully, ravine and stream bank erosion. Gullies - Classification, stages of development. Soil loss estimation – Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity - estimation by KE>25 and EI_{30} methods. Soil erodibility - topography, crop management and conservation practice factors. Measurement of soil erosion - Runoff plots, soil samplers. Water erosion control measures - agronomical measures - contour farming, strip cropping, conservation tillage and mulching. Engineering measures– Bunds and terraces. Bunds - contour and graded bunds - design and surplussing arrangements. Terraces - level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stonewall and trenching. Gully and ravine reclamation - principles of gully control - vegetative measures, temporary structures and diversion drains. Grassed waterways and design. Wind erosion- Factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes. Land capability classification. Rate of sedimentation, silt monitoring and storage loss in tanks.

Practical

Study of different types and forms of water erosion. Exercises on computation of rainfall erosivity index. Computation of soil erodibility index in soil loss estimation. Determination of length of slope (LS) and cropping practice (CP) factors for soil loss estimation by USLE and MUSLE. Exercises on soil loss estimation/ measuring techniques. Study of rainfall simulator for erosion assessment. Estimation of sediment rate using Coshocton wheel sampler and multi- slot devisor. Determination of sediment concentration through oven dry method. Design and layout of contour bunds. Design and layout of graded bunds. Design and layout of broad base terraces. Design and layout of bench terraces. Design of vegetative waterways. Exercises on rate of sedimentation and storage loss in tanks. Computation of soil loss by wind erosion. Design of shelterbelts and wind breaks for wind erosion control. Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures.

Suggested Readings

- Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service, New Delhi.
- Mal, B.C. 2014. Introduction to Soil and Water Conservation Engineering. 2014. Kalyani Publishers.
- Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
- Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
- Norman Hudson. 1985. Soil Conservation. Cornell University Press, Ithaka, New York, USA.
- Frevert, R.K., G.O. Schwab, T.W. Edminster and K.K. Barnes. 2009. Soil and Water Conservation Engineering, 4th Edition, John Wiley and Sons, New York.
- Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

c. Water Harvesting and Soil Conservation Structures 3(2+1)

Theory

Water harvesting-principles, importance and issues. Water harvesting techniques- classification based on source, storage and use. Runoff harvesting – short-term and long-term techniques. Short-term harvesting techniques - terracing and bunding, rock and ground catchments. Long- term harvesting techniques - purpose and design criteria. Structures - farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes. Farm pond - components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction. Percolation pond - site selection, design and construction details. Design considerations of *nala* bunds. Soil erosion control structures - introduction, classification and functional requirements. Permanent structures for soil conservation and gully control - check dams, drop, chute and drop inlet spillways - design requirements, planning for design, design procedures - hydrologic, hydraulic and structural design and stability analysis. Hydraulic jump and its application. Drop spillway - applicability, types - straight drop, box-type inlet spillways - description,

functional use, advantages and disadvantages, straight apron and stilling basin outlet, structural components and functions. Loads on head wall, variables affecting equivalent fluid pressure, triangular load diagram for various flow conditions, creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension. Chute spillway - description, components, energy dissipaters, design criteria of Saint Antony Falls (SAF) stilling basin and its limitations. Drop inlet spillway - description, functional use and design criteria.

Practical

Study of different types of farm ponds. Computation of storage capacity of embankment type of farm ponds. Design of dugout farm ponds. Design of percolation pond and *nala* bunds. Runoff measurement using H-flume. Exercise on hydraulic jump. Exercise on energy dissipation in water flow. Hydrologic, hydraulic and structural design of drop spillway and stability analysis. Design of SAF stilling basins in chute spillway. Hydrologic, hydraulic and structural design of drop inlet spillway. Design of small earthen embankment structures. Practice on softwares for design of soil and water conservation structures. Field visit to watershed project areas treated with soil and water conservation measures / structures.

Suggested Readings

- Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
- Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
- Schwab, G.O., D.D. Fangmeier, W.J. Elliot, R.K. Frevert. 1993. Soil and Water Conservation Engineering.4th Edition, John Wiley and Sons Inc. New York.
- Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.
- Samra, J.S., V.N. Sharda and A.K. Sikka. 2002. Water Harvesting and Recycling: Indian Experiences. CSWCR&TI, Dehradun, Allied Printers, Dehradun.
- Theib Y. Oweis, Dieter Prinz and Ahmed Y. Hachum. 2012. Rainwater Harvesting for Agriculture in the Dry Areas. CRC Press, Taylor and Francis Group, London.
- Studer Rima Mekdaschi and Hanspeter Liniger. 2013. Water Harvesting - Guidelines to Good Practice. Centre for Development and Environment, University of Bern, Switzerland.

d. Watershed Planning and Management 2(1+1)

Theory

Watershed - introduction and characteristics. Watershed development - problems and prospects, investigation, topographical survey, soil characteristics, vegetative cover, present land use practices and socio-economic factors. Watershed management - concept, objectives, factors affecting, watershed planning based on land capability classes, hydrologic data for watershed planning, watershed codification, delineation and prioritization of watersheds – sediment yield index. Water budgeting in a watershed. Management measures

- rainwater conservation technologies - *in-situ* and *ex-situ* storage, water harvesting and recycling. Dry farming techniques - inter-terrace and inter-bund land management. Integrated watershed management - concept, components, arable lands - agriculture and horticulture, non-arable lands - forestry, fishery and animal husbandry. Effect of cropping systems, land management and cultural practices on watershed hydrology. Watershed programme - execution, follow-up practices, maintenance, monitoring and evaluation. Participatory watershed management - role of watershed associations, user groups and self-help groups. Planning and formulation of project proposal for watershed management programme including cost-benefit analysis.

Practical

Exercises on delineation of watersheds using toposheets. Surveying and preparation of watershed map. Quantitative analysis of watershed characteristics and parameters. Watershed investigations for planning and development. Analysis of hydrologic data for planning watershed management. Water budgeting of watersheds. Prioritization of watersheds based on sediment yield index. Study of functional requirement of watershed development structures. Study of watershed management technologies. Practice on softwares for analysis of hydrologic parameters of watershed. Study of role of various functionaries in watershed development programmes. Techno-economic viability analysis of watershed projects. Visit to watershed development project areas.

Suggested Readings

- Ghanshyam Das. 2008. Hydrology and Soil Conservation Engineering: Including Watershed Management. 2nd Edition, Prentice-Hall of India Learning Pvt. Ltd., New Delhi.
- Katyal, J.C., R.P. Singh, Shriniwas Sharma, S.K. Das, M.V. Padmanabhan and P.K. Mishra. 1995. Field Manual on Watershed Management. CRIDA, Hyderabad.
- Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service. New Delhi.
- Sharda, V.N., A.K. Sikka and G.P. Juyal. 2006. Participatory Integrated Watershed Management: A Field Manual. Central Soil and Water Conservation Research and Training Institute, Dehradun.
- Singh, G.D. and T.C. Poonia. 2003. Fundamentals of Watershed Management Technology. Yash Publishing House, Bikaner.
- Singh, P.K. 2000. Watershed Management: Design and Practices. E-media Publications, Udaipur.
- Singh, R.V. 2000. Watershed Planning and Management. Yash Publishing House, Bikaner.
- Tideman,E.M. 1999. Watershed Management: Guidelines for Indian Conditions. Omega Scientific Publishers, New Delhi.

3) Department of Irrigation and Drainage Engineering 10(6+4)

a. Irrigation Engineering 3(2+1)

Theory

Major and medium irrigation schemes of India, purpose of irrigation, environmental impact of irrigation projects, source of irrigation water, present status of development and utilization of different water resources

of the country; measurement of irrigation water: weir, flumes and orifices and other methods; open channel water conveyance system : design and lining of irrigation field channels, on farm structures for water conveyance, control & distribution; underground pipe conveyance system: components and design; land grading: criteria for land levelling, land levelling design methods, estimation of earth work; soil water plant relationship: soil properties influencing irrigation management, soil water movement, infiltration, soil water potential, soil moisture characteristics, soil moisture constants, measurement of soil moisture, moisture stress and plant response; water requirement of crops: concept of evapotranspiration (ET), measurement and estimation of ET, water and irrigation requirement of crops, depth of irrigation, frequency of irrigation, irrigation efficiencies; surface methods of water application: border, check basin and furrow irrigation-adaptability, specification and design considerations.

Practical

Measurement of soil moisture by different soil moisture measuring instruments; measurement of irrigation water; measurement of infiltration characteristics; determination of bulk density, field capacity and wilting point; estimation of evapotranspiration; land grading methods; design of underground pipeline system; estimation of irrigation efficiency; study of advance, recession and computation of infiltration opportunity time; infiltration by inflow-outflow method; evaluation of border irrigation method; evaluation of furrow irrigation method; evaluation of check basin irrigation method.

Suggested Readings

- Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing House New Delhi.
- Majumdar D. K. 2013. Irrigation Water Management Principles. PHI learning Private Limited New Delhi 2nd Edition.
- Allen R. G., L. S. Pereira, D. Raes, M. Smith. 1998. Crop Evapotranspiration guidelines for computing crop water requirement. Irrigation and drainage Paper 56, FAO of United Nations, Rome.
- Murthy VVN. 2013. Land and Water Management Engineering. Kalyani Publishers, New Delhi.
- Israelsen O W. and Hansen V. E and Stringham G. E. 1980. Irrigation Principles and Practice, John Wiley & Sons, Inc. USA.

b. Drainage Engineering 2(1+1)

Theory

Water logging- causes and impacts; drainage, objectives of drainage, familiarization with the drainage problems of the state; surface drainage coefficient, types of surface drainage, design of surface drains; sub-surface drainage: purpose and benefits, investigations of design parameters- hydraulic conductivity, drainable porosity, water table; derivation of Hooghoudt's and Ernst's drain spacing equations; design of subsurface drainage system; drainage materials, drainage pipes, drain envelope; layout, construction and installation of drains; drainage structures; vertical drainage; bio-drainage; mole drains; salt balance, reclamation of saline and alkaline soils, leaching requirements, conjunctive use of fresh and saline water.

Practical

In-situ measurement of hydraulic conductivity by single auger hole and inverse auger hole method; Estimation of drainage coefficients; installation of piezometer and observation wells; preparation of iso-

bath and isobar maps; determination of drainable porosity; design of surface drainage systems; design of gravel envelop; design of subsurface drainage systems; determination of chemical properties of soil and water; study of drainage tiles and pipes; installation of sub-surface drainage system; cost analysis of surface and sub-surface drainage system.

Suggested Readings

- Bhattacharya AK and Michael AM. 2013. Land Drainage, Principles , Methods and Applications. Vikas Publication House, Noida (UP).
- Ritzema H.P.1994 Drainage Principles and Applications, ILRI Publication 16, Second Edition (Completely Revised).
- Michael AM. and Ojha TP. 2014. Principles of Agricultural Engineering Vol-II 5th Edition. Jain Brothers Publication, New Delhi.
- Kadam U.S., Thokal R.T., Gorantiwar S.D. and Powar A.G. 2007. Agricultural Drainage- Principles and Practices, Westville Publishing House.
- FAO Irrigation and Drainage Paper No. 6, 9, 15, 16, 28 and 38. Rome, Italy.

c. Groundwater, Wells and Pumps 3(2+1)

Theory

Occurrence and movement of ground water; aquifer and its types; classification of wells, fully penetrating tubewells and open wells, familiarization of various types of bore wells; design of open wells; groundwater exploration techniques; methods of drilling of wells: percussion, rotary, reverse rotary; design of tubewell and gravel pack, installation of well screen, completion and development of well; groundwater hydraulics-determination of aquifer parameters by different method such as Theis, Jacob and Chow's, Theis recovery method; well interference, multiple well systems, estimation of ground water potential, quality of ground water; artificial groundwater recharge techniques; pumping systems: water lifting devices; different types of pumps, classification of pumps, component parts of centrifugal pumps, priming, pump selection, installation and trouble shooting, performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics; hydraulic ram, propeller pumps, mixed flow pumps and their performance characteristics; deep well turbine pump and submersible pump.

Practical

Verification of Darcy's Law; study of different drilling equipments; sieve analysis for gravel and well screens design; estimation of specific yield and specific retention; testing of well screen; estimation of aquifer parameters by Theis method, Coopers-Jacob method, Chow method; Theis Recovery method; well design under confined and unconfined conditions; well losses and well efficiency; estimating ground water balance; study of artificial ground water recharge structures; study of radial flow and mixed flow centrifugal pumps, multistage centrifugal pumps, turbine, propeller and other pumps; installation of centrifugal pump; testing of centrifugal pump and study of cavitations; study of hydraulic ram; study and testing of submersible pump.

Suggested Readings

- Michael AM, Khepar SD. and SK Sondhi. 2008. Water Well and Pumps, 2nd Edition, Tata Mc-Graw Hill.

- Todd David Keith and Larry W. Mays. 2004. Groundwater Hydrology, 3rd Edition, John Wiley & Sons, New York (International Book Distributing Company Lucknow).
- Michael AM. and Ojha TP. 2014. Principles of Agricultural Engineering Vol-II, 5th Edition. Jain Brothers Publication, New Delhi.

d. Sprinkler and Micro irrigation Systems 2(1+1)

Theory

Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems; design of sprinkler irrigation system: layout selection, hydraulic design of lateral, sub- main and main pipe line, design steps; selection of pump and power unit for sprinkler irrigation system; performance evaluation of sprinkler irrigation system: uniformity coefficient and pattern efficiency; Micro Irrigation Systems: types-drip, spray, & bubbler systems, merits and demerits, different components; Design of drip irrigation system: general considerations, wetting patters, irrigation requirement, emitter selection, hydraulics of drip irrigation system, design steps; necessary steps for proper operation of a drip irrigation system; maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment; fertigation: advantages and limitations of fertigation, fertilizers solubility and their compatibility, precautions for successful fertigation system, fertigation frequency, duration and injection rate, methods of fertigation.

Practical

Study of different components of sprinkler irrigation system; design and installation of sprinkler irrigation system; determination of precipitation pattern, discharge and uniformity coefficient; cost economics of sprinkler irrigation system; study of different components of drip irrigation; design and installation of drip irrigation system; determination of pressure discharge relationship and emission uniformity for given emitter; study of different types of filters and determination of filtration efficiency; determination of rate of injection and calibration for chemigation/fertigation; design of irrigation and fertigation schedule for crops; field visit to micro irrigation system and evaluation of drip system; cost economics of drip irrigation system.

Suggested Readings

- Keller Jack and Bliesner Ron D.2001. Sprinkle and Trickle Irrigation. Springer Science+ business Media, New York .
- Mane M.S. and Ayare B.L.2007. Principles of Sprinkler Irrigation systems, Jain Brothers, New Delhi.
- Mane M.S and Ayare B.L. and MagarS.S.2006.Principles of Drip Irrigation systems, Jain Brothers, New Delhi.
- Michael AM, Shrimohan and KR Swaminathan. Design and evaluation of irrigation methods, (IARI Monograph No.1). Water Technology Centre, IARI New Delhi.
- Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Pub. House New Delhi.
- Choudhary M.L and Kadam U.S 2006. Micro irrigation for cash crops Westville Publishing House.

4) Department of Farm Machinery and Power Engineering 14(8+6)

a. Farm Machinery and Equipment-I 3(2+1)

Theory

Introduction to farm mechanization. Classification of farm machines. Unit operations in crop production. Identification and selection of machines for various operations on the farm. Hitching systems and controls of farm machinery. Calculation of field capacities and field efficiency. Calculations for economics of machinery usage, comparison of ownership with hiring of machines. Introduction to seed-bed preparation and its classification. Familiarization with land reclamation and earth moving equipment. Introduction to machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage. Measurement of draft of tillage tools and calculations for power requirement for the tillage machines. Introduction to tillage machines like mould-board plough, disc plough, chisel plough, sub-soiler, harrows, cultivators, Identification of major functional components. Attachments with tillage machinery. Introduction to sowing, planting & transplanting equipment. Introduction to seed drills, no-till drills, and strip- till drills. Introduction to planters, bed-planters and other planting equipment. Study of types of furrow openers and metering systems in drills and planters. Calibration of seed-drills/ planters. Adjustments during operation. Introduction to materials used in construction of farm machines. Heat treatment processes and their requirement in farm machines. Properties of materials used for critical and functional components of agricultural machines. Introduction to steels and alloys for agricultural application. Identification of heat treatment processes specially for the agricultural machinery components.

Practical

Familiarization with different farm implements and tools. Study of hitching systems, Problems on machinery management. Study of primary and secondary tillage machinery – construction, operation, adjustments and calculations of power and draft requirements. Study of sowing and planting equipment – construction, types, calculation for calibration and adjustments. Study of transplanters – paddy, vegetable, etc. Identification of materials of construction in agricultural machinery and study of material properties. Study of heat treatment processes subjected to critical components of agricultural machinery.

Suggested Readings

- Kepner RA, Roy Barger & EL Barger. Principles of Farm Machinery.
- Smith HP and LH Wilkey. Farm Machinery and Equipment.
- Culpin Claude. Farm Machinery.
- Srivastava AC. Elements of Farm Machinery.
- Lal Radhey and AC Datta. Agricultural Engineering.

b. Farm Machinery and Equipment-II 3(2+1)

Theory

Introduction to plant protection equipment – sprayers and dusters. Classification of sprayers and sprays. Types of nozzles. Calculations for calibration of sprayers and chemical application rates. Introduction to interculture equipment. Use of weeders – manual and powered. Study of functional requirements of

weeders and main components. Familiarization of fertilizer application equipment. Study of harvesting operation – harvesting methods, harvesting terminology. Study of mowers – types, constructional details, working and adjustments. Study of shear type harvesting devices – cutter bar, inertial forces, counter balancing, terminology, cutting pattern. Study of reapers, binders and windrowers – principle of operation and constructional details. Importance of hay conditioning, methods of hay conditioning, and calculation of moisture content of hay. Introduction to threshing systems – manual and mechanical systems. Types of threshing drums and their applications. Types of threshers- tangential and axial, their constructional details and cleaning systems. Study of factors affecting thresher performance. Study of grain combines, combine terminology, classification of grain combines, study of material flow in combines. Computation of combine losses, study of combine troubles and troubleshooting. Study of chaff cutters and capacity calculations. Study of straw combines – working principle and constructional details. Study of root crop diggers – principle of operation, blade adjustment and approach angle, and calculation of material handled. Study of potato and groundnut diggers. Study of Cotton harvesting – Cotton harvesting mechanisms, study of cotton pickers and strippers, functional components. Study of maize harvesting combines. Introduction to vegetables and fruit harvesting equipment and tools.

Practical

Familiarization with plant protection and interculture equipment. Study of sprayers, types, functional components. Study of dusters, types and functional components. Calculations for chemical application rates. Study of nozzle types and spread pattern using patternator. Familiarization with manual and powered weeding equipment and identification of functional components. Study of fertilizer application equipment including manure spreaders and fertilizer broadcasters. Study of various types of mowers, reaper, reaper binder. Study of functional components of mowers and reapers. Familiarization with threshing systems, cleaning systems in threshers. Calculations of losses in threshers. Familiarization with functional units of Grain combines and their types. Calculations for grain losses in a combine. Study of root crop diggers and familiarization with the functional units and attachments. Familiarization with the working of cotton and maize harvesters. Familiarization with vegetable and fruit harvesters.

Suggested Readings

- Kepner RA, Roy Barger & EL Barger. Principles of Farm Machinery.
- Smith HP and LH Wilkey. Farm Machinery and Equipment.
- Culpin Claude. Farm Machinery.
- Srivastava AC. Elements of Farm Machinery.
- Lal Radhey and AC Datta. Agricultural Engineering Principles of Farm Machinery.

c. Tractor and Automotive Engines 3(2+1)

Theory

Study of sources of farm power –conventional & non-conventional energy sources. Classification of tractors and IC engines. Review of thermodynamic principles of IC (CI & SI) engines and deviation from ideal cycle. General energy equation and heat balance sheet. Study of mechanical, thermal and volumetric efficiencies. Study of engine components their construction, operating principles and functions. Study of

engine strokes and comparison of 2-stroke and 4-stroke engine cycles and CI and SI engines. Study of Engine Valve systems, valve mechanism, Valve timing diagram, and valve clearance adjustment Study of Cam profile, valve lift and valve opening area. Study of importance of air cleaning system. Study of types of air cleaners and performance characteristics of various air cleaners. Study of fuel supply system. Study of fuels, properties of fuels, calculation of air-fuel ratio. Study of tests on fuel for SI and CI engines. Study of detonation and knocking in IC engines. Study of carburetion system, carburetors and their main functional components. Study of fuel injection system – Injection pump, their types, working principles. Fuel injector nozzles – their types and working principle. Engine governing-need of governors, governor types and governor characteristics. Study of lubrication system – need, types, functional components. Study of lubricants – physical properties, additives and their application. Engine cooling system – need, cooling methods and main functional components. Study of need and type of thermostat valves. Additives in the coolant. Study of radiator efficiency. Study of ignition system of SI engines. Study of electrical system including battery, starting motor, battery charging, cut-out, etc. Comparison of dynamo and alternator. Familiarization with the basics of engine testing

Practical

Introduction to different systems of CI engines; Engine parts and functions, working principles etc. Valve system – study, construction and adjustments; Oil & Fuel – determination of physical properties; Air cleaning system; Fuel supply system of SI engine; Diesel injection system & timing; Cooling system, and fan performance, thermostat and radiator performance evaluation; Part load efficiencies & governing; Lubricating system & adjustments; Starting and electrical system; Ignition system; Tractor engine heat balance and engine performance curves; Visit to engine manufacturer/ assembler/ spare parts agency.

Suggested Readings

- Liljedahl J B and Others. Tractors and Their Power Units.
- Rodichev V and G Rodicheva. Tractors and Automobiles.
- Mathur ML and RP Sharma. A course in Internal Combustion Engines.
- Singh Kirpal. Automobile Engineering – Vol II.
- Heitner Joseph. Automotive Mechanics : Principles and Practices.

d. Tractor Systems and Controls 3(2+1)

Theory

Study of need for transmission system in a tractor. Transmission system – types, major functional systems. Study of clutch – need, types, functional requirements, construction and principle of operation. Familiarization with single plate, multi-plate, centrifugal and dual clutch systems. Study of Gear Box – Gearing theory, principle of operation, gear box types, functional requirements, and calculation for speed ratio. Study of differential system – need, functional components, construction, calculation for speed reduction. Study of need for a final drive. Study of Brake system – types, principle of operation, construction, calculation for braking torque. Study of steering system – requirements, steering geometry characteristics, functional components, calculation for turning radius. Familiarization with Ackerman steering. Steering systems in track type tractors. Study of Hydraulic system in a tractor – Principle of operation, types, main functional

components, functional requirements. Familiarization with the Hydraulic system adjustments and ADDC. Study of tractor power outlets – PTO. PTO standards, types and functional requirements. Introduction to traction. Traction terminology. Theoretical calculation of shear force and rolling resistance on traction device. Study of wheels and tyres – Solid tyres and pneumatic tyres, tyre construction and tyre specifications. Study of traction aids. Study of tractor mechanics – forces acting on the tractor. Determination of CG of a tractor. Determination and importance of moment of inertia of a tractor. Study of tractor static equilibrium, tractor stability especially at turns. Determination of maximum drawbar pull. Familiarization with tractor as a spring-mass system. Ergonomic considerations and operational safety. Introduction to tractor testing. Deciphering the engine test codes.

Practical

Introduction to transmission systems and components; Study of clutch functioning, parts and design problem on clutch system; Study of different types of gear box, calculation of speed ratios, design problems on gear box; Study on differential and final drive and planetary gears; Study of brake systems and some design problems; Steering geometry and adjustments; Study of hydraulic systems in a tractor, hydraulic trainer and some design problems; Appraisal of various controls in different makes tractors in relation to anthropometric measurements. Determination of location of CG of a tractor, Moment of Inertia of a tractor. Traction performance of a traction wheel.

Suggested Readings

- Liljedahl J B and Others. Tractors and Their Power Units.
- Rodichev V and G Rodicheva. Tractors and Automobiles.
- Singh Kirpal. Automobile Engineering – Vol I.
- Heitner Joseph. Automotive Mechanics: Principles and Practices.
- C.B.Richey. Agricultural Engineering Handbook.
- John Deere. Fundamentals of Service Hydraulics.
- Relevant BIS Test Codes for Tractors.

e. Tractor and Farm Machinery Operation and Maintenance 2(0+2)

Practical

Familiarization with different makes and models of agricultural tractors. Identification of functional systems including fuels system, cooling system, transmission system, steering and hydraulic systems. Study of maintenance points to be checked before starting a tractor. Familiarization with controls on a tractor. Safety rules and precautions to be observed while driving a tractor. Driving practice of tractor. Practice of operating a tillage tool (mould-board plough/ disc plough) and their adjustment in the field. Study of field patterns while operating a tillage implement. Hitching & De-hitching of mounted and trail type implement to the tractor. Driving practice with a trail type trolley – forward and in reverse direction. Introduction to tractor maintenance – precautionary and break-down maintenance. Tractor starting with low battery charge. Introduction to trouble shooting in tractors. Familiarization with tools for general and special maintenance. Introduction to scheduled maintenance after 10, 100, 300, 600, 900 and 1200 hours of operation. Safety hints. Top end overhauling. Fuel saving tips. Preparing the tractor for storage.

Care and maintenance procedure of agricultural machinery during operation and off- season. Repair and maintenance of implements – adjustment of functional parameters in tillage implements. Replacement of broken components in tillage implements. Replacement of furrow openers and change of blades of rotavators. Maintenance of cutter bar in a reaper. Adjustments in a thresher for different crops. Replacement of V-belts on implements. Setting of agricultural machinery workshop.

Suggested Readings

- Ghosh RK and S Swan. Practical Agricultural Engineering.
- Black PO and WE Scahill. Diesel Engine Manual.
- Southorn N. Tractor operation and maintenance.
- Jain SC and CR Rai. Farm Tractor Maintenance and Repair.
- Operators manuals of tractors.
- Service manuals provided by manufacturers.

5. Department of Processing and Food Engineering 13(8+5)

a. Engineering Properties of Agricultural Produce 2(1+1)

Theory

Classification and importance of engineering properties of Agricultural Produce, shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area of grains, fruits and vegetables, Thermal properties, Heat capacity, Specific heat, Thermal conductivity, Thermal diffusivity, Heat of respiration; Co-efficient of thermal expansion, Friction in agricultural materials; Static friction, Kinetic friction, rolling resistance, angle of internal friction, angle of repose, Flow of bulk granular materials, Aero dynamics of agricultural products, drag coefficients, terminal velocity. Rheological properties; force, deformation, stress, strain, elastic, plastic and viscous behaviour, Newtonian and Non-Newtonian liquid, Visco-elasticity, Newtonian and Non- Newtonian fluid, Pseudo-plastic, Dilatant, Thixotropic, Rheopectic and Bingham Plastic Foods, Flow curves. Electrical properties; dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant, method of determination. Application of engineering properties in handling processing machines and storage structures

Practical

Determination of the shape and size of grains, fruits and vegetables, Determination of bulk density and angle of repose of grains, Determination of the particle density/true density and porosity of solid grains, Finding the co-efficient of external and internal friction of different crops, Finding out the terminal velocity of grain sample and study the separating behaviour in a vertical wind tunnel, Finding the thermal conductivity of different grains, Determination of specific heat of some food grains, Determination of hardness of food material and determination of viscosity of liquid foods.

Suggested Readings

- Mohesin, N.N. 1980. Physical Properties of Plants & Animals. Gordon & Breach Science
- Publishers , New York.

- Mohesin, N.N. 1980. Thermal Properties of Foods and Agricultural Materials. Gordon & Breach Science Publishers , New York.
- Prentice, J.H. 1984. Measurement in Rheological Properties of Food Stuffs. Elsevier Applied science Pub. Co. Inc. New York.
- Rao, M.A. and Rizvi, S.H., 1995. Engineering Properties of Foods. Marcel Dekker Inc. New York.
- Singhal OP & Samuel DVK. 2003. Engineering Properties of Biological Materials. Saroj Prakashan.

b. Agricultural Structures and Environmental Control 3(2+1)

Theory

Planning and layout of farmstead. Scope, importance and need for environmental control, physiological reaction of livestock environmental factors, environmental control systems and their design, control of temperature, humidity and other air constituents by ventilation and other methods, Livestock production facilities, BIS Standards for dairy, piggery, poultry and other farm structures. Design, construction and cost estimation of farm structures; animal shelters, compost pit, fodder silo, fencing and implement sheds, barn for cows, buffalo, poultry, etc. Storage of grains, Causes of spoilage, Water activity for low and high moisture food and its limits for storage, Moisture and temperature changes in grain bins; Traditional storage structures and their improvements, Improved storage structures (CAP, hermetic storage, Pusa bin, RCC ring bins), Design consideration for grain storage godowns, Bag storage structures, Shallow and Deep bin, Calculation of pressure in bins, Storage of seeds. Rural living and development, rural roads, their construction cost and repair and maintenance. Sources of water supply, norms of water supply for human being and animals, drinking water standards and water treatment suitable to rural community. Site and orientation of building in regard to sanitation, community sanitation system; sewage system and its design, cost and maintenance, design of septic tank for small family. Estimation of domestic power requirement, source of power supply and electrification of rural housing.

Practical

Measurements for environmental parameters and cooling load of a farm building, Design and layout of a dairy farm, Design and layout of a poultry house, Design and layout of a goat house/ sheep house, Design of a farm fencing system, Design of a feed/fodder storage structures, Design of grain storage structures, Design and layout of commercial bag and bulk storage facilities, Study and performance evaluation of different domestic storage structure, Estimation of a Farm building.

Suggested Readings

- Pandey, P.H. Principles and practices of Agricultural Structures and Environmental Control, Kalyani Publishers, Ludhiana.
- Ojha, T.P and Michael, A.M. Principles of Agricultural Engineering, Vol. I, Jain Brothers, Karol Bag, New Delhi.
- Nathonson, J.A. Basic Environmental Technology, Prentice Hall of India, New Delhi.
- Venugopal Rao, P. Text Book of Environmental Engineering, Prentice Hall of India, New Delhi.
- Garg, S.K. Water Supply Engineering, Khanna Publishers, New Delhi-6.

- Dutta, B.N. Estimating and Costing in Civil Engineering, Duttta & CO, Lucknow.
- Khanna, P.N. Indian Practical Civil Engineer's Hand Book, Engineer's Publishers, New Delhi.
- Sahay, K.M. and Singh, K.K. Unit Operations of Agricultural Processing, Vikas publishing pvt. Ltd, Noida.
- Banerjee, G.C. A Text Book of Animal Husbandry, Oxford IBH Publishing Co, New Delhi.

c. Post Harvest Engineering of Cereals, Pulses and Oil Seeds 3(2+1)

Theory

Cleaning and grading, aspiration, scalping; size separators, screens, sieve analysis, capacity and effectiveness of screens. Various types of separators: specific gravity, magnetic, disc, spiral, pneumatic, inclined draper, velvet roll, colour sorters, cyclone, shape graders. Size reduction: principle, Bond's law, Kick's law, Rittinger's law, procedure (crushing, impact, cutting and shearing), Size reduction machinery: Jaw crusher, Hammer mill, Plate mill, Ball mill. Material handling equipment. Types of conveyors: Belt, roller, chain and screw. Elevators: bucket, Cranes & hoists. Trucks (refrigerated/ unrefrigerated), Pneumatic conveying. Drying: moisture content and water activity; Free, bound and equilibrium moisture content, isotherm, hysteresis effect, EMC determination, Psychrometric chart and its use in drying, Drying principles and theory, Thin layer and deep bed drying analysis, Falling rate and constant rate drying periods, maximum and decreasing drying rate period, drying equations, Mass and energy balance, Shedd's equation, Dryer performance, Different methods of drying, batch-continuous; mixing-non-mixing, Sun- mechanical, conduction, convection, radiation, superheated steam, tempering during drying, Different types of grain dryers: bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray. Mixing: Theory of mixing of solids and pastes, Mixing index, types of mixers for solids, liquid foods and pastes. Milling of rice: Conditioning and parboiling, advantages and disadvantages, traditional methods, CFTRI and Jadavpur methods, Pressure parboiling method, Types of rice mills, Modern rice milling, different unit operations and equipment. Milling of wheat, unit operations and equipment. Milling of pulses: traditional milling methods, commercial methods, pre-conditioning, dry milling and wet milling methods: CFTRI and Pantnagar methods. Pulse milling machines, Milling of corn and its products. Dry and wet milling. Milling of oilseeds: mechanical expression, screw press, hydraulic press, solvent extraction methods, preconditioning of oilseeds, refining of oil, stabilization of rice bran., Extrusion cooking: principle, factors affecting, single and twin screw extruders. By-products utilization.

Practical

Performance evaluation of different types of cleaners and separators, Determination of separation efficiency, Study of different size reduction machines and performance evaluation, Determination of fineness modulus and uniformity index, Study of different types of conveying and elevating equipments, Study of different types of mixers. Measurement of moisture content: dry basis and wet basis, Study on drying characteristics of grains and determination of drying constant, Determination of EMC (Static and dynamic method), Study of various types of dryers, Study of different equipments in rice mills and their performance evaluation, Study of different equipments in pulse mills and their performance evaluation, Study of different equipments in oil mills and their performance evaluation, Type of process flow charts with examples relating to processing of cereals pulses and oil seeds, Visit to grain processing industries.

Suggested Readings

- Chakraverty, A. Post Harvest Technology of cereals, pulses and oilseeds. Oxford & IBH publishing Co. Ltd., New Delhi.
- Dash, S.K., Bebartta, J.P. and Kar, A. Rice Processing and Allied Operations. Kalyani Publishers, New Delhi.
- Sahay, K.M. and Singh, K.K. 1994. Unit operations of Agricultural Processing. Vikas Publishing house Pvt. Ltd. New Delhi.
- Geankoplis C. J. Transport processes and unit operations, Prentice Hall of India Pvt Ltd, New Delhi
- Earle, R.L. 2003. Unit Operations in Food Processing. Pergamon Press. Oxford. U.K.
- Henderson, S.M., and Perry, R. L. Agricultural Process Engineering, Chapman and hall, London
- McCabe, W.L., Smith J.C. and Harriott, P. Unit operations of Chemical Engineering. McGraw Hill.
- Singh, R. Paul. and Heldman, R.Dennis. 2004. Introduction to Food Engineering. 3rd Edition. Academic Press, London.

d. Post Harvest Engineering of Horticultural Crops 2(1+1)

Theory

Importance of processing of fruits and vegetables, spices, condiments and flowers. Characteristics and properties of horticultural crops important for processing, Peeling: Different peeling methods and devices (manual peeling, mechanical peeling, chemical peeling, and thermal peeling), Slicing of horticultural crops: equipment for slicing, shredding, crushing, chopping, juice extraction, etc., Blanching: Importance and objectives; blanching methods, effects on food (nutrition, colour, pigment, texture), Chilling and freezing: Application of refrigeration in different perishable food products, Thermophilic, mesophilic & Psychrophilic micro-organisms, Chilling requirements of different fruits and vegetables, Freezing of food, freezing time calculations, slow and fast freezing, Equipment for chilling and freezing (mechanical & cryogenic), Effect on food during chilling and freezing, Cold storage heat load calculations and cold storage design, refrigerated vehicle and cold chain system, Dryers for fruits and vegetables, Osmo-dehydration, Packaging of horticultural commodities, Packaging requirements (in terms of light transmittance, heat, moisture and gas proof, micro organisms, mechanical strength), Different types of packaging materials commonly used for raw and processed fruits and vegetables products, bulk and retail packages and packaging machines, handling and transportation of fruits and vegetables, Pack house technology, Minimal processing, Common methods of storage, Low temperature storage, evaporative cooled storage, Controlled atmospheric storage, Modified atmospheric packaging, Preservation Technology, General methods of preservation of fruits and vegetables, Brief description and advantages and disadvantages of different physical/ chemical and other methods of preservation, Flowcharts for preparation of different finished products, Important parameters and equipment used for different unit operations, Post harvest management and equipment for spices and flowers, Quality control in fruit and vegetable processing industry. Food supply chain.

Practical

Performance evaluation of peeler and slicer, Performance evaluation of juicer and pulper, Performance evaluation of blanching equipment, Testing adequacy of blanching, Study of cold storage and its design, Study of CAP and MAP storage, Minimal processing of vegetables, Preparation of value added products, Visit to fruit and vegetable processing industry, Visit to spice processing plant.

Suggested Readings

- Arthey, D. and Ashurst, P. R. 1966. Fruit Processing. Chapman and Hall, New York.
- Pantastico, E.C.B. 1975. Postharvest physiology, handling and utilization of tropical and subtropical fruits and vegetables AVI Pub. Co., New Delhi.
- Pandey, R.H. 1997. Postharvest Technology of fruits and vegetables (Principles and practices). Saroj Prakashan, Allahabad.
- Sudheer, K P. and Indira, V. 2007. Post Harvest Engineering of horticultural crops. New india Publishing House.

e. Dairy and Food Engineering 3(2+1)

Theory

Deterioration in food products and their controls, Physical, chemical and biological methods of food preservation. Nanotechnology: History, fundamental concepts, tools and techniques nanomaterials, applications in food packaging and products, implications, environmental impact of nanomaterials and their potential effects on global economics, regulation of nanotechnology. Dairy development in India, Engineering, thermal and chemical properties of milk and milk products, Process flow charts for product manufacture, Unit operation of various dairy and food processing systems. Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization, centrifugation and cream separation. Preparation methods and equipment for manufacture of cheese, *paneer*, butter and ice cream, Filling and packaging of milk and milk products; Dairy plant design and layout, Plant utilities; Principles of operation and equipment for thermal processing, Canning, Aseptic processing, Evaporation of food products: principle, types of evaporators, steam economy, multiple effect evaporation, vapour recompression, Drying of liquid and perishable foods: principles of drying, spray drying, drum drying, freeze drying, Filtration: principle, types of filters; Membrane separation, RO, Nano-filtration, Ultra filtration and Macro-filtration, equipment and applications, Non-thermal and other alternate thermal processing in Food processing.

Practical

Study of pasteurizers, Study of sterilizers, Study of homogenizers, Study of separators, Study of butter churns, Study of evaporators, Study of milk dryers, Study of freezers, Study of filtration, Design of food processing plants & preparation of layout, Visit to multi-product dairy plant, Estimation of steam requirements, Estimation of refrigeration requirements in dairy & food plant, Visit to Food industry.

Suggested Readings

- Ahmed, T. 1997. Dairy Plant Engineering and Management. 4th Ed. Kitab Mahal.
- McCabe, W.L. and Smith, J. C. 1999. Unit Operations of Chemical Engineering. McGraw Hill.
- Rao, D.G. Fundamentals of Food Engineering. PHI learning Pvt. Ltd. New Delhi.
- Singh, R.P. & Heldman, D.R. 1993. Introduction to Food Engineering. Academic Press.
- Toledo, R. T. 1997. Fundamentals of Food Process Engineering. CBS Publisher.

6) Department of Renewable Energy Engineering 9(6+3)

a. Fundamentals of Renewable Energy Sources3(2+1)

Theory

Concept and limitation of Renewable Energy Sources (RES), Criteria for assessing the potential of RES, Classification of RES, Solar, Wind, Geothermal, Biomass, Ocean energy sources, Comparison of renewable energy sources with non renewable sources. Solar Energy: Energy available from Sun, Solar radiation data, solar energy conversion into heat through, Flat plate and Concentrating collectors, different solar thermal devices, Principle of natural and forced convection drying system, Solar Photo voltaics: p-n junctions. Solar cells, PV systems, Stand alone, Grid connected solar power station, Calculation of energy through photovoltaic power generation and cost economics. Wind Energy: Energy available from wind, General formula, Lift and drag. Basis of Wind energy conversion, Effect of density, Frequency variances, Angle of attack, Wind speed, Types of Windmill rotors, Determination of torque coefficient, Induction type generators, Working principle of wind power plant. Bio-energy: Pyrolysis of Biomass to produce solid, liquid and gaseous fuels. Biomass gasification, Types of gasifier, various types of biomass cook stoves for rural energy needs. Biogas: types of biogas plants, biogas generation, factors affecting biogas generation and usages, design consideration, advantages and disadvantages of biogas spent slurry.

Practical

Study of different types of solar cookers, solar water heating system, natural convection solar dryer, forced convection solar dryer, solar desalination unit, solar greenhouse for agriculture production, biogas plants, biomass gasifiers, biomass improved cook-stoves, solar photovoltaic system.

Suggested Readings

- Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.
- Rai, G.D., Solar Energy Utilization, Khanna Publishers, Delhi.
- Khandelwal, K.C. & S. S. Mahdi. 1990. Biogas Technology- A Practical Handbook.
- Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Non Conventional Energy Sources, Himanshu Publications.
- Tiwari, G.N. and Ghoshal, M.K. 2005. Renewable Energy Resources: Basic Principles and Applications. Narosa Pub. House. Delhi.
- Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Renewable Energy, Theory and Practice, Himanshu Publications.

b. Renewable Power Sources 3(2+1)

Theory

Energy consumption pattern & energy resources in India. Renewable energy options, potential and utilization. Biogas technology and mechanisms, generation of power from biogas, Power generation from urban, municipal and industrial waste. Design & use of different commercial sized biogas plant. Solar

thermal and photovoltaic Systems for power generation. Central receiver (Chimney) and distributed type solar power plant, OTEC, MHD, hydrogen and fuel cell technology. Wind farms. Aero-generators. Wind power generation system. Power generation from biomass (gasification & Dendro thermal), Mini and micro small hydel plants. Fuel cells and its associated parameters.

Practical

Performance evaluation of solar water heater; Performance evaluation of solar cooker; Characteristics of solar photovoltaic panel; evaluation of solar air heater/dryer; Performance evaluation of biomass gasifier engine system (throatless & downdraft), Performance evaluation of a fixed dome type biogas plant; Performance evaluation of floating drum type biogas plant; Estimation of calorific value of biogas & producer gas; Testing of diesel engine operation using dual fuel and gas alone.

Suggested Readings

- Garg H.P. 1990. Advances in Solar Energy Technology; D. Publishing Company, Tokyo.
- Alan L: Farredbruch & R.H. Buse. 1983. Fundamentals of Solar Academic Press, London.
- Bansal N.K., Kleemann M. & Meliss Michael. 1990. Renewable Energy Sources & Conversion Technology; Tata Mecgrow Publishing Company, New Delhi.
- Rathore N. S., Kurchania A. K. & N.L. Panwar. 2007. Non Conventional Energy Sources, Himanshu Publications.
- Mathur, A.N. & N.S. Rathore. 1992. Biogas Production Management & Utilization. Himanshu Publications, Udaipur.
- Khandelwal, K.C. & S.S. Mahdi. 1990. Biogas Technology.
- Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.
- Mathur A.N. & N.S. Rathore. Renewable Energy Sources Bohra Ganesh Publications, Udaipur.

c. Bio-Energy Systems: Design and Applications 3(2+1)

Theory

Fermentation processes and its general requirements, An overview of aerobic and anaerobic fermentation processes and their industrial application. Heat transfer processes in anaerobic digestion systems, land fill gas technology and potential. Biomass Production: Wastelands, classification and their use through energy plantation, selection of species, methods of field preparation and transplanting. Harvesting of biomass and coppicing characteristics. Biomass preparation techniques for harnessing (size reduction, densification and drying). Thermo- chemical degradation. History of small gas producer engine system. Chemistry of gasification. Gas producer – type, operating principle. Gasifier fuels, properties, preparation, conditioning of producer gas. Application, shaft power generation, thermal application and economics. Trans- esterification for biodiesel production. A range of bio-hydrogen production routes. Environmental aspect of bio-energy, assessment of greenhouse gas mitigation potential.

Practical

Study of anaerobic fermentation system for industrial application, Study of gasification for industrial process heat, Study of biodiesel production unit, Study of biomass densification technique (briquetting,

pelletization, and cubing), Integral bio energy system for industrial application, Study of bio energy efficiency in industry and commercial buildings, Study and demonstration of energy efficiency in building, Measuring efficiency of different insulation technique, Study of Brayton, Striling and Rankine cycles, Study of modern greenhouse technologies.

Suggested Readings

- British BioGen. 1997, Anaerobic digestion of farm and food processing practices- Good practice guidelines, London, available on www.britishbiogen.co.UK.
- Butler, S. 2005. Renewable Energy Academy: Training wood energy professionals.
- Centre for biomass energy. 1998. Straw for energy production; Technology- Environment- Ecology. Available: www.ens.dk.

ELECTIVE COURSES

The students will be offered 3 (three) need based elective courses equivalent to 9 Credit Hours as per the need of the state/industries/other stake holders under the proposed list of Elective Courses.

1. Floods and Control Measures 3(2+1)

Theory

Floods - causes of occurrence, flood classification - probable maximum flood, standard project flood, design flood, flood estimation - methods of estimation; estimation of flood peak rational method, empirical methods, unit hydrograph method. Statistics in hydrology, flood frequency methods - log normal, Gumbel's extreme value, log-Pearson type-III distribution; depth-area-duration analysis. Flood forecasting. Flood routing - channel routing, Muskingum method, reservoir routing, modified Pul's method. Flood control - history of flood control, structural and non-structural measures of flood control, storage and detention reservoirs, levees, channel improvement. Gully erosion and its control structures - design and implementation. Ravine control measures. River training works, planning of flood control projects and their economics. Earthen embankments - functions, classification - hydraulic fill and rolled fill dams - homogeneous, zoned and diaphragm type, foundation requirements, grouting, seepage through dams, flow net and its properties, seepage pressure, seepage line in composite earth embankments, drainage filters, piping and its causes. Design and construction of earthen dam, stability of earthen embankments against failure by tension, overturning, sliding etc., stability of slopes - analysis of failure by different methods. Subsurface dams - site selection and constructional features. Check dam - Small earthen embankments - types and design criteria. Subsurface dams - site selection and constructional features.

Practical

Determination of flood stage-discharge relationship in a watershed. Determination of flood peak-area relationships. Determination of frequency distribution functions for extreme flood values using Gumbel's method. Determination of confidence limits of the flood peak estimates for Gumbel's extreme value distribution. Determination of frequency distribution functions for extreme flood values using log-Pearson Type-III distribution. Determination of probable maximum flood, standard project flood and spillway design flood. Design of levees for flood control. Design of jetties. Study of vegetative and structural

measures for gully stabilization. Design of gully/ravine control structures and cost estimation. Designing, planning and cost- benefit analysis of a flood control project. Study of different types, materials and design considerations of earthen dams. Determination of the position of phreatic line in earth dams for various conditions, stability analysis of earthen dams against head water pressure, foundation shear, sudden draw down condition etc. Stability of slopes of earth dams by friction circle and other methods. Construction of flow net for isotropic and anisotropic media. Computation of seepage by different methods. Determination of settlement of earth dam. Input-output-storage relationships by reservoir routing. Visit to sites of earthen dam and water harvesting structures.

Suggested Readings

- Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
- Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
- Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.
- Mutreja, K.N. 1990. Applied Hydrology. Tata McGraw-Hill Publishing Co., New York, Delhi.
- Subramanya, K. 2008. Engineering Hydrology. 3rd Edition, Tata McGraw-Hill Publishing Co., New Delhi.
- Bureau of Reclamation. 1987. Design of Small Dams. US Department of Interior, Washington DC, USA.
- Arora, K.R. 2014. Soil Mechanics and Foundation Engineering (Geotechnical Engineering). Standard Publishers Distributors, Delhi.
- Garg, S.K. 2014. Soil Mechanics and Foundation Engineering. Khanna Publishers Pvt. Ltd., New Delhi.
- Stephens Tim. 2010. Manual on Small Earth Dams - A Guide to Siting, Design and Construction. Food and Agriculture Organization of the United Nations, Rome.

2. Wasteland Development 3(2+1)

Theory

Land degradation – concept, classification - arid, semiarid, humid and sub-humid regions, denuded range land and marginal lands. Wastelands - factors causing, classification and mapping of wastelands, planning of wastelands development - constraints, agro- climatic conditions, development options, contingency plans. Conservation structures - gully stabilization, ravine rehabilitation, sand dune stabilization, water harvesting and recycling methods. Afforestation - agro-horti-forestry-silvipasture methods, forage and fuel crops - socioeconomic constraints. Shifting cultivation, optimal land use options. Wasteland development hills, semi-arid, coastal areas, water scarce areas, reclamation of waterlogged and salt-affected lands. Mine spoils- impact, land degradation and reclamation and rehabilitation, slope stabilization and mine environment management. Micro-irrigation in wastelands development. Sustainable wasteland development - drought situations, socio-economic perspectives. Government policies. Participatory approach. Preparation of proposal for wasteland development and benefit-cost analysis.

Practical

Mapping and classification of wastelands. Identification of factors causing wastelands. Estimation of vegetation density and classification. Planning and design of engineering measures for reclamation of wastelands. Design and estimation of different soil and water conservation structures under arid, semiarid and humid conditions. Planning and design of micro-irrigation in wasteland development. Cost estimation of the above measures / structures. Visit to wasteland development project sites.

Suggested Readings

- Abrol, I.P., and V.V. Dhruvanarayana. 1998. Technologies for Wasteland Development. ICAR, New Delhi.
- Ambast, S.K., S.K. Gupta and Gurcharan Singh (Eds.) 2007. Agricultural Land Drainage - Reclamation of Waterlogged Saline Lands. Central Soil Salinity Research Institute, Karnal, Haryana.
- Hridai Ram Yadav. 2013. Management of Wastelands. Concept Publishing Company. New Delhi.
- Karthikeyan, C., K. Thangaraja, C. Cinthia Fernandez and K. Chandrakandon. 2009. Dryland Agriculture and Wasteland Management. Atlantic Publishers and Distributors Pvt. Ltd., New Delhi.
- Rattan Lal and B.A. Stewart (Ed.). 2015. Soil Management of Smallholder Agriculture. Volume 21 of Advances in Soil Science. CRC Press, Taylor and Francis Group, Florida, USA.
- Robert Malliva and Thomas Missimer. 2012. Arid Lands Water Evaluation and Management. Springer Heidelberg, New York.
- Swaminathan, M.S. 2010. Science and Integrated Rural Development. Concept Publishing Company (P) Ltd., Delhi.
- The Energy and Resources Institute. 2003. Looking Back to Think Ahead-Green India 2047. Growth with Resource Enhancement of Environment and Nature. New Delhi.
- Virmani, S.M. (Ed.). 2010. Degraded and Wastelands of India: Status and Spatial Distribution. ICAR, New Delhi.

3. Information Technology for Land and Water Management 3(2+1)

Theory

Concept of Information Technology (IT) and its application potential. Role of IT in natural resources management. Existing system of information generation and organizations involved in the field of land and water management. Application and production of multimedia. Internet application tools and web technology. Networking system of information. Problems and prospects of new information and communication technology. Development of database concept for effective natural resources management. Application of remote sensing, geographic information system (GIS) and GPS. Rational data base management system. Object oriented approaches. Information system, decision support systems and expert systems. Agricultural information management systems - use of mathematical models and programmes. Application of decision support systems, multi sensor data loggers and overview of software packages in natural resource management. Video-conferencing of scientific information.

Practical

Multimedia production. Internet applications: E-mail, voice mail, web tools and technologies. Handling and maintenance of new information technologies and exploiting their potentials. Exercises on database management using database and spreadsheet programmes. Usage of remote sensing, GIS and GPS survey in information generation and processing. Exercises on running computer software packages dealing with water balance, crop production, land development, land and water allocation, watershed analysis etc. Exercises on simple decision support and expert systems for management of natural resources. Multimedia production using different softwares. Exercises on development of information system on selected theme(s). Video-conferencing of scientific information.

Suggested Readings

- Climate-Smart Agriculture – Source Book. 2013. Food and Agriculture Organization, Rome.
- Daniel P. Loucks and Eelco van Beek. 2005. Water Resources Systems Planning and Management - An Introduction to Methods, Models and Applications. UNESCO, Paris.
- Dipak De and Basavaprabhu Jirli (Eds.). 2010. Communication Support for Sustainable Development. Ganga Kaveri Publishing House, Varanasi – 221001.
- FAO. 1998. Land and Water Resources Information Systems. FAO Land and Water Bulletin 7, Rome.
- Fuling Bian and Yichun Xie (Eds.). 2015. Geo-Informatics in Resource Management and Sustainable Ecosystem. Springer, New York.
- ICFAI Business School (IBS). 2012. Information Technology and Systems. IBS Centre for Management Research, Hyderabad.
- Robert Malliva and Thomas Missimer. 2012. Arid Lands Water Evaluation and Management. Environmental Science. Springer, New York.
- Sarvanan. R. 2011. Information and Communication Technology for Agriculture and Rural Development. New India Publishing Agency, New Delhi.
- Soam, S.K., P.D. Sreekanth and N.H. Rao (Eds.). 2013. Geospatial Technologies for Natural Resources Management. New India Publishing Agency, Delhi**.**

4. Remote Sensing and GIS Applications 3(2+1)

Theory

Basic component of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources; electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface; major atmospheric windows; principal applications of different wavelength regions; typical spectral reflectance curve for vegetation, soil and water; spectral signatures; different types of sensors and platforms; contrast ratio and possible causes of low contrast; aerial photography; types of aerial photographs, scale of aerial photographs, planning aerial photography- end lap and side lap; stereoscopic vision, requirements of stereoscopic photographs; air-photo interpretation- interpretation elements; photogrammetry- measurements on a single vertical aerial photograph, measurements on a stereo-pair- vertical measurements by the parallax method; ground control for aerial photography; satellite

remote sensing, multispectral scanner- whiskbroom and push-broom scanner; different types of resolutions; analysis of digital data- image restoration; image enhancement; information extraction, image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices; microwave remote sensing. GI Sand basic components, different sources of spatial data, basic spatial entities, major components of spatial data, Basic classes of map projections and their properties, Methods of data input into GIS, Data editing, spatial data models and structures, Attribute data management, integrating data (map overlay) in GIS, Application of remote sensing and GIS for the management of land and water resources.

Practical

Familiarization with remote sensing and GIS hardware; use of software for image interpretation; interpretation of aerial photographs and satellite imagery; basic GIS operations such as image display; study of various features of GIS software package; scanning, digitization of maps and data editing; data base query and map algebra. GIS supported case studies in water resources management.

Suggested Readings

- Reddy Anji, M. 2006. Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad.
- Elangovan, K. 2006. GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi.
- George Joseph. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad.
- Jensen, J.R. 2013. Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education Limited, UK.
- Lillesand, T., R.W. Kiefer and J. Chipman. 2015. Remote Sensing and Image Interpretation. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.
- Sabins, F.F. 2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA.
- Sahu, K.C. 2008. Text Book of Remote Sensing and Geographic Information Systems. Atlantic Publishers and Distributors (P) Ltd., New Delhi.
- Shultz, G.A. and E.T. Engman. 2000. Remote Sensing in Hydrology and Water Management. Springer, New York

5. Management of Canal Irrigation System 3(2+1)

Theory

Purpose benefits and ill effects of irrigation; typical network of canal irrigation system and its different physical components; canal classification based on source of water, financial output, purpose, discharge and alignment; canal alignment: general considerations for alignment; performance indicators for canal irrigation system evaluation, Estimation of water requirements for canal command areas and determination of canal capacity; water duty and delta, relationship between duty, base period and delta, factors affecting

duty and method of improving duty; silt theory: Kennedy's theory, design of channels by Kennedy's theory, Lacey's regime theory and basic regime equations, design of channels by Lacey's theory, maintenance of unlined irrigation canals, measurement of discharge in canals, rostering (canal running schedule) and warabandhi, necessity of canal lining: advantages and disadvantages, types of canal lining and desirable characteristics for the suitability of lining materials; design of lined canals; functions of distributary head and cross regulators; canal falls, their necessity and factors affecting canal fall; sources of surplus water in canals and types of canal escapes; requirements of a good canal outlet and types of outlet.

Practical

Estimation of water requirement of canal commands; determination of canal capacity; layout of canal alignments on topographic maps, drawing of canal sections in cutting, full banking and partial cutting and partial banking; determination of longitudinal section of canals; design of irrigation canals based on silt theories; design of lined canals; formulation of warabandhi; Study of canal outlets, regulators, escapes and canal falls.

Suggested Readings

- Arora, K.R. 2001. Irrigation, Water Power and Water Resources Engineering. Standard Publishers Distributors, Delhi.
- Garg S. K. 2014. Irrigation Engineering and Hydraulic Structures, Khanna Publishers New Delhi.
- Sahasrabudhe SR. 2011. Irrigation Engineering and Hydraulic structures. SK Kataria & Sons Reprint 2015.

6. Minor Irrigation and Command Area Development 3(2+1)

Theory

Factors affecting performance of irrigation projects; types of minor irrigation systems in India; lift irrigation systems: feasibility, type of pumping stations and their site selection, design of lift irrigation systems; tank Irrigation: grouping of tanks, storage capacity, supply works and sluices; command area development (CAD) programme- components, need, scope, and development approaches, historical perspective, command area development authorities- functions and responsibilities; on farm development works, reclamation works, use of remote sensing techniques for CAD works; water productivity: concepts and measures for enhancing water productivity; Farmers' participation in command area development;

Practical

Preparation of command area development layout plan; Irrigation water requirement of crops; Preparation of irrigation schedules; Planning and layout of water conveyance system; design of surplus weir of tanks; determination of storage capacity of tanks; design of intake pipe and pump house.

Suggested Readings

- Arora, K.R. 2001. Irrigation, Water Power and Water Resources Engineering. Standard Publishers Distributors, Delhi.
- Garg S. K. 2014. Irrigation Engineering and Hydraulic Structures, Khanna Publishers New Delhi.
- Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Publ.House New Delhi.
- Sahasrabudhe SR. 2011. Irrigation Engineering and Hydraulic structures. SK Kataria & Sons Reprint 2015.

7. Precision Farming Techniques for Protected Cultivation 3(2+1)

Theory

Protected cultivation: Introduction, History, origin, development, National and International Scenario, components of green house, perspective, Types of green houses, polyhouses /shed nets, Cladding materials, Plant environment interactions – principles of limiting factors, solar radiation and transpiration, greenhouse effect, light, temperature, relative humidity, carbon dioxide enrichment, Design and construction of green houses – site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system, selection of equipment, Greenhouse cooling system – necessity, methods – ventilation with roof and side ventilators, evaporative cooling, different shading material fogging, combined fogging and fan- pad cooling system, design of cooling system, maintenance of cooling and ventilation systems, pad care etc. Greenhouse heating – necessity, components, methods, design of heating system. Root media – types – soil and soil less media, composition, estimation, preparation and disinfection, bed preparation. Planting techniques in green house cultivation. Irrigation in greenhouse and net house – Water quality, types of irrigation system, components, design, installation and material requirement. Fogging system for greenhouses and net houses – introduction, benefits, design, installation and material requirement. Maintenance of irrigation and fogging systems. Fertilization – nutrient deficiency symptoms and functions of essential nutrient elements, principles of selection of proper application of fertilizers, fertilizer scheduling, rate of application of fertilizers, methods, automated fertilizer application. Greenhouse climate measurement, control and management. Insect and disease management in greenhouse and net houses Selection of crops for greenhouse cultivation, major crops in greenhouse – irrigation requirement, fertilizer management, cultivation, harvesting and post harvest techniques; Economic analysis.

Practical

Estimation of material requirement for construction of greenhouse ; Determination of fertilization schedule and rate of application for various crops; Estimation of material requirement for preparation of root media; Root media preparation, bed preparation and disinfections; Study of different planting techniques ; Design and installation of irrigation system; Design and installation of fogging system ; Greenhouse heating; Study of different greenhouse environment control instruments; Study of operation maintenance and fault detection in irrigation system; Study of operation maintenance and fault detection in fogging system; Economic analysis of greenhouses and net houses; Visit to greenhouses.

Suggested Readings

- Singh Brahma and Balraj Singh. 2014. Advances in protected cultivation, New India Publishing Company.
- Sharma P. 2007. Precision Farming. Daya Publishing House New Delhi.

8. Water Quality and Management Measures 3(2+1)

Theory

Natural factors affecting quality of surface water and groundwater, water quality objectives in relation to domestic, industrial and agricultural activities, drinking water quality standards, irrigation water quality classification as per USSL and All Indian Coordinated Research Project (AICRP) criteria, point and non-point

water pollution sources, water contamination due to inorganic and organic compounds, water contamination related to agricultural chemicals, food industry, hydrocarbon and synthetic organic compounds. Arsenic and fluoride contamination in groundwater and remedial measures, water decontamination technologies, cultural and management practices for using poor quality water for irrigation.

Practical

Water quality analysis and classification according to USSL and AICRP criteria; soil chemical analysis and estimation of lime and gypsum requirements; study of salinity development under shallow and deep water table conditions; study of contamination movement and transport in soil profile; study of different water decontamination techniques; study of different cultural and management practices for using poor quality water for irrigation; field visit to industrial effluent disposal sites.

Suggested Readings

- FAO. 1996. Control of water pollution from agriculture - FAO irrigation and drainage paper 55.
- Gray, N.F. Water Technology. Raj Kamal Electric Press, Kundli, Haryana.
- Hussain, S.K. 1986. Text Book of Water Supply and Sanitary Engineering. Oxford & IBH Publishing Co. New Delhi.
- Manahan, S.E. 2009. Fundamentals of Environmental Chemistry. CRC Press, New York.
- McGauhey, P.H. 1968. Engineering Management of water quality. McGraw Hill Book Company, New York.
- Minhas, P.S. and Tyagi, N.K. 1998. Guidelines for irrigation with saline and alkali waters. Bull. No, 1/98, CSSRI, Karnal, p. :36.
- Punmia, B.C. and Lal, P.B.B. 1981. Irrigation and water power engineering. Standard Publishers Distributors, Delhi.

9. Landscape Irrigation Design and Management 3(2+1)

Theory

Conventional method of landscape irrigation- hose irrigation system, quick release coupling system and portable sprinkler with hose pipes; Modern methods of landscape irrigation- pop- up sprinklers, spray pop-up sprinkler, shrub adopter, drip irrigation and bubblers; Merits and demerits of conventional and modern irrigation systems, types of landscapes and suitability of different irrigation methods, water requirement for different landscapes, Segments of landscape irrigation systems, Main components of modern landscape irrigation systems and their selection criteria; Types of pipes, pressure ratings, sizing and selection criteria; Automation system for landscape irrigation- main components, types of controllers and their application, Design of modern landscape irrigation systems, operation and maintenance of landscape irrigation systems.

Practical

Study of irrigation equipments for landscapes; Design and installation of irrigation system for landscape, determination of water requirement. Determination of power requirement, pump selection. Irrigation scheduling of landscapes, Study of irrigation controllers and other equipments, Use of AutoCAD in irrigation design: blocks & symbols, head layout, zoning and valves layout, pipe sizing, Pressure calculations etc., Visit to landscape irrigation system and its evaluation.

Suggested Readings

- Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Publ. House New Delhi.
- Singh Neeraj Partap. 2010. Landscape Irrigation and Floriculture Terminology, Bangalore.
- Smith Stepehen W. Landscape Irrigation and Management. Amazon. com.

10. Plastic Applications in Agriculture 3(2+1)

Theory

Introduction of plasticulture - types and quality of plastics used in soil and water conservation, production agriculture and post harvest management. Quality control measures. Present status and future prospective of plasticulture in India. Water management - use of plastics in in-situ moisture conservation and rain water harvesting. Plastic film lining in canal, pond and reservoir. Plastic pipes for irrigation water management, bore-well casing and subsurface drainage. Drip and sprinkler irrigation systems. Use of polymers in control of percolation losses in fields. Soil conditioning - soil solarisation, effects of different colour plastic mulching in surface covered cultivation. Nursery management - Use of plastics in nursery raising, nursery bags, trays etc. Controlled environmental cultivation - plastics as cladding material, green / poly / shade net houses, wind breaks, poly tunnels and crop covers. Plastic nets for crop protection - anti insect nets, bird protection nets. Plastic fencing. Plastics in drying, preservation, handling and storage of agricultural produce, innovative plastic packaging solutions for processed food products. Plastic cap covers for storage of food grains in open. Use of plastics as alternate material for manufacturing farm equipment and machinery. Plastics for aquacultural engineering and animal husbandry - animal shelters, vermi-beds and inland fisheries. Silage film technique for fodder preservation. Agencies involved in the promotion of plasticulture in agriculture at national and state level. Human resource development in plasticutlure applications.

Practical

Design, estimation and laying of plastic films in lining of canal, reservoir and water harvesting ponds. Study of plastic components of drip and sprinkler irrigation systems, laying and flushing of laterals. Study of components of subsurface drainage system. Study of different colour plastic mulch laying. Design, estimation and installation of green, poly and shade net houses, low tunnels etc. Study on cap covers for food grain storage, innovative packaging solutions - leno bags, crates, bins, boxes, vacuum packing, unit packaging, CAS and MAP and estimation. Study on use of plastics in nursery, plant protection, inland fisheries, animal shelters, preparation of vermi-bed and silage film for fodder preservation. Study of plastic parts in making farm machinery. Visits to nearby manufacturing units/dealers of PVC pipes, drip and sprinkler irrigation systems, greenhouse/ polyhouse/shadehouse/ nethouse etc. Visits to farmers' fields with these installations.

Suggested Readings

- Brahma Singh, Balraj Singh, Naved Sabir and Murtaza Hasan. 2014.Advances in Protected Cultivation. New India Publishing Agency, New Delhi.
- Brown, R.P. 2004. Polymers in Agriculture and Horticulture. RAPRA Review Reports : Vol. 15, No. 2, RAPRA Technology Limited, U.K.

- Central Pollution Control Board. 2012. Material on Plastic Waste Management. Parivesh Bhawan, East Arjun Nagar, Delhi-110032.
- Charles A. Harper. 2006. Handbook of Plastics Technologies. The Complete Guide to Properties and Performance. McGraw-Hill, New Delhi.
- Dubois. 1978. Plastics in Agriculture. Applied Science Publishers Limited, Essex, England.
- Manas Chanda, Salil K. Roy. 2008. Plastics Fundamentals, Properties, and Testing. CRC Press.
- Ojha,T.P. and Michael, A.M., 2012, Principles of Agricultural Engineering - I. Jain Brothers, Karol Bagh, New Delhi.
- Pandey, P.H. 2014. Principles and Practices of Agricultural Structures and Environmental Control. Kalyani Publishers, Ludhiana, India.
- Shankar, A.N. 2014. Integrated Horticulture Development in Eastern Himalayas, Plasticulture in Agri-Horticulture Systems, 241-247.
- Srivastava, R.K., R.C. Maheswari, T.P. Ojha, and A. Alam. 1988. Plastics in Agriculture. Jain Brothers, Karol Bagh, New Delhi.

11. Mechanics of Tillage and Traction (2+1)

Theory

Introduction to mechanics of tillage tools, engineering properties of soil, principles and concepts, stress strain relationship, design of tillage tools principles of soil cutting, design equation, force analysis, application of dimensional analysis in soil dynamics and traction prediction equation. Introduction to traction and mechanics, off road traction and mobility, traction model, traction improvement, tyre size, tyre lug geometry and their effects, tyre testing, soil compaction and plant growth, variability and application of GIS in soil dynamics.

Practical

Measurement of static and dynamic soil parameters related to tillage, soil parameters related to puddling and floatation, draft for passive rotary and oscillating tools, slip and sinkage under dry and wet soil conditions and load and fuel consumption for different farm operations; Weight transfer and tractor loading including placement and traction aids; Studies on tyres, tracks and treads under different conditions, and soil compaction and number of operations.

Suggested Readings

- Vandenberg and Gill. Tillage and Traction.
- Liljedahl JB and others. Tractor and Power Units.
- Daniel Hill. Fundamentals of Soil Physics.
- Terzaghi K & Peck Ralph B. Soil Mechanics in Engineering Practices.

12. Farm Machinery Design and Production 3(2+1)

Theory

Introduction to design parameters of agricultural machines & design procedure. Characteristics of farm machinery design. Research and development aspects of farm machinery. Design of standard power transmission components used in agricultural machines: mechanical & hydraulic units. Introduction to safety in power transmission. Application of design principles to the systems of selected farm machines. Critical appraisal in production of Agricultural Machinery; Advances in material used for agricultural machinery. Cutting tools including CNC tools and finishing tools. Advanced manufacturing techniques including powder metallurgy, EDM (Electro- Discharge Machining), Heat Treatment of steels including pack carburizing, shot pining process, etc. Limits, Fits & Tolerances, Jigs & Fixtures. Industrial lay-out planning, Quality production management. Reliability. Economics of process selection. Familiarization with Project Report.

Practical

Familiarization with different design aspects of farm machinery and selected components. Solving design problems on farm machines & equipment Visit to Agricultural machinery manufacturing industry, Tractor manufacturing industry Jigs and Fixtures study in relation to agricultural machinery. Fits, tolerances and limits; Layout planning of a small scale industry; Problems on Economics of process selection; Preparation of a project report; Case study for manufacturing of simple agricultural machinery.

Suggested Readings

- Richey, C.B. Agricultural Engineering Handbook.
- Adinath M and AB Gupta. Manufacturing Technology.
- Sharma PC and DK Aggarwal. Machine Design.
- Narula V. Manufacturing process.
- Singh S. Mechanical Engineer's Handbook.
- Chakrabarti NR. Data book for Machine Design.

13. Human Engineering and Safety 3(2+1)

Theory

Human factors in system development – concept of systems; basic processes in system development, performance reliability, human performance. Information input process, visual displays, major types and use of displays, auditory and factual displays. Speech communications. Biomechanics of motion, types of movements, Range of movements, strength and endurance, speed and accuracy, human control of systems. Human motor activities, controls, tools and related devices. Anthropometry: arrangement and utilization of work space, atmospheric conditions, heat exchange process and performance, air pollution. Dangerous machine (Regulation) act, Rehabilitation and compensation to accident victims, Safety gadgets for spraying, threshing, Chaff cutting and tractor & trailer operation etc.

Practical

Calibration of the subject in the laboratory using bi-cycle ergo-meter. Study and calibration of the subject in the laboratory using mechanical treadmill; Use of respiration gas meter from human energy point of view. Use of Heart Rate Monitor. Study of general fatigue of the subject using Blink ratio method, Familiarization with electro-myograph equipment, anthropometric measurements of a selected subjects. Optimum work space layout and locations of controls for different tractors. Familiarization with the noise and vibration equipment. Familiarization with safety gadgets for various farm machines.

Suggested Readings

- Chapanis A. 1996. Human Factors in System Engineering. John Wiley & Sons, New York.
- Dul J. and Weerdmeester B.1993. Ergonomics for Beginners. A Quick Reference Guide. Taylor and Francis, London.
- Mathews J. and Knight A. A. 1971. Ergonomics in Agricultural Equipment Design. National Institute of Agricultural Engineering.
- Astrand P. And and Rodahl K. 1977. Textbook of Work Physiology. Mc Hill Corporation, New York.
- Mark S. Sanders and Ernest James McCormick. 1993. Human Factors in Engineering and Design. Mc Hill Corporation, New York.
- Keegan J J, Radke AO. 1964. Designing vehicle seats for greater comfort. SAE Journal;72:50~5.
- Yadav R, Tewari V.K. 1998. Tractor operator workplace design-a review. Journal of Terra mechanics 35: 41-53.

14. Tractor Design and Testing 3(2+1)

Theory

Procedure for design and development of agricultural tractor, Study of parameters for balanced design of tractor for stability & weight distribution, traction theory, hydraulic lift and hitch system design. Design of mechanical power transmission in agricultural tractors: single disc, multi disc and cone clutches. Rolling friction and anti-friction bearings. Design of Ackerman Steering and tractor hydraulic steering. Study of special design features of tractor engines and their selection viz. cylinder, piston, piston pin, crankshaft, etc. Design of seat and controls of an agricultural tractor. Tractor Testing.

Practical

Design problem of tractor clutch – (Single/ Multiple disc clutch). Design of gear box(synchromesh/constant mesh), variable speed constant mesh drive; Selection of tractor tires – Problem solving. Problem on design of governor. Design and selection of hydraulic pump. Engine testing as per BIS code. Drawbar performance in the lab; PTO test and measure the tractor power in the lab/field; Determining the turning space, turning radius and brake test, hydraulic pump performance test and air cleaner and noise measurement test; Visit to tractor testing centre/ industry.

Suggested Readings

- Liljedahl J B & Others. Tractors and Their Power Units.
- Raymond N, EA Yong and S Nicolas. Vehicle Traction Mechanics.

- Maleev VL. Internal Combustion Engines.
- Kirpal Singh. Automobile Engineering – Vol I and Vol II.
- Richey C.B. Agricultural Engineering Handbook.
- Mehta ML, SR Verma, SK Mishra, VK Sharma. Testing & Evaluation of Agricultural Machinery.

15. Hydraulic Drives and Controls 3(2+1)

Theory

Hydraulic Basics: Pascal's Law, Flow, Energy, Work, and Power. Hydraulic Systems, Color Coding, Reservoirs, Strainers and Filters, Filtering Material and Elements. Accumulators, Pressure Gauges and Volume Meters, Hydraulic Circuit, Fittings and Connectors. Pumps, Pump Classifications, operation, performance, Displacement, Design ofGear Pumps, Vane Pumps, Piston Pumps. Hydraulic Actuators, Cylinders, Construction and Applications, Maintenance, Hydraulic Motors. Valves, Pressure-Control Valves, Directional- Control Valves, Flow-Control Valves, Valve. Installation, Valve Failures and Remedies, Valve Assembly, Troubleshooting of Valves Hydraulic Circuit Diagrams and Troubleshooting, United States of American Standards Institute USASI Graphical Symbols Tractor hydraulics, nudging system, ADDC. Pneumatics: Air services, logic units, Fail safe and safety systems Robotics: Application of Hydraulics and Pneumatics drives in agricultural systems, Programmable Logic Controls (PLCs).

Practical

Introduction to hydraulic systems. Study of hydraulic pumps, hydraulic actuators. Study of hydraulic motors, hydraulic valves, colour codes and circuits. Building simple hydraulic circuits, hydraulics in tractors. Introduction to pneumatics, pneumatics devices, pneumatics in agriculture; Use of hydraulics and pneumatics for robotics.

Suggested Readings

- Kepner RA, Roy Barger & EL Barger. Principles of Farm Machinery.
- Anthony E. Fluid Power and Applications.
- Majumdar. Oil Hydraulic System.
- Merit. Hydraulic Control Systems.
- John Deere. Fundamentals of Service Hydraulics.

16. Precision Agriculture and System Management 3(2+1)

Theory

Precision Agriculture – need and functional requirements. Familiarization with issues relating to natural resources. Familiarization with equipment for precision agriculture including sowing and planting machines, power sprayers, land clearing machines, laser guided land levellers, straw- chopper, straw-balers, grain combines, etc. Introduction to GIS based precision agriculture and its applications. Introduction to sensors and application of sensors for data generation. Database management. System concept. System approach in farm machinery management, problems on machinery selection, maintenance and scheduling of operations. Application to PERT and CPM for machinery system management

Practical

Familiarization with precision agriculture problems and issues. Familiarization with various machines for resource conservation. Solving problems related to various capacities, pattern efficiency, system limitation, etc. Problems related to cost analysis and inflation and problems related to selection of equipment, replacement, break-even analysis, time value of money etc.

Suggested Readings

- Kuhar J E. The Precision Farming Guide for Agriculturist.
- Dutta SK. Soil Conservation and land management.
- Sigma and Jagmohan. Earth Moving Machinery.
- Wood and Stuart. Earth Moving Machinery.
- DeMess MN. Fundamentals of Geographic Information System.
- Hunt Donnell. Farm Power and Machinery Management.
- Sharma DN and S Mukesh. Farm Power and Machinery Management Vol I.

17. Food Quality and Control 3(2+1)

Theory

Basics of Food Science and Food Analysis, Concept, objectives and need of food quality. Measurement of colour, flavour, consistency, viscosity, texture and their relationship with food quality and composition. Sampling; purpose, sampling techniques, sampling procedures for liquid, powdered and granular materials, Quality control, Quality control tools, Statistical quality control, Sensory evaluation methods, panel selection methods, Interpretation of sensory results. Instrumental method for testing quality. Food adulteration and food safety. TQM and TQC, consumer preferences and acceptance, Food Safety Management Systems GAP, GHP, GMP, Hazards and HACCP (Hazard analysis and critical control point), Sanitation in food industry (SSOP), Food Laws and Regulations in India, FSSAI, Food grades and standards BIS, AGMARK, PFA, FPO, ISO 9000, 22000 Series. CAC (Codex Alimantarious Commission),Traceability and Quality Assurance system in a process plant, Bio safety and Bioterrorism.

Practical

Examination of cereals & pulses from one of go-downs and market shops in relation to FPO and BIS specifications, Detection of adulteration and examination of ghee for various standards of AGMARK & BIS standards, Detection of adulteration and examination of spices for AGMARK and BIS standards, Detection of adulteration and examination of milk and milk products for BIS standards, Detection of adulteration and examination of fruit products such as jams, jellys, marmalades for FPO specification, Visit to quality control laboratory, Case study of statistical process control in food processing industry, Study of registration process and licensing procedure under FSSAI, Study of sampling techniques from food processing establishments, Visit to food processing laboratory and study of records and reports maintained by food processing laboratory.

Suggested Readings

- Ranganna S. Hand book of Analysis and Quality Control for Fruit and Vegetable Products.
- Srilakshmi B, Food Science.
- Sharma Avanthi. A text book of Food Science and Technology.
- Mudambi Sumati R, Rao Shalini M and Rajagopal M.V. Food Science.
- Potter NN and Hotchkiss JH, Food Science.
- Dev Raj, Rakesh Sharma and Joshi V.K, Quality for Value Addition in Food Processing.
- The Food Safety and Standards Act along with Rules & Regulations. Commercial Law Publishers (India) Pvt. Ltd.

18. Food Plant Design and Management 3(2+1)

Theory

Food plant location, selection criteria, Selection of processes, plant capacity, Requirements of plant building and its components, Project design, flow diagrams, selection of equipment, process and controls, Objectives and principles of food plant layout. Salient features of processing plants for cereals, pulses, oilseeds, horticultural and vegetable crops, poultry, fish and meat products, milk and milk products. Introduction to Finance, Food Product Marketing, Food Business Analysis and Strategic Planning, Introduction to Marketing, Food Marketing Management, Supply chain management for retail food products, Entrepreneurship development in food industry, SWOT analysis, generation, incubation and commercialization of ideas and innovations, New product development process, Government schemes and incentive for promotion of entrepreneurship, Govt. policy on small and medium scale food processing enterprise, export and import policies relevant to food processing sector, procedure of obtaining license and registration under FSSAI, Cost analysis and preparation of feasibility report.

Practical

Preparation of project report, Preparation of feasibility report, Salient features and layout of pre processing house, Salient features and layout of Milk and Milk product plants, Evaluation of given layout, Salient features, design and layout of modern rice mill, Salient features, design and layout of Bakery and related product plant, Study of different types of records relating to production of a food plant, Study of different types of records relating to finance of a food plant, Study of different types of records relating to marketing of a food business, Brain storming and SWOT analysis to start a food processing business.

Suggested Readings

- Hall, H.S. and Rosen, Y.S. Milk Plant Layout. FAO Publication, Rome.
- López Antonio. Gómez. Food Plant Design.
- Robberts Theunis C. Food plant engineering systems by, CRC Press, Washington.
- Maroulis Z B and Saravacos G D. Food plant economics. Taylor and Francis, LLC
- Mahajan M. Operations Research. Dhanpat Rai and Company Private Limited, Delhi
- Maroulis Z B. Food Process Design. Marcel Dekker, Inc ,Cimarron Road, Monticello, New York 12701, USA.

19. Food Packaging Technology 3(2+1)

Theory

Factors affecting shelf life of food material during storage, Interactions of spoilage agents with environmental factors as water, oxygen, light, pH, etc. and general principles of control of the spoilage agents; Difference between food infection, food intoxication and allergy. Packaging of foods, requirement, importance and scope, frame work of packaging strategy, environmental considerations, Packaging systems, types: flexible and rigid; retail and bulk; levels of packaging; special solutions and packaging machines, technical packaging systems and data management packaging systems, Different types of packaging materials, their key properties and applications, Metal cans, manufacture of two piece and three piece cans, Plastic packaging, different types of polymers used in food packaging and their barrier properties. manufacture of plastic packaging materials, profile extrusion, blown film/ sheet extrusion, blow molding, extrusion blow molding, injection blow molding, stretch blow molding, injection molding. Glass containers, types of glass used in food packaging, manufacture of glass and glass containers, closures for glass containers. Paper and paper board packaging, paper and paper board manufacture process, modification of barrier properties and characteristics of paper/ boards. Relative advantages and disadvantages of different packaging materials; effect of these materials on packed commodities. Nutritional labelling on packages, CAS and MAP, shrink and cling packaging, vacuum and gas packaging; Active packaging, Smart packaging, Packaging requirement for raw and processed foods, and their selection of packaging materials, Factors affecting the choice of packaging materials, Disposal and recycle of packaging waste, Printing and labelling, Lamination, Package testing: Testing methods for flexible materials, rigid materials and semi rigid materials; Tests for paper (thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply bond test, surface oil absorption test, etc.), plastic film and laminates (thickness, tensile strength, gloss, haze, burning test to identify polymer, etc.), aluminium foil (thickness, pin holes, etc.), glass containers (visual defects, colour, dimensions, impact strength, etc.), metal containers (pressure test, product compatibility, etc.).

Practical

Identification of different types of packaging materials, Determination of tensile/ compressive strength of given material/package, To perform different destructive and non-destructive tests for glass containers, Vacuum packaging of agricultural produces, Determination of tearing strength of paper board, Measurement of thickness of packaging materials, To perform grease-resistance test in plastic pouches, Determination of bursting strength of packaging material, Determination of water-vapour transmission rate, Shrink wrapping of various horticultural produce, Testing of chemical resistance of packaging materials, Determination of drop test of food package and visit to relevant industries.

Suggested Readings

- Coles, R., McDowell, D., Kirwan, M .J. 2003. Food Packaging Technology. Blackwell Publishing Co.
- Gosby, N.T. 2001. Food Packaging Materials. Applied Science Publication
- John, P.J. 2008. A Handbook on Food Packaging Narendra Publishing House,
- Mahadevia, M., Gowramma, R.V. 2007. Food Packaging Materials. Tata McGraw Hill

- Robertson, G. L. 2001. Food Packaging and Shelf life: A Practical Guide. Narendra Publishing House.
- Robertson, G. L. 2005. Food Packaging: Principles and Practice. Second Edition. Taylor and Francis Pub.

20. Development of Processed Products 3(2+1)

Theory

Process design, Process flow chart with mass and energy balance, Unit operations and equipments for processing, New product development, Technology for value added products from cereal, pulses and oil seeds, Milling, puffing, flaking, Roasting, Bakery products, snack food. Extruded products, oil extraction and refining, Technology for value added products from fruits, vegetables and spices, Canned foods, Frozen foods, dried and fried foods, Fruit juices, Sauce, Sugar based confection, Candy, Fermented food product, spice extracts, Technology for animal produce processing , meat, poultry, fish, egg products, Health food, Nutra-ceuticals and functional food, Organic food.

Practical

Process design and process flow chart preparation, preparation of different value added products, Visit to roller wheat flour milling, rice milling, spice grinding mill, milk plant, dal and oil mill, fruit/vegetable processing plants & study of operations and machinery, Process flow diagram and study of various models of the machines used in a sugar mill.

Suggested Readings

- Geankoplis C. J. Transport processes and unit operations, Prentice-Hall.
- Rao, D. G. Fundamentals of Food Engineering PHI Learning Pvt. Ltd, New Delhi.
- Norman N. Potter and Joseph H. Hotchikss. Food Science. Chapman and Hall Pub.
- Acharya, K T Everyday Indian Processed foods. National Book Trust.
- Mudambi Sumati R., Shalini M. Rao and M V Rajgopal. Food Science. New Age International Publishers.
- Negi H.P.S., Savita Sharma, K. S. Sekhon. Hand book of Cereal technology. Kalyani Pub.

21. Process Equipment Design 3(2+1)

Theory

Introduction on process equipment design, Application of design engineering for processing equipments, Design parameters and general design procedure, Material specification, Types of material for process equipments, Design codes, Pressure vessel design, Design of cleaners. Design of tubular heat exchanger, shell and tube heat exchanger and plate heat exchanger, Design of belt conveyer, screw conveyer and bucket elevator, Design of dryers. Design of milling equipments. Optimization of design with respect to process efficiency, energy and cost, Computer Aided Design.

Practical

Design of pressure vessel, cleaners, milling equipments, tubular heat exchanger, shell and tube type heat exchanger, plate heat exchanger, dryer, belt conveyor, bucket elevator, screw conveyor.

Suggested Readings

- Mahajani, V. V. and Umarji, S. B., Process equipment design, Macmillan.
- Bhattacharyya, B. C., Introduction to Chemical Equipment design, CBS Publishers and Distributors.
- Geankoplis C. J. Transport processes and unit operations, Prentice-Hall.
- Rao, D. G. Fundamentals of Food Engineering PHI Learning Pvt. Ltd, New Delhi.

22. Photovoltaic Technology and Systems 3(2+1)

Theory

Solar PV Technology: Advantages, Limitations, Current Status of PV technology, SWOT analysis of PV technology. Types of Solar Cell, Wafer based Silicon Cell, Thin film amorphous silicon cell Thin Cadmium Telluride (CdTe) Cell, Copper Indium Gallium Selenide (CiGS) Cell, Thin film crystalline silicon solar cell. Solar Photo Voltaic Module: Solar cell, solar module, solar array, series & parallel connections of cell, mismatch in cell, fill factor, effect of solar radiation and temperature on power output of module, I-V and power curve of module. Balance of Solar PV system: Introduction to batteries, battery classification, lead acid battery, Nicked Cadmium battery, comparison of batteries, battery parameters, Charge controller: types of charge controller, function of charge controller, PWM type, MPPT type charge controller, Converters: DC to DC converter and DC to AC type converter. Application of Solar PV system. Solar home lighting system, solar lantern, solar fencing, solar street light, solar water pumping system, Roof top solar photovoltaic power plant and smart grid.

Practical

Study of V-I characteristics of solar PV system, smart grid technology and application, manufacturing technique of solar array, different DC to DC and DC to AC converter, domestic solar lighting system, various solar module technologies, safe measurement of PV modules electrical characteristics and Commissioning of complete solar PV system.

Suggested Readings

- Rai GD. 1998. Non-conventional Sources of Energy. Khanna Pub.
- Rathore N.S., Kurchania A.K., Panwar N.L. 2006. Renewable Energy: Theory & Practice, Himanshu Publications,.
- Solanki C.S. 2011. Solar Photovoltaic: Fundamentals, Technologies and Applications, PHI Learning Private Ltd.
- Meinel & Meinel. Applied Solar Energy.
- Derrick, Francis and Bokalders, Solar Photo-voltaic Products.

23. Waste and By-Products Utilization 3(2+1)

Theory

Types and formation of by-products and waste; Magnitude of waste generation in different food processing industries; Uses of different agricultural by-products from rice mill, sugarcane industry, oil mill etc., Concept, scope and maintenance of waste management and effluent treatment, Temperature, pH, Oxygen

demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, Waste utilization in various industries, furnaces and boilers run on agricultural wastes and byproducts, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization, Waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants, concept of vermin-composting, Pre- treatment of waste: sedimentation, coagulation, flocculation and floatation, Secondary treatments: Biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons, Tertiary treatments: Advanced waste water treatment process-sand, coal and activated carbon filters , phosphorous, sulphur, nitrogen and heavy metals removal, Assessment, treatment and disposal of solid waste; and biogas generation, Effluent treatment plants, Environmental performance of food industry to comply with ISO-14001 standards.

Practical

Determination of temperature, pH, turbidity solids content, BOD and COD of waste water, Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash, Study about briquetting of agricultural residues, Estimation of excess air for better combustion of briquettes, Study of extraction of oil from rice bran, Study on bioconversion of agricultural wastes, Recovery of germ and germ oil from by-products of cereals, Visit to various industries using waste and food by-products.

Suggested Readings

- Markel, I.A. 1981. Managing Livestock Waste, AVI Publishing Co.
- Pantastico, ECB. 1975. Post Harvest Physiology, Handling and utilization of Tropical and Sub-tropical fruits and vegetables, AVI Pub. Co.
- Shewfelt, R.L. and Prussi, S.E. 1992. Post-Harvest Handling – A Systems approach, Academic Press Inc.
- USDA. 1992. Agricultural Waste Management Field Hand book. USDA, Washington DC.
- Weichmann J. 1987. Post Harvest Physiology of vegetables, Marcel and Dekker Verlag.
- V.K. Joshi & S.K. Sharma. Food Processing Waste Management: Treatment & Utilization. New India Publishing Agency.
- Vasso Oreopoulou and Winfried Russ (Edited). 2007. Utilization of By-products and Treatment of waste in the Food Industry. Springer Science & Business media, LLC 233 New York.
- Prashar, Anupama and Bansal, Pratibha. 2007-08. Industrial Safety and Environment. S.K. Kataria and sons, New Delhi
- Garg, S K. 1998. Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering. Khanna Publishers, New Delhi
- Bhatia, S.C.. 2001. Environmental Pollution and Control in Chemical Process Industries. Khanna Publishers, New Delhi.

24. Artificial Intelligence 3(3+0)

Theory

Foundation and history of artificial intelligent, problems and techniques – AI programming languages, introduction to LISP and PROLOG- problem spaces and searches, blind search strategies, Breadth first-Depth first- heuristic search techniques Hill climbing: best first-A* algorithm AO* algorithm- game tree, Min max algorithms, game playing- alpha beta pruning. Knowledge representation issues, predicate logic-logic programming, semantic nets- frames and inheritance, constraint propagation, representing knowledge using rules, rules based deduction systems. Reasoning under uncertainty, review of probability, Baye's probabilistic interferences and Dempster shafer theory, Heuristic methods, symbolic reasoning under uncertainty, Statistical reasoning, Fuzzy reasoning, Temporal reasoning, Non monotonic reasoning. Planning and planning in situational calculus, representation for planning, partial order planning algorithm, learning from examples, discovery as learning, learning by analogy, explanation based learning, neural nets, genetic algorithms. Principles of Natural language processing, rule based systems architecture, Expert systems, knowledge acquisition concepts, AI application to robotics, and current trends in intelligent systems.

Suggested Readings

- Russell, S. and P. Norvig. 1998. Artificial Intelligence: A Modern Approach. Prentice Hall.
- Rich, Elain and Kevin Knight. 1991. Artificial Intelligence. 3rd TMH.
- Patrick Henry Winston. 1992. Artificial intelligence. Addition Wesley 3 Ed.
- Nilson Nils J. Principles of Artificial Intelligence. Norsa Publishing House

25. Mechatronics 3(2+1)

Theory

Definition of mechatronics, measurement system, control systems, microprocessor based controllers, mechatronics approach. Sensors and transducers, performance terminology, Displacement, Position & Proximity Sensors, photo-electric transducers, flow transducers, optical sensors and transducers. Actuators, Mechanical Actuation Systems, Hydraulic & Pneumatic Actuation Systems, Electrical Actuation Systems, A.C. Motor, D.C. Motor, Stepper Motor. Signal conditioning process, filtering digital signal, multiplexers, data acquisition, digital signal processing, measurement system, pulse modulation, data presentation systems. System modelling & control, Mathematical Models, Engineering Systems, Electro-mechanical & Hydraulic- mechanical Systems, Modelling Dynamic Systems, Transfer Functions, Control Modes, PID Controller. Micro-processor & computer, Computer and Interfacing, Micro-computer Structure, Micro-controllers, Application of Microcontrollers, PLC. Robotics, Robot components, robot classification and specification, Work envelopes, other basic parameters of robots. Robot applications, Robot applications in manufacturing, Material transfer and machine loading/ unloading, Processing operations like Welding & painting, Assembly operations, Inspection automation, Future applications.

Practical

Selection of sensor for a particular application from Catalogue/Internet. Design a mechatronics product/ system and incorporate application of mechatronics for enhancing product values. To study the hardware and software of mechatronics kit. To move a table in X-direction within the range of proximity sensors using

Control-X software. To run a motor with PLC. To run a conveyor with computer. To study the movement of actuating cylinders and sensors.

Suggested Readings

- Bolton, W. Mechatronics. Pearson Education Asia.
- Wolfram, Stadler. Analytical Robotics and Mechatronics. Mc-Graw Hill.
- Doeblin E.O. Measurement Systems. Mc-Graw Hill.
- Mahind, A.P. Introduction to Digital Computer Electronics. TMH.
- Niku, S.Y. Introduction to Robotics: Analysis, systems and applications", Pearson Education Asia
- Craig, J.J. Introduction to Robotics. Pearson Education Asia.

5. B.Tech. Biotechnology

The B. Tech. Biotechnology degree programme curriculum has a total of 183 credit hours including non-credit hours. The finalized curriculum has more than 68 per cent courses from biotechnology discipline. Four electives, each of 18 credit hours, will be offered for the degree programme and the students will have to opt for one of these electives during their sixth semester of the degree programme. The B. tech. Biotech. programme includes a well-structured two-semester 'Student READY Programme' for a maximum of 40 credit hours. The 24 weeks 'Student Ready In-house Skill Development Modules' of 20 credit hours. In addition, the programmes will offer 10 weeks 'Student READY Project Formulation, Execution and Presentation' of 10 credit hours and 10 weeks On-campus/Off-campus 'Student READY Entrepreneurial Development in Biotechnology' of 10 credit hours.

Course Curriculum of B. Tech. Biotechnology

Semester-wise Distribution of Courses		
Semester I		
Course No.	**Course Title**	**Credit hours**
Bot. 101/Math. 101	Basic Botany / Basic Mathematics - I	2+1 / 3+0
Agron. 101	Crop Production Technology	2+1
Biotech.101	Cell Biology	2+0
Biotech. 102	Basic Genetics	2+1
Biotech. 103	Introduction to Biotechnology	2+1
CSPD 101	Communication Skills and Personality Development	1+1
Env. 101	Environmental Studies and Disaster Management	2+1
FT 101	Food Science and Processing	1+1
HD 101	Human Ethics	1+0
	NCC/NSO/NSS	0+1 NC
Total		**16+6/15+7 (22)+1NC=23**
Semester II		
Course No.	**Course Title**	**Credit hours**
Zoo. 101/ Math. 102	Basic Zoology/ Basic Mathematics – II	2+1/3+0
Biotech. 104	Plant Tissue Culture	2+1
Biotech. 105	Molecular Biology	2+1
Bot. / Zoo. 102	Biodiversity and its Conservation	2+0
*Hort. 101/ **AS 101	Production Technologies for Horticultural Crops/ Anatomy and Physiology of Livestock	2+1/3+0
*PB 101/ **AS 102	Basics of Plant Breeding/ Introduction to Animal Breeding	2+1
Micro. 101	Microbiology	2+1
Stat. 101	Basic Statistics	1+1
	NCC/NSO/NSS	0+1 NC
Total		**16+6/15+7 (22)+1 NC=23**
Semester III		
Course No.	**Course Title**	**Credit hours**
AS 201	Livestock Production and Management	2+1
Bot. 201	Plant Physiology	2+1
ICT 201	Information and Communication Technology	1+1

Econ. 201	Economics and Marketing	2+1
*Ent.-Pl.Path. 201/**AS 202	Fundamentals of Crop Protection/ Livestock Product Technology	2+1
Math. 201	Biomathematics	2+1
Biotech. 201	Recombinant DNA Technology	2+1
*PB 201/ **AS 203	Breeding of Field Crops/ Animal Health Care	2+1
	NCC/NSO/NSS	0+1 NC
	Total	**15+8 (23)+1 NC=24**
Semester IV		
Course No.	**Course Title**	**Credit hours**
EDBM 201	Entrepreneurship Development and Business Management	1+1
Biochem. 201	General Biochemistry	3+1
Biotech. 202	Introductory Bioinformatics	2+1
Biotech. 203	Plant Genetic Transformation	2+1
Biotech./ECE 204	Electronics and Instrumentation in Biotechnology	1+1
Biotech. 205	Classical and Molecular Cytogenetics	2+1
Micro. 201	Microbial Genetics	2+1
Phy. 201	Biophysics	2+1
	NCC/NSO/NSS	0+1 NC
	Total	**15+8 (23) +1 NC=24**
Semester V		
Course No.	**Course Title**	**Credit hours**
Biochem. 301	Enzymology and Enzyme Technologies	2+1
Bioteh. 301	Immunology	2+1
Bioteh. 302	Molecular Genetics	2+0
Bioteh. 303	Nanobiotechnology	2+0
Bioteh. 304	Animal Biotechnology	3+1
Bioteh. 305	Molecular Marker Technology	2+0
Bioteh. 306	Genomics and Proteomics	3+0
Bioteh. 307	IPR, Biosafety and Bioethics	2+0
ICT 301	Agricultural Informatics	2+1
	Total	**20+4=24**
Semester VI		
Course No.	**Course Title**	**Credit hours**
Biotech. 308	Computational Biology	2+1
Stat. 301	Biostatistics	2+1

Optional/ Elective Courses (6)		Electives (4): Only one to be chosen (each with six courses) 18	
	1. Plant Biotechnology	12+6	
	2. Animal Biotechnology	13+5	
	3. Microbial and Environmental Biotechnology	14+4	
	4. Bioinformatics	11+7	
1. Plant Biotechnology			
Biotech. 411		Plant Tissue Culture and its Applications	2+1
Biotech. 412		Principles and Applications of Plant Genetic Transformation	2+1
Biotech. 413		Applications of Genomics and Proteomics	2+1
Biotech. 414		Molecular Breeding in Field Crops	2+1
Biotech. 415		Molecular Breeding of Horticultural Crops and Forest Trees	2+1
Biotech. 416		Epigentics and Gene Regulation	2+1
2. Animal Biotechnology			
Biotech. 421		Principles and Procedures of Animal Cell Culture	2+1
Biotech. 422		Animal Genomics	2+1
Biotech. 423		Embryo Transfer Technologies	2+1
Biotech. 424		Transgenic Animal Production	3+0
Biotech. 425		Molecular Diagnostics	2+1
Biotech. 426		Molecular Virology and Vaccine Production	2+1
3. Microbial and Environmental Biotechnology			
Biotech. 431		Microbial Biotechnology	2+1
Biotech. 432		Bio-prospecting of Molecules and Genes	3+0
Biotech. 433		Molecular Ecology and Evolution	3+0
Biotech. 434		Fundamentals of Molecular Pharming and Biopharmaceuticals	2+1
Biotech. 435		Food Biotechnology	2+1
Biotech. 436		Green Biotechnology	2+1
4. Bioinformatics			
Biotech. 441		Programming for Bioinformatics	2+2
Biotech. 442		Bioinformatics Tools and Biological Databases	2+1
Biotech. 443		Structural Bioinformatics	2+1
Biotech. 444		Pharmacogenomics	2+1

Biotech. 445	Metabolomics and System Biology	2+1
Biotech. 446	Computational Methods for Data Analysis	1+1
Total		**16+8/17+7 18+6/15+9=24**

Semester VII		
Course No.	**Module***	**Credit hours**
Biotech. 491 Student READY - In-house Skill Development Modules	1. Plant Biotechnology 2. Animal Biotechnology 3. Microbial and Environmental Biotechnology 4. Bioinformatics ***To opt only one module as per the chosen elective***	0+20
	Educational Tour	2 NC
Total		**20+2 NC =22**

Semester VIII		
Course No.	**Module***	**Credit hours**
Biotech. 492	Student READY - Project Formulation, Execution and Presentation	0+10
Biotech. 493	Student READY - Entrepreneurial Development in Biotechnology (- On-campus/Off Campus)	0+10
Total		**0+20 =20**

SYLLABUS

Students joining degree programme with +2 in medical stream will take Math. 101 and Math. 102 as remedial courses, while the students joining B.Tech. Biotechnology with +2 in Non-Medical stream will take Bot. 101 and Zoo. 101 as remedial courses. These courses will cover syllabus for +1 & +2 classes. There will be a total of six credit hours in each of the deficiency/remedial courses package.

Semester – I

Bot. 101: Basic Botany (2+1)

Theory

UNIT-I

Plant kingdom and features of each group; Morphology, modifications and functions of root, stem, leaf, flower and inflorescence; Pollination and fertilization; Fruit types; Structure of dicot and monocot seed, seed germination.

UNIT-II

Cell structure; DNA, chromosome and genes; Cell and tissue types; Internal structure of root, stem and leaf.

UNIT-III

Plant taxonomy, systems of classification; Characteristics and economic importance of Poaceae, Brassicaceae, Fabaceae, Malvaceae, Rutaceae, Rosaceae, Asteraceae and Solanaceae families.

Practical

Description of one plant species from each group of plant kingdom; Study of morphology and modifications of root, stem, leaf, flower; Types of inflorescence; Structure of various types of seeds and fruits; Demonstration of cell structure, tissue types; Structure of monocot and dicot root, stem and leaf; One flower from each family.

Suggested Readings:

- *Bendre A & Kumar A. 1999. Textbook of Practical Botany. Vol. 2, 7th Ed., Rastogi Publications.*
- *Bendre AM & Pande PC. 2009. Introduction to Botany. Rastogi publications.*
- *Dutta AC. 1995. A Class Book of Botany, 16th Edition. Oxford University Press.*

Math. 101: Basic Mathematics-I (3+0)

Theory

UNIT-I

Complex numbers: Properties of real numbers, complex numbers, their addition, multiplication and division, square root of complex numbers, cube roots of unity and theirproperties, De-Moivre's theorem; Theory of

equations: Solution of quadratic equation, equationreducible to quadratic equation, relation between roots and coefficients, nature of roots and formation of quadratic equation with given roots.

UNIT-II

Geometric series: nth term of G.P. series, sum of G.P. series, geometric mean; Harmonicseries, harmonic mean; Arithmetico geometric series and special series. Partial fractions; Logarithms; Binomial theorem for any index: Expansion, middle term, generalterm, terms independent of x.

UNIT-III

Trigonometry: Trigonometric ratios, allied angles, graphs of trigonometric functions; Addition and subtraction formulae; Product and sum formulae; Multiple and sub-multiple angles, sine, cosine and projection formulae; Area of a triangle.

Suggested Readings

- *NCERT 2012. Mathematics of Class XI. NCERT India.*
- *Sharma RD. 2014. Mathematics of Class XI. Dhanpat Rai Publisher*.

Agron. 101: Crop Production Technology (2+1)

Theory

UNIT-I

Soil and its components; Soil morphological, physical, chemical and biological properties; Acidic, saline and alkali soils and their reclamation; Essential plant nutrients: Functions and deficiency symptoms; Soil micro-organisms; Rhizosphere and its domain in soil; Organic manures and inorganic fertilizers.

UNIT-II

Agriculture; Agronomy and its relation with other sciences; Classification of crops; Tillage and tillage practices, concepts of tillage and objectives; Seed, its characteristics and different sowing methods; Weed management: definition of weed, losses and benefits of weeds, different weed control methods and their suitability under different conditions; Irrigation: Soil water classification, methods of irrigation, approaches for scheduling irrigation.

UNIT-III

Soil fertility and productivity; Concept of essentiality of plant nutrients; Fertilizers, manures and their types, methods of fertilizer application; Concepts of crop rotation, multiplecroppingandintercropping-their principles, advantages and limitations; Cropping intensity; Production technology of major crops: Rice, maize, cotton, soybean, mung bean, mash, wheat, rapeseed andmustard, gram and Egyptian clover.

Practical

Study of soil profile and its characteristics; Determination of soil particle size distribution, particle density and bulk density; Determination of soil pH, electrical conductivity and organic carbon; Isolation of soil micro-flora (bacteria, fungus and actinomycetes).

Land measurement; Practice in seed bed preparation and seeding methods; Identification of crop seeds, crops, weeds and fertilizers; Identification and use of hand tools and implements; Computation of fertilizer doses and their method of application.

Suggested Readings:

- *Acquaah G. 2005. Principles of Crop Production: Theory, Techniques and Technology. Prenice Hall.*
- *Alexander M.1977. Introduction to Soil Microbiology, 2nd Edition. John Wiley & Sons.*
- *Balasubrananiyan P & Palaniappan SP.2010.Principles and Practices of Agronomy. Agrobios.*
- *Brady NC & Well RR. 2002. The Nature and Properties of Soils, Thirteenth Edition. Pearson Prentice Hall.*
- *Chandrasekaran B, Annadural K & Samasundaram E. 2010. A Text Book of Agronomy. New Age International (P) Limited Publishers.*
- *Das DK.2 011. Introductory Soil Science. Third Revised Edition, Kalyani Publishers.*
- *Reddy SR. 2011. Principles of Agronomy. Kalyani Publishers.*

Biotech. 101: Cell Biology 2 (2+0)

Theory

UNIT-I

Origin and evolution of cell; Introduction to microscopy; Sub-cellular structure of prokaryotic and eukaryotic cells; Membrane structure and function: plasma membrane, cell wall and extracellular matrix; Structural organization and function of intracellular organelles and organelle biogenesis: Nucleus, mitochondria, endoplasmic reticulum, Golgi apparatus, lysosomes, peroxisomes, plastids, vacuoles.

UNIT-II

Structure and function of cytoskeleton and its role in motility; Cell membrane transport; Introduction to cell signalling; Cell growth, cell cycle and its control; Cell death and cell renewal.

Suggested Readings

- *Alberts B, Johnson A, Lewis J, Raff M, Roberts K & Walter P. 2008. Molecular Biology of the Cell. 5th Ed.Garland Science/Taylor and Francis Group.*
- *Lodish H,Berk A,Kaiser CA, Krieger M, Bretscher A,Ploegh H, Amon A & Scott MP. 2012. Molecular Cell Biology. W.H.Freeman.*
- *Sadava DE. 1993.Cell Biology: Organelle Structure and Function. Jones and Bartlett Publishers.*

Biotech. 102: Basic Genetics (2+1)

Theory

UNIT-I

History of Genetics; Mendel's principles and rediscovery; Cell division; Chromosomes structure and function; Chromosome Theory of inheritance; Sex-linked, sex-limited and sex-influenced inheritance; Sex determination and sex differentiation.

UNIT-II

Multiple allelism; Linkage and crossing-over; Gene-gene interaction; Genetic analysis in prokaryotes and eukaryotes; Extrachromosomal inheritance; Mutations; Hardy-Weinberg law; Quantitative inheritance; Introduction to Human genetics; Genetic basis of evolution.

Practical

Life cycle in model plants and animals; microscopy; Mitosis and meiosis; Mono-hybrid crosses(segregation); Di-hybrid crosses (independent assortment); Probability and use of Chi-square; Sex-linked inheritance; Multiple allelism; Detection and estimation of linkage.

Suggested Readings

- *Gupta PK. 2014.Genetics 4th ed. Rastogi Publications.*
- *Inbasekar P. 2009. Cell Biology and Genetics.Panima Publications.*
- *Miglani GS. 2000. Basic Genetics.Narosa Publishing House, New Delhi.*
- *Russell PJ. 2013. Genetics: Pearson New International Edition: A Molecular Approach. Pearson.*
- *WatsonJD, BakeeTA, Bell SP, Gann A, Levine M & Losick R. 2008. Molecular Biology of the Gene. 6th Ed.Pearson Education International.*

Biotech. 103: Introduction to Biotechnology (2+1)

Theory

UNIT-I

History, definitions, concepts, scope and importance of Biotechnology: Plant, microbial, animal, medical, environmental, industrial, Marine, Agricultural and food Biotechnology; Nano biotechnology.

UNIT-II

Introduction to recombinant DNA technology and its applications: Vectors, DNA restriction and modifying enzymes, gene cloning; Introduction to genomics and proteomics: Molecular markers, DNA sequencing; Genetic transformation and transgenic organisms; Bioinformatics. Biosafety guidelines.

Practical

Orientation to the laboratories: glass houses, screen houses, transgenic facilities and field area; General guidelines for working in Biotechnology laboratories; Familiarization with basic equipment's used in biotechnology; Selection of chemicals (different grade), buffer preparation, calculations and scientific notations used in laboratories.

Suggested Readings

- *Brown TA.2 002. Genomes2. 2nd ed. New York: Wiley-Liss.*
- *Prave P, Faust U, Sittig W & Sukatsch DA.1987. Basic Biotechnology: A Student's Guide. VCH Verlagsgesellschaft.*
- *Prave P, Faust U & Sittig W.1987.Fundamentals of Biotechnology.VCH Verlagsgesellschaft.*
- *Renneberg R.2008.Biotechnology for Beginners. Academic Press Publishers.*

CSPD 101: Communication Skills and Personality Development (1+1)

Theory

UNIT- I

Communication skills: Structural and functional grammar; Meaning and process of communication; Verbal and nonverbal communication; Listening and note taking; Writing skills; Oral presentation skills; Field diary and lab record; Indexing, footnote and bibliographic procedures; Reading and comprehension of general and technical articles; Precise writing, summarizing, abstracting; Individual and group presentations; Impromptu presentation; Public speaking; Group discussion and interviews; Organizing seminars and conferences.

UNIT- II

Voice modulation basics and their usage for meaningful impact on people; Attributes of an effective leader; Stress and conflict management; Time management: Personal organization, prioritizing and balancing; Cosmopolitan culture; Impact of non-verbal communication; Science of body language; Role of team work.

Practical

Listening and note taking, writing skills, oral presentation skills; Field diary and lab record; Indexing, footnote and bibliographic procedures; Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; Individual and group presentations; Video recorded mock group discussions and interviews; Attitude management; Setting and achieving a short term goal; Creating a personal vision statement of life; Voice modulation; Practicing conscious body postures and movements; Rapport building; Video recorded practical to evaluate change in confidence level; Team work exercises; Time management.

Suggested Readings

- *Carnegie, Dale. 2012. How to Win Friends and Influence People in the Digital Age. Simon & Schuster.*
- *Covey Stephen R. 1989. The Seven Habits of Highly Successful People. Free Press.*
- *Spitzberg B, Barge K & Morreale, Sherwyn P. 2006. Human Communication: Motivation, Knowledge & Skills. Wadsworth.*
- *Verma, KC. 2013. The Art of Communication. Kalpaz.*

Env. 101: Environmental Studies and Disaster Management (2+1)

Theory

Environmental Studies

UNIT-I

Multi-disciplinary nature of environmental studies; Definition, scope and importance.

UNIT-II

Natural Resources: Renewable and non-renewable resources; Natural resources and associated problems.

Forest resources: Use and over-exploitation; Deforestation; Case studies. Timber extraction, mining; Dams and their effects on forest and tribal people.

Water resources: Use and over-utilization of surface and ground water; Floods; Drought; Conflicts over water; Dams-benefits and problems.

Mineral resources: Use and exploitation; Environmental effects of extracting and using mineral resources; Case studies.

Food resources: World food problems; Changes caused by agriculture and overgrazing; Effects of modern agriculture; Fertilizer-pesticide problems; Water logging; Salinity; Case studies.

Energy resources: Growing energy needs; Renewable and non-renewable energy sources; Use of alternate energy sources; Case studies.

Land resources: Land as a resource; Land degradation; Man-induced land-slides; Soil erosion and desertification. Role of an individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.

UNIT-III

Ecosystems; Concept of an ecosystem; Structure and function of ecosystem; Producers, consumers and decomposers; Energy flow in ecosystem; Ecological succession; Food chains, foodwebs and ecological pyramids; Introduction, types, characteristic features, structure and function of forest ecosystem, grassland ecosystem, desert ecosystem and aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

UNIT-IV

Biodiversity and its conservation; Introduction, definition, genetic, species and ecosystem diversity and bio-geographical classification of India; Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values; Biodiversity at global, national andlocal levels; India as a mega-diversity nation; Hot-sports of biodiversity; Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; Endangered and endemic species of India; Conservation of biodiversity: *In-situ* and *Ex-situ* conservation of biodiversity.

UNIT-V

Environmental Pollution: definition, cause, effects and control measures air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards; Solid waste management: causes, effects and control measures of urban and industrial wastes; Role of an individual in prevention of pollution; Pollution case studies.

UNIT-VI

Social issues and the environment; From unsustainable to sustainable development; Urban problems related to energy; Water conservation, rain water harvesting,water shed management; Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents

and holocaust; Waste land reclamation; Consumerism and waste products; Environment Protection Act; Air (Prevention and Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; Issues involved in enforcement of environmental legislation; Public awareness.

UNIT-VII

Human population and environment: population growth, variation among nations, population explosion, Family Welfare Programme; Environment and human health: human rights, value education, HIV/ AIDS; Women and child welfare; Role of information technology in environment and human health; Case studies.

Disaster Management

UNIT-I

Natural disasters – Meaning and nature of natural disasters; their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves; Climatic change: global warming, sea level rise, ozone depletion.

UNIT-II

Man-made disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT-III

Disaster management - Effect to migrate natural disaster at national and global levels; International strategy for disaster reduction; Concept of disaster management; National disaster management framework; Financial arrangements; Role of NGOs, community-based organizations and media; Role of central, state, district and local administration; Armed forces, police and other organizations in disaster response.

Practical

Visit to a local area to document environmental assets: river/ forest/ grassland/ hill/ mountain; Visit to a local polluted site-urban/rural/industrial/agricultural; Studyof common plants, insects, birds and study of simple ecosystems - pond, river, hill slopes, etc.; Visit to disaster management organizations; Collection of statistics of national disasters occurred since 20th century.

Suggested Readings

- *Ahluwalia VK & Malhotra S. 2006. Environmental Science. An eBooksIndia.*
- *Anjaneyulu Y. 2004. Introduction to Environmental Science. BS Publications.*
- *Chauhan AS. 2009. Environmental Studies.3rdEdition. Jain Brothers.*
- *Das RC & Behera DK. 2008. Environmental Science - Principles and Practice. Prentice –Hall of India Pvt Ltd.*
- *Dhaliwal GS & Kukal SS. 2005. Essentials of Environment Science. Kalyani Publishers. Santra*

FT 101: Food Science and Processing (1+1)

Theory

UNIT-I

Definition: Food and nutrition; Food production and consumption trends in India; Major deficiencies of calories, proteins, vitamins and micronutrients; Food groups and concept of balanced diet; RDA.

UNIT-II

Causes of food spoilage; Principles of processing and preservation of food by heat, low temperature, drying and dehydration, chemicals and fermentation; Preservation through ultraviolet and ionizing radiations.

UNIT-III

Post-harvest handling and technology of fruits, vegetables, cereals, oilseeds, milk, meat and poultry; Food safety, adulteration and food laws; Status of food industry in India

Practical

Physical and chemical quality assessment of cereals, fruits, vegetables, egg, meat and poultry; Value added products from cereals, millets, fruits, vegetables, milk, egg and meat; Visit to local processing units.

Suggested Readings

- *Potter NN & Hotchkiss JH.1995. Food Science.Chapman and Hall Publishers.*
- *Swaminathan M. 2005.Handbook of Foods and Nutrition. Ganeshand Co. Pvt.Ltd.*
- *Swaminathan M.1990. Food Science, Chemistry and Experimental Foods. BAPPCO.*
- *Vickie A., Vaclavik & Elizabeth W. Christian. 2003. Essentials of Food Science, 2nd Ed. Kluwer Academic/Plenum Publishers, New York.*

HD 101: Human Ethics (1+0)

Theory

UNIT-I

Universal human aspirations: Happiness and prosperity; Human values and ethics: Concept, definition, significance and sources; Fundamental values: Right conduct, peace, truth, love and non-violence; Ethics: professional, environmental, ICT; Sensitization towards others particularly senior citizens, developmentally challenged and gender.

UNIT-II

Spirituality, positive attitude and scientific temper; Team work and volunteering; Rights and responsibilities; Road safety; Human relations and family harmony; Modern challenges and value conflict: Sensitization against drug abuse and other social evils; Developing personal code of conduct (SWOT Analysis); Management of anger and stress.

Suggested Readings

- *Gaur RR, Sangal R & Bagaria GP. 2011. A Foundation Course in Human Values and Professional Ethics. Excel Books.*
- *Mathur SS. 2010. Education for Values,Environment and Human Rights. RSA International.*
- *Sharma RA. 2011. Human Values and Education-Axiology, In culcation and Research. R.Lall Book Depot.*
- *Sharma RP & Sharma M. 2011.Value Education and Professional Ethics. Kanishka Publishers.*
- *Srivastava S. 2011. Human Values and Professional Ethics.SK Kataria & Sons.*
- *Srivastava S. 2011.Environmental Science. SK Kataria & Sons.*
- *Tripathi A.N. 2009. Human Values.New Age International (P) Ltd Publishers.*

Semester – II

Zoo. 101: Basic Zoology 3 (2+1)

Theory

UNIT I

Introduction to Zoology; Structure and functions of cell and cell organelles; Difference between prokaryotic and eukaryotic cell; Cell division – mitosis and meiosis; Structure and function of biomolecules; Types of simple and compound tissues.

UNIT II

Binomial Nomenclature; Classification and general survey of animal kingdom; Functional organization of various systems of a mammal: digestive, circulatory, respiratory, excretory, nervous and reproductive; Laws of inheritance; Multiple allelism - blood groups; Genetic disorders in human and their inheritance.

Practical

Study of animal cell structure and cell division; Histological preparation of simple and compound tissues; General survey of animal kingdom up to phyla in invertebrates and up to classes in vertebrates; Demonstration of mammalian anatomy; Blood grouping.

Suggested Readings

- *Bhatia KN & Tyagi MP. 2012. Trueman's Elementary Biology. 24th ed. Trueman Book Company.*
- *Dhami PS & Mahindru RC. 1996. A Text Book of Biology for 10+2. Pradeep Publications.*

Math. 102: Basic Mathematics-II (3+0)

Unit -I

Functions; Limit: Introduction, left handed and right handed limits, general rules for calculation of limits Standard limits., Continuity: Definition of continuity, continuity of algebraic functions, Continuity of trigonometric and exponential functions.

UNIT- II

Differentiation: Differentiation by first principle, sum, difference, product and quotient formulae, differentiation using chain rule, differentiation of functions in parametric and implicit form, logarithmic differentiation, geometrical interpretation of derivative, Successive differentiation, geometrical interpretation of derivative, maxima and minima, tangent and normal.

UNIT- III

Integration: Integration by substitution, integration by partial fractions, integration by parts, integration by trigonometric substitution.

UNIT- IV

Matrices and Determinants: Definition of matrix, addition, subtraction and multiplication, inverse of matrix; Solution of linear equations: By Crammer's rule and inverse of matrix.

Suggested Readings

- *NCERT 2012. Mathematics of Class XII. NCERT India.*
- *Sharma RD. 2014. Mathematics of Class XII. Dhanpat Rai Publisher.*

Biotech. 104: Plant Tissue Culture (2L+1P)

Theory

UNIT-I

History of plant tissue culture; concept of totipotency; Concept of aseptic culture practices; Components of *in vitro* culture media and role of different macro and micronutrients, vitamins, plant growth regulators and growth supplements; Sterilization techniques.

UNIT-II

Various plant cell, tissue and organ culture techniques and uses; Somatic cell cultures; morphogenesis: organogenesis and somatic embryogenesis; Micropropagation: *In vitro* grafting, meristem culture; Anther, pollen, embryo, ovule, ovary culture; Protoplast culture and somatic hybridization; Somaclonal variation.

Practical

Good laboratory practices; Media preparation and sterilization; Surface sterilization of explants; Establishment of callus/ cell suspension cultures; Micropropagation; Embryo culture; Anther and pollen culture; Induction of plant regeneration; Hardening and transfer to soil.

Suggested Readings

- *Bhojwani SS & Razdan MK. 1996.Plant Tissue Culture:Theory and Practice. Elsevier.*
- *Bhojwani SS & Dantu PK. 2013. Plant Tissue Culture: An Introductory Text. Springer*
- *Dixon RA & Gonzales RA. 2003. Plant Cell Culture: A Practical Approach. Oxford University Press.*
- *Helgason CD & Miller CL. 2005. Basic Cell Culture Protocols. 3rdEd. Humana Press.*

Biotech. 105: Molecular Biology (2L+1P)

Theory

UNIT-I

History of molecular biology; Central dogma of life; Structure of DNA and RNA; Gene structure and function; DNA replication; transcription; Genetic code and translation; Structure of prokaryotic and eukaryotic nuclear and organelle genomes; Gene regulation in prokaryotes: Lac operon concept, tryp concept.

UNIT-II

Introduction to microbial genetics; conjugation, transformation and transduction; Tools in molecular biology: Role of enzymes in molecular biology; Principles of Polymerase Chain Reaction; Electrophoresis; PCR and hybridization based molecular markers.

Practical

Preparation of bacterial competent cells and transformation; Isolation and purification of plant and animal DNA; Measurement of nucleic acid concentration using spectrophotometer and gel electrophoresis; DNA amplification using RAPD, microsatellite primers and analysis; CAPS primers; Generation of linkage maps and mapping of qualitative genes; Estimation of genetic similarities and generation of dendrograms.

Suggested Reading

- *Allison LA. 2011. Fundamental Molecular Biology. Wiley Global Education.*
- *Carson S, Miller HB & Witherow DS. 2012. Molecular Biology Techniques A Classroom Laboratory manual. Elsevier.*
- *Kreuzer H & Massey A. 2008. Molecular Biology and Biotechnology: A Guide for Teachers. ASM Press.*
- *Lodish H, BerkA, Kaiser CA, Krieger M, Bretscher A, Ploegh H, Amon A & Scott MP. 2012. Molecular Cell Biology. W.H. Freeman.*
- *Sambrook J, Russel D. 2001. Molecular Cloning: A Laboratory Manual. 3rd Ed Cold Spring Harbor Laboratory Press.*
- *Surzycki S. 2000. Basic Techniques in Molecular Biology. Springer Berlin Heidelberg*
- *Voet D, Voet JG & Pratt CM. 2004. Fundamentals of Biochemistry. 2nd Ed. New York: Wiley.*
- *Walker JM & Rapley R. 2000. Molecular Biology and Biotechnology. 4thEd.The Royal Society of Chemistry.*
- *Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008. Molecular Biology of the Gene. 6th Ed.Pearson EducationI nternational.*
- *Das HK. 2017. Textbook of Biotechnology, 5th Edition, Wiley*

Bot. /Zoo. 102: Biodiversity and its Conservation (2+0)

Theory

UNIT-I

Concepts of biodiversity, bioresource and wild life management, conservation strategies: *in situ* and *ex situ* conservation; Wild life conservation projects in India; Protection of biodiversity for its suitable utilization; Threats to biodiversity; WCU Red data book; Biodiversity hotspots in India; National bureaus of genetic resources.

UNIT-II

Sustainable development; Diversification of cropping system; Diversity of indigenous livestock; Vulnerability and extinction of flora and fauna; Endangered species in various ecosystems; Germplasm banks; Environmental impact assessment; Bioremediation and biosafety; Introduction to regulatory agencies and legislation.

Suggested Readings

- *Das MK & Choudhury BP. 2008. A Text book on Plant Nomenclature and Biodiversity Conservation. Kalyani Publishers.*
- *Hopsetti BB & Venketashwarlaru M.2001.Trends in Wild Life Conservation and Management. Vol.2, Daya Publishing House.*
- *Singh MP & Singh BS. 2002. Plant Biodiversity and Taxonomy. Daya Publishing House, Delhi.*

Hort. 101: Production Technologies for Horticultural Crops (2L+1P)

Theory

UNIT-I

Importance and scope of fruit cultivation; Classification of fruit crops; Climatic requirement; Selection of site; Fencing and wind break; Lay out and planting systems; Sexual and asexual methods of plant propagation; Production technology of important tropical, sub tropical and temperate fruit crops.

UNIT-II

Importance of vegetable cultivation for nutritional security; Production technology of important vegetable crops: potato, brinjal, tomato, chilli, onion, okra, cabbage, cauliflower, muskmelon, watermelon, cucumber and leafy vegetables.

UNIT-III

Status and scope of floriculture in India and abroad; Production technology of commercial flower crops: Rose, chrysanthemum, gladiolus, marigold, gerbera, carnation, lilium, jasmine, anthurium and orchids.

Practical

Introductory Ornamental Identification of different fruit, vegetables, ornamental and flower crops; Lay out and planning for planting orchards; Preparation of seed beds; Raising of seeds, rootstocks, and

propagation techniques of major fruit, vegetable and flower crops;Visit to commercial nurseries and orchards.

Suggested Readings

- *Arora JS. 2013. Horticulture. Kalyani Publishers.*
- *Bal JS. 2013. Fruit Growing. Kalyani Publishers.*
- *Chadha KL. 2012. Handbook of Horticulture. ICAR*
- *Dhaliwal MS. 2014. Handbook of Vegetable Crops. Kalyani Publishers*

PB 101: Basics of Plant Breeding (2L+1P)

Theory

UNIT-I

History, aims and objectives of Plant breeding; Role of related sciences in plant breeding; Modes of reproduction - sexual, asexual, apomixes: Significance in plant breeding; Modes of pollination, genetic consequences, differences between self- and cross pollinated crops; Germplasm resources and their utilization.

UNIT-II

Methods of breeding: Introduction and Acclimatization; Selection: Mass selection, Johannesen's pure-line Theory, genetic basis, pure-line selection; Hybridization: Aims and objectives, types of hybridization; Methods of handling segregating generations: Pedigree method, bulk method, back cross method; Heterosis, inbreeding depression, various theories of heterosis, exploitation of hybrid vigor, Hardy Weinberg law, selection in cross pollinated crops; Population improvement programmes; Synthetics and composites; Methods of breeding vegetatively propagated crops.

UNIT-III

Incompatibility and male sterility and their utilization in crop improvement; Mutation breeding; Ploidy breeding; Wide hybridization and its significance in crop improvement; Procedure for release of new varieties.

Practical

Classification of plants; Botanical description and floral biology of field crops: rice, sorghum, maize, wheat, bajra, sugarcane, brassicas, groundnut, sunflower, sesamum, redgram, Bengal gram, green gram, soybean, black gram, cotton; Study of mega-sporogenesis and micro-sporogenesis; Fertilization and life cycle of an angiospermic plant; Hybridization techniques and precautions to be taken; selfing, emasculation and crossing techniques; Study of male sterility and incompatibility.

Suggested Readings

- *Allard RW.1960.Principles of Plant Breeding. John Wiley and Sons.*
- *Chahal GS & Gosal SS. 2002. Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches. Narosa Publishers.*

- *Phundan Singh. 2014. Essentials of Plant Breeding. Kalyani Publishers.*
- *Singh BD.2009.Plant Breeding: Principles and Methods. Kalyani Publishers,India.*
- *Singh BD. 2022. Plant Breeding Principles and Methods 12TH Edition, MedTech Science Press*

Micro. 101: Microbiology (2L+1P)

Theory

UNIT-I

History of Microbiology-its applied areas; Microorganisms and their role in fermentation; Germ Theory of diseases and protection; Introduction to eukaryotic and prokaryotic cell; Major groups of eukaryotes-fungi, algae and protozoa; Major groups of prokaryotes–Actinomycetes, Cyanobacteria, Archaebacteria, Rickettsias and Chlamydia; Preservation of microorganisms; Microbial repositories at national and international level.

UNIT-II

Bacterial growth; Metabolism in bacteria- ATP generation, chemoautotrophy, photo autotrophy, respiration, fermentation; Viruses: Bacteriophages - structure and properties, lytic and lysogenic cycles; viriods, prions.

UNIT-III

Microbial groups in soil; Microbes in biotic and abiotic stressed environments; Microbial transformation of carbon, nitrogen and sulphur; Biological nitrogen fixation; Beneficial microorganisms in agriculture-biofertilizers, microbial pesticides; Plant microbe interaction; Microbes in composting and biodegradation; Microbiology of water and food.

Practical

Microscope and other instruments in a microbiological laboratory; Media preparation, sterilization and aseptic methods for isolation, identification, preservation and storage; Identification of bacteria by staining methods; Enumeration of bacteria by pour plate and spread plate methods; Micrometery.

Suggested Readings

- *Brock TD.1961.Milestones in Microbiology. InfinityBooks.*
- *Pelczar MJ, Chan ECS & Kreig NR.1997.Microbiology: Concepts and Application. Tata McGrawHill.*
- *Stainier RY, Ingraham JL, Wheelis ML & Painter PR.2003.General Microbiology. MacMillan.*
- *Tauro P, Kapoor KK & Yadav KS. 1996. Introduction to Microbiology. Wiley Eastern.*

Stat. 101: Basic Statistics (1L+1P)

Theory

UNIT-I

Definition of statistics, its use and limitations; Frequency distribution and frequency curve and cumulative frequency curve; Measures of central tendency; Measures of dispersion; Probability: Definition, additive

and multiplicative law for two events; Normal distribution and its properties; Introduction to sampling; Sampling techniques.

UNIT-II

Tests of significance: Null hypothesis, alternate hypothesis, Type I & II Error, one and two tail tests, level of significance and confidence interval; SND test for means: Single sample and twosamples Z-test; Student's t-test for means, single sample, two samples and paired t-test; F-test;

UNIT-III

Chi-square test in 2x2 contingency table; Yate's correction for continuity; Correlation: Scatter diagram and Karl Pearson's coefficient of correlation for ungrouped data and its testing; Linear regression and its properties; Analysis of variance and its assumptions, Analysis of CRD and RBD; Analysis of Latin Square Design.

Practical

Construction of frequency distribution tables and frequency curves; Computation of Arithmetic: Mean, median, mode; Standard deviation; Variance and coefficient of variation for ungrouped and grouped data; SND test for means; Student's t-test; F-test and Chi-square test; Correlation coefficient 'r' and its testing; Fitting of regression equations; Analysis of CRD, RBD and LSD.

Suggested Readings

- *Freud JE & Perles BM. 2006.Modern Elementary Statistics. 12th Ed. Pearson India.*
- *Kapoor VK. 2003. Problems and Solutions in Statistics. 7th Edition. Sultan Chand and Sons.*
- *Snedecor GW & Cochran WG.1989. Statistical Methods. Iowa State University Press.*

Semester – III

AS 201: Livestock Production and Management (2L+1P)

Theory

UNIT-I

Livestock history in India: Vedic, medieval and modern era; Demographic distribution of livestock and role in economy; Introductory animal husbandry; Breeds of livestock; Cattle, Buffalo, Sheep, Goat and Pig; Important traits of livestock; General management and feeding practices of animals; Handling and restraining of animals; Housing systems. Importance of grasslands and fodders in livestock production; Common farm management practices including disinfection, isolation, quarantine and disposal of carcass; Common vices of animals and their prevention; Diseases and parasite control & hygiene care.

UNIT-II

History and economic importance of poultry; Poultry breeds; Reproductive system of male and female birds; Formation and structure of eggs; Important economic traits of poultry, Egg production, Egg weight, Egg quality; Fertility and Hatchability, Plumage characteristics and combtypes. Care and management of chicks, grower and layers/broiler; Brooding management; Hatchery practices; Poultry Diseases, control and hygiene care;

Practical

Visit to livestock farms/demonstration centres; Breeds of cattle, buffalo, sheep, goat and Pigs; Familiarization with body parts of animals; Handling and restraining of cattle, buffalo, sheep, goat and swine; Male and female reproductive system and Artificial Insemination; Feeding of livestock; Methods of identification: marking, tattooing, branding, tagging; Milking methods; Record Keeping. Visit to the Poultry farm; Poultry breeds; Body parts of chicken, duck, quail and turkey; Housing, equipment, nesting and brooding requirements; Male and female reproductive system; Methods of identification and sexing; Hatchery layout and equipment; Identification of diseases and control of parasites,Vaccination;Maintenance of farm records;

Suggested Readings

- *Banerjee GC.1989.Text Book of Animal Husbandry. Oxford and IBH.*
- *ICAR. 1962. Handbook of Animal Husbandry. ICAR Publication.*
- *Parsad Jagdish. 2001. Poultry Production and Management. Kalyani Publishers.*
- *Sastry NSR & Thomas CK. 1991. Dairy Bovine Production. Kalyani Publishers.*
- *Singh RA. 1990. Poultry Production. Kalyani Publishers.*
- *Thomas CK &Sastry NSR. 2013. Livestock Production Management. KalyaniPublishers.*

Bot. 201: Plant Physiology (2L+1P)

Theory

UNIT-I

Plant physiology, its scope in agriculture; Osmosis, imbibition, water absorption, water translocation and transpiration; Stomatal mechanisms; Physiological role and deficiency symptoms of major and minor elements, Absorption and translocation of minerals.

UNIT-II

Concepts of photosynthesis, photorespiration, respiration and translocation of photoassimilates; Dynamics of growth; Stress physiology; Nitrogen and sulphur metabolism; Plant growth regulators: Their biosynthesis and physiological roles, seed germination & seed dormancy, senescence, vernalization.

Practical

Demonstration of processes of diffusion, osmosis, imbibition and plasmolysis; Ascent of sap, transpiration; Deficiency symptoms of nutrients in crop plants; Plant growth analysis; Quantitative and qualitative estimation of plant pigments; Experiments on photosynthesis and respiration; Effects of plant growth regulators on plant growth and seed germination; Experiments on seed dormancy; Relative water content and plant water potential; Proline estimation.

Suggested Readings

- *Bhatia KN & Prashar AN. 1990. Plant Physiology. Trueman Book Company.*
- *Salisbury FB & Ross CW. 1992. Plant Physiology. Wordsworth Publishing Company.*
- *Srivastava HN. 2000. Plant Physiology. Pradeep Publications.*

ICT 201: Information and Communication Technology (1L+1P)

Theory

UNIT-I

IT and its importance; IT tools; IT-enabled services and their impact on society; Computer fundamentals; Hardware and software; Input and output devices; Word and character representation.

UNIT-II

Features of machine language, assembly language, high-level language and their advantages and disadvantages; Principles of programming-algorithms and flowcharts.

UNIT-III

Operating systems (OS)- definition, basic concepts; Introduction to WINDOWS and LINUX Operating Systems; Local area network (LAN); Wide area network (WAN); Internet and World Wide Web; HTML and IP.

UNIT-IV

Introduction to MS Office- Word, Excel, Power Point; Audio-visual aids-definition, advantages, classification and choice of A.V. aids; Criteria for selection and evaluation of A.V aids; Video conferencing; Communication process, Berlo's model, feedback and barriers to communication.

Practical

Exercises on binary number system; Algorithm and flowchart; MS Word; MS Excel; MS Power Point; Internet applications: web browsing, creation and operation of email account; Analysis of data using MS Excel; Handling of audio visual equipments; Planning, preparation, presentation of posters, charts, overhead transparencies and slides; Organization of an audiovisual programme.

Suggested Readings

- *Gurvinder Singh, Rachhpal Singh & Saluja KK. 2003. Fundamentals of Computer Programming and Information Technology. Kalyani Publishers.*
- *Harshawardhan P. Bal. 2003. Perl Programming for Bioinformatics. Tata McGraw-Hill Education.*
- *Kumar A. 2015. Computer Basics with Office Automation. IK International Publishing House Pvt Ltd.*
- *Rajaraman V & Adabala N.2015. Fundamentals of Computers. PHI*
- *Recommended Latest Online Tutorials (over Internet).*

Econ. 201: Economics and Marketing (2L+1P)

Theory

UNIT- I

Economics – Terms and definitions; Consumption, demand, price and supply; Factors of production; Gross Domestic Product; Role of Biotechnology/ Agriculture sector in national GDP.

UNIT- II

Marketing – definition; Marketing process; Need for marketing; Role of marketing; Marketing functions; Classification of markets; Marketing of various channels; Price spread; Marketing efficiency; Constraints in marketing of agricultural produce; Market intelligence.

UNIT- III

Basic guidelines for preparation of project reports; Bank norms; Insurance; SWOT analysis; Crisis management.

Practical

Techno-economic parameters for preparation of projects; Preparation of bankable projects for various biotechnology/ agricultural products and value-added products; Identification of marketing channel; Calculation of pricespread; Identification of market structure; Visit to different markets, market institutions; Study of SWC, CWC and STC; Analysis of information of daily prices; Marketed and marketable surplus of different commodities.

Suggested Readings

- *Acharya SS & Aggarwal NL. 2011. Agricultural Marketing in India. Fifth Edition. Oxford and IBH Publishing Company Pvt. Ltd.*
- *Ahuja HL. 2007. Advanced Economic Theory. S Chand and Company.*
- *Chandra P.1984. Projects: Preparation, Appraisal &I mplementation. McGraw Hill Inc.*
- *Dewett KK. 2005. Modern Economic Theory. S Chand and Company.*
- *Gupta RD & Lekhi RK. 1982. Elementary Economic Theory. Kalyani Publishers.*
- *Sampat Mukherjee. 2002. Modern Economic Theory. New Age International.*

Ent.- Pl. Path. 201: Fundamentals of Crop Protection (2L+1P)

Theory

UNIT-I

Insects-their general body structure; Importance of insects in agriculture; Life cycle of insects; Insects diversity; Feeding stages of insects and kinds (modifications) of mouth parts; Concepts in population build-up of insects–GEP, DB, EIL, ETH and pest status; Causes of insect-pests outbreak; General symptoms of insects attack; Principles and methods of insect-pests management; Integrated Pest Management concept; Bio-ecology and management of important pests of major crops and storage products.

UNIT-II

Importance and scope of plant pathology; Concept of disease in plants; Nature and classification of plant diseases; Importance and general characters of fungi, bacteria, fastidious bacteria, nematodes, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa and phanerogamic parasites; Pathogenesis due to obligate and facultative parasites; Variability in plant pathogens; Conditions necessary for development of disease epidemics; Survival and dispersal of plant pathogens; Management of key diseases and nematodes of major crops.

Practical

Familiarization with generalized insect's body structure and appendages; Life stages; Acquaintance with insect diversity; Identification of important insect-pests of cereals, cotton, oilseeds, pulses, sugarcane, fruit and vegetables crops and stored-grains, and their symptoms of damage; Acquaintance with useful insects: predators, parasitoids, pollinators, honey bees and silk worms; Acquaintance with various pesticidal formulations; Principles and working of common plant protection appliances; Calculation for preparing spray material; Acquaintance to plant pathology laboratory equipment; Preparation of culture media for fungi and bacteria; Demonstration of Koch's postulates; Study of different groups of fungicides and antibiotics and methods of their evaluation; Diagnosis and identification of important diseases of cereals, cotton, oilseeds, pulses, sugarcane, fruit and vegetables crops and their characteristic symptoms.

Suggested Readings

- *Agrios, GN. 2010. Plant Pathology. Acad. Press.*
- *Atwal AS & Dhaliwal GS. 2002. Agricultural Pests of South-Asia and Their Management. Kalyani Publishers.*
- *Dhaliwal GS & Arora R.1996. Principles of Insect Pest Management. National Agriculture Technology Information Centre.*
- *Dhaliwal GS, Singh R & Chhillar BS. 2006. Essentials of Agricultural Entomology. Kalyani Publishers.*
- *Mehrotra RS & Aggarwal A. 2007. Plant Pathology. 7th Ed. Tata McGraw Hill Publ. Co. Ltd.*
- *Singh H. 1984. House-hold and Kitchen Garden Pests-Principles and Practices. Kalyani Publishers.*
- *Singh RS. 2008. Plant Diseases. 8th Ed. Oxford & IBH. Pub. Co.*
- *Singh RS. 2013. Introduction to Principles of Plant Pathology. Oxford and IBH Pub. Co.*
- *Stakman EC & Harrar J G. 1957. Principles of Plant Pathology. Ronald Press, USA.*
- *Tarr SAJ. 1964. The Principles of Plant Pathology. McMillan, London.*
- *Vander Plank, JE. 1975. Principles of Plant Infection. Acad. Press.*

Math. 201: Biomathematics (2L+1P)

Theory

UNIT-I

Rolle's theorem; Lagrange's theorem; Taylor's and Maclaurin's series; Partial differentiation, Euler's theorem on homogeneous function, change of variable; Jacobian, maxima and minima of two or more than two variables eigen values and eigen vectors of a matrix; Reduction formulae, definite integrals and its applications.

UNIT-II

Solution of ordinary differential equation of first degree and first order and their application for determination of volume of blood and drug distribution; Epidemic models, Simultaneous differential

equation of first order and their applications to predator models; Linear differential equations of higher order and their applications to simple biological problem; Numerical methods for solving algebraic and transcendental equations.

Practical

Tutorials on Taylor's and Maclaurin's expansions; Partial differentiation; Euler's theorem; Change of variable, total derivative, implicit function, maxima and minima, eigen values and eigen vectors of matrix, reduction formulae, definite integrals and their properties; Epidemic models, predator models; Determination of volume of blood and drug distribution; Ordinary differential equation of first order, linear differential equation of higher older and their applications to biological problems, numerical methods.

Suggested Readings

- *Grewal BS.2013.Higher Engineering Mathematics. Khanna Publishers, India.*
- *Rastogi SK. 2008. Biomathematics. Krishna Prakashan Media Pvt. Ltd.*
- *Srivastava AC & Srivastava PK. 2011. Engineering Mathematics. Vol. I. PHI Learning Pvt. Ltd.*
- *Srivastava AC & Srivastava PK. 2011. Engineering Mathematics. Vol. III. PHI Learning Pvt. Ltd.*

Biotech. 201: Recombinant DNA Technology (2L+1P)

Theory

UNIT-I

Recombinant DNA technology; Restriction endonucleases: Types and uses; DNA ligases; Vectors: plasmids, cosmids, phagemids, BACs, PACs, YACs, transposon vectors, expression vectors, shuttle vectors, binary plant vectors, co-integrating vectors.

UNIT-II

Competent cells; Gene isolation and cloning; Genetic transformation of *E. coli*; Gel electrophoresis; Preparation of probes; Southern blotting; Northern blotting; Western blotting; PCR and gene amplification.

Practical

Orientation to recombinant DNA lab; preparation of stock solutions and buffers; Plasmid DNA isolation; Genomic DNA isolation; Quality and quantity determination of DNA; restriction digestion of DNA; Agarose gel electrophoresis, SDS-PAGE; PCR; Genetic transformation of *E. coli*; Screening of recombinant DNA clones in *E. coli*.

Suggested Readings

- *Brown TA. 1998.Genetics: A Molecular Approach. 3rd Ed. Stanley Thornes.*
- *Singer M & Berg P.1991.Genes & Genome. University Science Books.*
- *Winnacker EL. 2003. From Genes to Clones: Introduction to Gene Technology. 4th Ed. Panima Publishers.*
- *Watson JD & Zoller M. Recombinant DNA. 3rd Ed. Panima Publishers*

PB 201: Breeding of Field Crops (2L+1P)

Theory

Unit-I

Application of genetic, cytogenetic and biotechnological techniques in breeding of: Wheat, triticale, rice, maize, bajra, barley, sorghum, cotton, sugarcane, important pulses, oilseeds and forage crops including their origin and germplasm sources.

Unit-II

Problems and present status of crop improvement in India with emphasis on the work done in state National and International centres of crop improvement.

Unit-III

Classes of seed; seed production and maintenance; seed storage; seed certification.

Practical

Emasculation and hybridization techniques; Handling of segregating generations : pedigree method, bulk method, back cross methods; Field layout of experiments; Field trials, maintenance of records and registers; Estimation of heterosis and inbreeding depression; Estimation of heritability; Parentage of released varieties/ hybrids; Study of quality characters; Sources of donors for different characters; seed sampling; seed quality; seed viability; seed vigour; seed health testing; Visit to seed production plots.

Suggested Readings

- *Chopra VL. 2001. Breeding Field Crops.Oxford and IBH Publishing Co.*
- *Fehr WR. 1987. Principles of Cultivar Development, Vol. II Crop Species. MacMillan Publishing Co.*
- *Sleper DA & Poehlman JM.2006. Breeding Field Crops.Wiley-Blackwell.*

Semester – IV

EDBM 201: Entrepreneurship Development and Business Management (1l+1P)

Theory

UNIT- I

Concept of entrepreneur; Entrepreneurship development; Assessment of entrepreneurship skills; SWOT analysis and achievement motivation; Entrepreneurial behaviour; Government policy and plan for entrepreneurship development; Setting up of a new entrepreneurial venture; Environmental factors influencing entrepreneurship; Constraints in setting up of agro based industries;

UNIT- II

Definition of business; Value chain concept in business; Stakeholders in business; Stages of Indian business; Importance of agribusiness in Indian economy and factors transforming Indian agribusiness; Government as a regulatory body in agribusiness; Opportunities and challenges to Indian agribusiness.

UNIT- III

Management: Definition, importance and functions; Levels of management; Planning: Definition, steps in planning, types of plan; Organizing: Meaning of organizing and organization;

Developing leadership skills; Encoding and decoding communication skills; Developing organizational and managerial skill; Problem solving skill; Supply chain management and total quality management; Project planning, formulation and report preparation.

Practical

Preparation of project report for starting a new venture; Case studies of successful entrepreneurs, analysis and discussion; Preparation of complete marketing plan of selected product/service; Case studies related to project management; Visits to industrial and agri-business houses; Numerical problems; Preparation of project report for various business ventures.

Suggested Readings

- *Harold Koontz & Heinz Weihrich. 2004. Essentials of Management: An International Perspective, 2nd Ed. Tata Mc-Graw Hill Publishing Pvt Ltd.*
- *Mukesh Pandey & Deepali Tewari. 2010. The Agribusiness Book. IBDC Publishers.*
- *Nandan H. 2011. Fundamentals of Entrepreneurship. PHI Learning Pvt Ltd India.*
- *Philip Kotler, Kavin Lane Keller, Abraham Koshy & Mithileshwar Jha. 2012. Marketing Management: A South Asian Perspective. Pearson Education.*
- *Poornima Charantimath. 2006. Entrepreneurship Development: Small Business Enterprise. Pearson Education.*
- *Stephans P Robbins & Mary Coulter. 2003. Management. Pearson Education.*

Biochem. 201: General Biochemistry (3L+1P)

Theory

UNIT-I

Introduction and importance; Cell structure; Biomolecules: Carbohydrates, lipids, proteins and nucleic acids-structure, functions and properties; Enzymes: Classification, factors affecting activity; Structure and role of water in biological system; Acids, bases and buffers of living systems; The pK of biomolecules; Vitamins and hormones.

UNIT-II

Bioenergetics; Metabolism - basic concept: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Oxidative phosphorylation, Fatty acid oxidation; General reactions of amino acid degradation; Biosynthesis-carbohydrates, lipids, proteins, nucleic acids.

UNIT-III

Secondary metabolites: Terpenoids, alkaloids, phenolics and their applications in food and pharmaceutical industries.

Practical

Qualitative tests for carbohydrates, amino acids, proteins and lipids; Extraction and characterization of lipids by TLC; Determination of acid, iodine and saponification values of oil; Extraction, quantitative estimation and separation of sugars by paper chromatography; Determination of phenols; Determination of free amino acids and proteins.

Suggested Readings

- *Berg JM, Tymoczko JL & Stryer L. 2002. Biochemistry. 5th Ed. W.H. Freeman & Co.*
- *Com EE & Stumpf PK. 2010. Outlines of Biochemistry. 5th Ed. John Wiley Publications.*
- *Goodwin TW & Mercer EI. 1983. Introduction to Plant Biochemistry. 2nd Ed. Oxford, New York. Pergaman Press.*
- *Murray RK, David B , Botham KM & Kennelly PJ. 2012. Harper's llustrated Biochemistry. 29th Ed. Lange Medical Books/ Mc. GrawHill.*
- *Nelson DL & Cox MM. 2000. Lehninger Principles of Biochemistry. 5th Ed. C.B.S Publilshers, Prentice Hall.*
- *Wilson K & Walker J. 1994. Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed. Cambridge University Press.*

Biotech. 202: Introductory Bioinformatics (2L+1P)

Theory

UNIT-I

Introduction to bioinformatics; Development and scope of bioinformatics; Applications of computers in bioinformatics: Operating systems, hardware, software, Internet, wwwresources, FTP.

UNIT-II

Primary databases: Nucleotide sequence databases (GenBank,EMBL), protein sequence databases; Secondary databases: SwissProt/TrEMBL,conserved domain database, Pfam;

Structure databases: Protein Data Bank(PDB), MMDB, SCOP, CATH; Fileformats: Genbank, EMBL, Fasta, PDB, Flatfile, ASN.1, XML.

UNIT-III

Introduction to sequence alignment and its applications: Pair wise and multiple sequence alignment, concept of local and global alignment; Algorithms: Dot Matrix method, dynamic programming methods (Needleman–Wunsch and Smith–Waterman); Tools of MSA: Clustal W, TCoffee; Phylogeny; Introduction to BLAST and FASTA.

Practical

Basic computing: Introduction to UNIX, LINUX; Nucleotide information resource: EMBL, GenBank, DDBJ, Unigene; Protein information resource: SwissProt, TrEMBL, Uniprot; Structure databases: PDB,

MMDB; Search Engines: Entrez, ARSA, SRS; Similarity Searching: BLAST and interpreting results; Multiple sequence alignment: Clustal W; Structure visualization of DNA and proteins using Rasmol.

Suggested Readings

- *Baxevanis AD & Ouellette BFF. 2001. Bioinformatics: A practical guide to the analysis of genes and proteins. John Wiley and Sons.*
- *Mount DW.2001. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor.*
- *Xiong J.2006.Essential Bioinformatics. Cambridge University Press.*

Biotech. 203: Plant Genetic Transformation (2L+1P)

Theory

UNIT-I

History of plant genetic transformation; Generation of gene construct and maintenance; Genetic transformation: *Agrobacterium* mediated, biolistics, electroporation, liposome, Polyethyleneglycol, *in planta* methods.

UNIT-II

Selection and characterization of transgenic plants using selectable and reportable markers; PCR; qRT-PCR; Southern, Northern, ELISA and Western techniques; Application of genetic transformation: for quality, yield, biotic, and abiotic stresses; Biosafety aspects of transgenic plants and regulatory framework.

Practical

Preparation of stock solutions, Preparation of competent cells of *Agrobacterium tumefaciens*; Restriction mapping of plasmid, Construction of binary vector and its transfer to an *Agrobacterium* strain; Confirmation of transformed bacterial colonies; *Agrobacterium tumefaciens* mediated and biolistic plant transformation; Colony hybridization.

Suggested Readings

- *Green & Sambrook. 2014. Molecular Cloning: A Laboratory Manual. 4thEd. 3 Vol Sets. Cold Spring Harbor Laboratory Press.*
- *Grierson D.2012. Plant Genetic Engineering. Springer Netherlands.*
- *Primose SB & Twyman RM. 2006. Principles of Gene Manipulation and Genomics, 7th Ed. Black Well Publishing.*
- *Sambrook J, Russel D. 2001.Molecular Cloning: A Laboratory Manual. 3rd Ed Cold Spring Harbor Laboratory Press.*
- *Stewart NCJr. 2008. Plant Biotechnology and Genetics: Principles,Techniques and Applications. John Wiley & Sons Inc.*

Biotech. /ECE 204: Electronics and Instrumentation in Biotechnology (1L+1P)

Theory

UNIT-I

Electronics

PN junction diode, diode forward and reverse characteristics; Diode as a circuit element; Application of PN junction diode such as: half wave, full wave bridge rectifier, clipper, clamper and voltage multiplier circuit; Construction and working of bipolar transistor, load line concept,analysis and design of various biasing methods of NPN transistor with common emitter configuration; AC model and analysis of small signal NPN transistor with common emitter configuration; Concept of generalized instrumentation system; Transducers for the measurement of temperature using thermometer and thermocouple, linear displacement measurement using LVDT; Force measurement using the strain gauge.

UNIT-II

Principles and working of laboratory equipments: Tabletop, refrigerated and ultra-centrifuges; Laminar air flow; Autoclaves, pH meter; Fermenters; Temperature control shakers, BOD shakers; Gel electrophoresis, 2-D gel electrophoresis, gel documentation, gel driers; ELISA readers; Freezedriers/lypholizers; Spectrophotometers; Genepulser; Particlegun; Plant growth chambers; Thermal cyclers; Realtime PCR; DNA synthesizer; DNA sequencer; Microscopes: Light, stereo, phase contrast and inverted.

Practical

To familiarize laboratory equipment and its equipment working; Forward and reverse VI Characteristics of a PN junction diode; To study half wave, full wave and bride rectifier using diode; Clipper, Clamper and Voltage multiplier circuit; To determine input V-I Characteristicss of bipolar transistor for common emitter configuration; To determine output V-I Characteristicss of bipolar transistor for common emitter configuration;To analyse abiasing circuits for CE transistor; To design and test a biasing circuits for CE transistor; To study the measure of temperature using the available sensor; To measure displacement with the available sensor; To study force with the available sensor.

Suggested Readings

- *Edward William Golding & Frederick Charles Widdis. 1969. Electrical Measurements and Measuring Instruments. Pitman.*
- *Gupta JB. 2009. Basic Electronics. S.K. Kataria & Sons.*
- *Malvino.2007. Electronics Principles.Tata McGraw-Hill Education.*
- *Manhas P & Thakral S. 2010. Digital Electronics. S.K. Kataria & Sons.*
- *Sharma Sanjay. 2012. Electronics Devices & Circuits. S.K. Kataria & Sons.*

Biotech. 205: Classical and Molecular Cytogenetics (2L+1P)

Theory

UNIT-I

Introduction and history; Mitosis and meiosis; Structure of chromatin; Chromosome structure and chromosome landmarks; Specialized chromosomes; Differential staining of the chromosomes-Q-banding, G-banding, C-banding, R-banding; *In situ* hybridization-FISH, GISH.

UNIT-II

Changes in chromosome number: aneuploidy -monosomy, trisomy and tetrasomy, haploidy and polyploidy- auto-polyploidy and allopolyploidy; Methods of doubled haploid production; Structural aberrations of chromosomes: deletions, duplications, inversions and translocations; Locating genes on chromosomes; Genome analysis.

Practical

Preparation of chromosome stains; Pollen fertility; Preparation of mitotic and meiotic slides of plant/animal cells; Preparation of karyotypes; C/G banding of the chromosomes; Genomic *in situ* hybridization; Micro-photography.

Suggested Readings

- *Becker K & Hardin. 2004. The World of Cell. 5th Ed. Pearson Edu.*
- *Carroll M.1989. Organelles. The Guilford Press.*
- *Charles B.1993.Discussions in Cytogenetics. Prentice Hall.*
- *Gupta PK. 2007.Cytogenetics. Rastogi publications.*
- *Khush GS.1973. Cytogenetics of Aneuploids. Academic Press.*
- *Mahabal Ram.2010. Fundamentals of cytogenetics and genetics. PHI Learning Pvt. Ltd.*
- *Yao-Shan Fan. 2002. Molecular Cytogenetics: Protocols and Applications. Humana Press.*

Micro. 201: Microbial Genetics (2L+1P)

Theory

UNIT-I

Microorganisms as tools for genetic studies; Genetic variability in microorganisms; Genetic analysis of representative groups of bacteria, fungi and viruses; Random and tetrad spore analysis; Recombination and chromosomal mapping; Complementation-intergenic and intragenic.

UNIT-II

Bacterial plasmids; Structure, life cycle, mode of infection and their role in genetic engineering; Transfer of genetic material in bacteria: Conjugation, transformation and transduction; Genetics of bacteriophage: T4, lambda and M13 - fine structure of gene, life cycle, mode of infection; Mutation: types, mutagens, DNA damage and repair; Transposable elements; Lac operon; Yeast genetics.

UNIT-III

Concept and application of recombinant DNA technology; Use of genetic tools to improve the microbial strains with respect to industry, agriculture and health.

Practical

Conjugation and transformation in bacteria; Spontaneous and auxotrophic mutation; Chemical and UV mutagenesis in fungi and bacteria; Complementation in fungi; Identification of mutants using replica

plating technique; Isolation of genomic DNA from *E. coli*; Isolation and curing of plasmid; Identification of plasmid by electrophoresis/antibiotic plates.

Suggested Readings

- *Birge EA. 1981.Bacterial and Bacteriophage Genetics. Springer Verlag.*
- *Gardner JE, Simmons MJ & Snustad DP. 1991. Principles of Genetics. John Wiley & Sons.*
- *Lewin B. 1999.Gene. Vols. VI-IX. John Wiley & Sons.*
- *Maloy A & Friedfelder D. 1994.Microbial Genetics. Narosa.*
- *Scaife J, Leach D & Galizzi A 1985. Genetics of Bacteria. Academic Press.*
- *William Hayes 1981. Genetics of Bacteria. AcademicPress.*

Phy. 201: Biophysics (2L+1P)

Theory

UNIT-I

Quantum mechanics; Electronics tructure of atoms; The wave particle duality, wave length of de-Broglie waves; Phase and group velocity; Some basic concepts of quantum mechanics; Schrodinger's wave equations; Particle inabox; Quantum mechanical tunneling; Ist and IInd law of thermodynamics; Enthalpy; Entropy; Statistical and thermodynamic definition of entropy; Helmholtz free energy, Equilibrium thermo-dynamic; Near-equilibrium thermodynamic; Gibbs freeenergy; Chemical potential; Thermodynamic analysis of membrane transport.

UNIT-II

Hydration of macromolecules; Role of friction; Diffusion; Sedimentation; The ultracentrifuge; Viscosity; Rotational diffusion; Light scattering, Small angle x-ray scattering; Ultraviolet and visible spectroscopy; Circular dichroism (CD) and optical rotatory dispersion (ORD); Fluorescence spectroscopy; Infrared spectroscopy; Raman spectroscopy; Electron spin resonance; NMR spectroscopy; Light microscopy.

UNIT-III

Electronoptics; Transmissionelectronmicroscope (TEM); Scanningelectronmicroscope (SEM); Preparation of the specimen for electron microscopy; Image reconstruction; Electron diffraction; Tunnelling electron microscope; Atomic force microscope; Crystals andsymmetries, crystal systems, point group and space groups; Growth of crystals of biological molecules; X-raydiffraction.

Practical

Refractive index and dispersive power of the prism using spectrometer; Calibration of prism spectrometer; Newton' srings; Polarimeter; Diffraction grating; Resolving power of telescope and grating; Ostwald viscometer; Planck's constant using photo voltaic cell; Photo spectrometer; Photo electric effect; Stefan's constant; Thermal diffusivity in metals.

Suggested Readings

- *Chang R.2005. Physical Chemistry for the Biosciences. University Science Books.*
- *Glaser.2012. Biophysics. Springer.*
- *Pattabhi V & Gautam N.2002.Biophysics. Narosa Publishing House.*
- *Rodney Cotterill. 2002. Biophysics: AnIntroduction.JohnWiley&Sons.*
- *Srivastava P K. 2006. Elementary Biophysics: An Introduction. Narosa Publishing House.*

Semester – V

Biochem. 301: Enzymology and Enzyme Technologies (2L+1P)

Theory

UNIT-I

Classification and nomenclature of enzymes; General characteristics of enzymes, active site, cofactors, prosthetic groups; Metallo enzymes; Isolation, purification, characterization and assays of enzyme and international units; Criteria for purity.

UNIT-II

Enzyme kinetics: effect of pH, temperature, determination of Km and Vmax; Regulation of enzyme activity; Enzyme inhibition: competitive, non-competitive and uncompetitive; Isoenzymes, schizomers and isoschizomers; Ribozymes; Immobilization of enzymes; Applications of enzymes: biotechnology, industry, environment, agriculture, food andmedicine.

Practical

Isolation, purification and assay of enzymes; Determination of optimum pH and optimum temperature of enzymes; Thermostability of enzymes; Activators and inhibitors of enzyme catalysis; Determination of kinetic parameters of enzymes; Immobilization of enzymes; Isoenzymes analysis.

Suggested Readings

- *Bisswanger H. 2011. Practical Enzymology. 2nd Ed. Wiley-Blackwell.*
- *Cook PF & Cleland WW. 2007. Enzyme Kinetics and Mechanism. Garland Publishing Inc.*
- *Cornish-Bowden A.2012. Fundamentals of Enzyme Kinetics.4thEd. Wiley-Blackwell.*
- *Price NC & Stevens L. 1999. Fundamentals of Enzymology: Cell and Molecular Biology of Catalytic Proteins. 3rd Ed. Oxford University Press.*

Bioteh. 301: Immunology (2L+1P)

Theory

UNIT-I

History and scope of immunology; Components of immune system: organs, tissues andcells, Immunoglobulin structure and functions; Molecular organization of immunoglobulins and classes of

antibodies; Antibody diversity; antigens, haptens, antigens antibody interactions; Immuno-regulation and tolerance.

UNIT-II

Allergies and hypersensitive response; Immuno-deficiency; Vaccines; Immunological techniques; Immunological application in plant science, monoclonal antibodies and their uses; Molecular diagnostics.

Practical

Preparation of buffers and reagents; Precipitation and agglutination test; HA, HI test; Immuno blotting, immune electrophoresis and fluorescent antibody test; Enzyme-immuno assays including ELISA variants, western blotting; Raising of antisera in laboratory animals; Collection and preservation of antisera–separation, filtration and aliquoting.

Suggested Readings

- *Murphy K.2012.Janeway's Immuno Biology. 8thEd. Garland Science/Taylor & Francis Group.*
- *Owen JA, Punt J, Kuby J & Sharon A. 2013.Kuby Immunology. 7th Ed. W. H. Freeman.*

Bioteh. 302: Molecular Genetics (2L+0P)

Theory

UNIT-I

Structures, properties and modification of DNA; Molecular mechanisms of DNA replication, repair, mutation, and recombination; Centromere and telomere sequences and DNA packaging; Synthesis and processing of RNA and proteins; Regulation of gene expression; Mutations and DNA repair.

UNIT-II

Repetitive DNA sequences and transposable elements; Promoters and their isolation; Transcription factors – their classification and role in gene expression; Epigenetic control of gene expression; Small RNAs, RNA interference and its applications.

Suggested Readings

- *Allison LA. 2011. Fundamental Molecular Biology. Wiley Global Education.*
- *Brown TA. 1998. Genetics: A Molecular Approach. 3rd Ed. Stanley Thornes.*
- *Lewin B. 2009. Genes9. Jones & Bartlett Learning.*
- *Tropp BE. 2014. Principles of Molecular Biology. Jones & Bartlett Learning.*
- *Tropp BE. 2012. Molecular Biology Genesto Proteins. 4th Ed. Jones & Bartlett Learning.*

Bioteh. 303: Nanobiotechnology (2L+0P)

Theory

UNIT-I

Introduction to nanotechnology; Concepts and Terminology; Nano-Bio Interface; Biological based Nano-systems, molecular motors, biosensors and other devices.

UNIT-II

Self- assembly of molecules for nanotechnology applications; Biomimetics, Biotemplating and *de novo* designed nanostructures and materials; DNA-Nanotechnology; Nanomanipulations, material design, synthesis and their applications.

Suggested Readings

- *David E. Reisner. 2009.Bionanotechnology: Global Prospects. CRCPress.*
- *GaborL. Hornyak, John J. Moore, Tibbals HF., Joydeep Dutta. 2008. Fundamentals of Nanotechnology. CRCPress.*
- *Jesus M. de la Fuente, V. Grazu. 2012. Nanobiotechnology: Inorganic nanoparticles Vs Organic nano particles. Elsevier.*
- *Yubing Xie. 2012. The Nano biotechnology Handbook. CRCPress.*

Bioteh. 304: Animal Biotechnology (3L+1P)

Theory

UNIT-I

History and development of animal biotechnology; Basic techniques in animal cell culture: Introduction to embryo biotechnology: oocyte collection and maturation; Spermpreparation; in vitro fertilization; Cryopreservation of oocyte, sperm and embryos; Embryo transfer technology.

UNIT-II

Breeds of livestock and their characteristics; Marker assisted breeding of livestock; Introduction to animal genomics: RFLP, RAPD, SSRs, QTL, SNP, STR, Mitochondrial DNA polymorphism; Rumen and its environment: Rumen microbes-manipulation of rumen microbes for better utilization of feed; Introduction to nutrigenomics; Milk biome; Manipulation of lactation by biotechnological tools; Application of biotechnology in meat and meat products.

UNIT-III

Genome and protein based diagnostics of important animal diseases: FMD, brucellosis, PPR, Mastitis, Blue tongue, Newcastle disease; Introduction to vaccinology: live attenuated vaccines, killed vaccines, cell culture based vaccines, recombinant vaccines.

Practical

Basic cell culture techniques; oocyte aspiration from ovaries; sperm preparation; In vitro fertilization; PCR based detection of animal pathogens; PCR-RFLP; Immuno histochemical localization of protein marker in tissues/cells – meat species identification by PCREDIT

Suggested Readings

- *Aberle Elton D, Forrest John C, Gerrard David E & Mills Edward W. 2012. Principles of Meat Science. 5th Ed. Kendall Hunt Publishing.*
- *Lawrie& Ledward. Lawrie's. 2006. Meat Science. 7th Ed. Wood head Publishing. Sukumar De. 1997. Outlines of Dairy Technology. Oxford University Press- New Delhi.*

- *Sharma B D. 1999. Meat and Meat Products Technology: Including Poultry Products Technology. Jaypee Bros. Medical Publishers.*
- *Varnam A &Jane P. 1994. Milk and Milk Products: Technology, Chemistry and Microbiology. Sutherl and Springer Science & Business Media.*

Bioteh. 305: Molecular Marker Technology (2L+0P)

Theory

UNIT-I

Types of molecular markers-RFLP; PCR based markers like RAPD, SCAR, SSR, STS, CAPS, AFLP, SNP and their variants; Uses of molecular markers: Application as a genetic tool for genotyping and gene mapping; Mapping populations: F_2, DH, RILs, NILs; Bulked segregant analysis; Linkage maps; Physical maps.

UNIT-II

Application of molecular markers: Assessing genetic diversity, variety protection; Marker-assisted breeding for accelerated introgression of trait/transgene and quantitative traits; Human and animal health: Association with genetic-based diseases, Paternity determinations; Forensic studies.

Suggested Readings

- *Huges S & Moody A. 2007. PCR: Methods Express. Royal College of General Practitioners.*

Bioteh. 306: Genomics and Proteomics (3L+0P)

Theory

UNIT-I

Introduction to Genomics, Functional Genomics and Proteomics; Structural genomics: Classical ways of genome analysis, BAC and YAC libraries; Physical mapping of genomes; Next generation sequencing; Genome analysis and gene annotation; Genome Projects: *E. coli*, Arabidopsis, Bovine, Human; Comparative Genomics: Orthologous and Paralogous sequences, Synteny, Gene Order, Phylogenetic foot printing.

UNIT-II

Functional genomics: Differential gene expression techniques: ESTs, cDNA-AFLP, microarray, Differential display, SAGE, RNAseq, Realtime PCR EDIT

UNIT-III

Introduction to proteomics; Analysis of proteome: Native PAGE, SDS PAGE, 2D PAGE; Edmann Degradation; Chromatographic techniques: HPLC, GC, Mass Spectrometry: MALDI-TOF, LC-MS; Post Translational modifications.

Suggested Readings

- *Branden C & Tooze J.l999. Introduction to Protein Structure. 2nd Ed. Garland Science.*
- *Connor DO & Hames BD. 2007. Proteomics: Methods Express. Royal College of General Practitioners.*

- *Pennington SR & Dunn MJ. 2001. Proteomics from protein sequence to function. BIOS Scientific Publishers Ltd.*
- *Singer M & Berg P.1991.Genes & Genome. University Science Books.*
- *Tropp BE. 2012. Molecular Biology Genes to Proteins. 4th Ed.J ones & Bartlett Learning.*

Bioteh. 307: IPR, Biosafety and Bioethics (2L+0P)

Theory

UNIT-I

Introduction to Intellectual Property, concepts and types; International treaties for protection of IP's; Indian Legislations for the protection of various types of Intellectual Property; Patent search, filing process; Material transfer agreements.

UNIT-II

Biodiversity definition, importance and geographical causes for diversity; Species and population biodiversity, maintenance of ecological biodiversity hot spots in India; Convention on biological diversity; Cartagena Protocol of bio-safety, and risk management for GMO's; Bio-safety guidelines, rules and regulations and regulatory frame work for GMOs in India.

Suggested Readings

- *Singh B D. 2007. Biotechnology: Expanding Horizon. Kalyani Publishers.*
- *http://patentoffice.nic.in*
- *www.wipo.org*
- *www.dbtindia.nic.in*
- *www.dbtbiosafety.nic.in*

ICT 301: Agricultural Informatics (2L+1P)

Theory

UNIT-I

Introduction to computers; Anatomy of computers; Memory concepts, units of memory; Operating system, definition and types; Applications of MS-Office for creating, editing and formatting a document; Data presentation, tabulation and graph creation; Statistical analysis, mathematical expressions; Database, concepts and types, creating database; Uses of DBMS in Agriculture; Internet and World Wide Web (WWW), concepts, components and creation of web; HTML & XML coding.

UNIT-II

Computer programming, concepts; Documentation and programme maintenance; Debugging programmes; Introduction to Visual Basic, Java, Fortran, C/ C++, etc.; Standard input/output operations; Variables and

constants; Operators and expressions; Flow of control; Inbuilt and user defined functions; Programming techniques for agriculture.

UNIT-III

e-Agriculture, concepts, design and development; Application of innovative ways to use information and communication technologies (IT) in agriculture; ICT for data collection; Formation of development programmes, monitoring and evaluation; Computer models in agriculture: statistical, weather analysis and crop simulation models - concepts, structure, input-output files, limitations, advantages and application for understanding plant processes, sensitivity, verification, calibration and validation; IT application for computation of water and nutrient requirement of crops; Computer-controlled devices (automated systems) for agri-input management; Smart phone mobileapps in agriculture for farm advice, marketprice, post-harvest management, etc; Geospatial technology, concepts, techniques, components and uses for generating valuable agri-information; Decision support systems, taxonomy, components,framework, classification and applications in agriculture; Agriculture Information/Expert System;Soil Information Systems, etc. for supporting farm decisions; Preparation of contingent crop-planning and crop calendars using IT tools.

Practical

Study of computer components, accessories; Practice of important DOS commands; Introduction of different operating systems such as windows, Unix, Linux; Creating files and folders; File management; Use of MS-WORD and MS Power point for creating, editing and presenting a scientific document; Handling of tabular data; Animation, video tools, art tool, graphics, template and designs; MS-EXCEL-Creating as preadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data, handling macros; MS-ACCESS: Creating database, preparing queries and reports, demonstration of agri-information system; Introduction to World Wide Web (WWW) and its components, creation of scientific website, presentation and management agricultural information through web; Introduction of programming languages- Visual Basic, Java, Fortran, C, C++, and their components; Hands-on practice on writing small programmes; Hands-on practice on Crop Simulation Models (CSM);DSSAT/Crop-Info/CropSyst/ Wofost; Preparation of input file for CSM and study of model outputs; Computation of water and nutrient requirements of crop using CSM and IT tools; Use of smart phones and other devices in agro-advisory and dissemination of market information; Introduction of Geospatial Technology; Demonstration of generating information important for agriculture; Hands on practice on preparation of Decision Support System.

Suggested Readings

- *Gurvinder Singh, Rachhpal Singh & Saluja KK. 2003. Fundamentals of Computer Programming and Information Technology. Kalyani Publishers.*
- *Harshawardhan P.Bal.2 003. Perl Programming for Bioinformatics.Tata McGraw-Hill Education.*
- *Kumar A. 2015. Computer Basics with Office Automation. IK International Publishing House Pvt Ltd.*
- *Maidasani D. 2016. Learning Computer Fundamentals, MS Office and Internet & Web Technology. 3rd edition, Laxmi Publications.*

Semester – VI

Biotech. 308: Computational Biology (2L+1P)

Theory

UNIT-I

Introduction to computational biology; Web based servers and software for genome analysis: Ensembl, UCSC genome browser, MUMMER, BLASTZ; Sequence submission.

UNIT-II

Protein interaction databases: BIND, DIP, GRID, STRING, PRIDE; Principles of Protein structure prediction; Fold Recognition (threading); Homology modeling; SCOP, CATH, PDB, PROSITE, P-FAM; Methods for comparison of 3D structures of proteins.

UNIT-III

Phylogenetic analysis: Evolutionary models, tree construction methods, statistical evaluation of tree methods; PHYLIP, dendroscope, MEGA;DNA barcoding database-BOLD.

Practical

Application of Genome browsers in genomic research; Exploring protein-protein interaction databases; Working with protein structural classification databases; SNP and SSR identification tools; PHYLIP.

Suggested Readings

- *Creighton TE. 1993.Proteins: Structures and Molecular Properties 2 nd Edition. W.H Freeman.*
- *DovStekel. 2003. Microarray Bioinformatics. 1stE d. Cambridge University Press.*
- *Mount D. 2001. Bioinformatics: Sequence and Genome Analysis, 2 ndEd. Cold Spring Harbor Laboratory Press.*
- *Malcolm Campbell A. & Laurie J. Heyer. 2007. Discovering Genomics, Proteomics and Bioinformatics. 2nd Ed. Benjamin Cummings.*
- *Setubal Joao & Meidanis Joao. 2004. Introduction to Computational Molecular Biology, PWS Publishing Company.*

Stat. 301: Biostatistics (2L+1P)

Theory

Unit-I

Random variables: expected value and its variance; probability distribution of random variables; Conditional probability; Baye's theorem and its applications; Introduction to Uniform, Binomial, Poisson, Normal, Exponential and Gamma probability distributions.

Unit-II

Random mating populations, Hardy-Weinberg Law; Introduction to Poisson process and Markov chains: Transition probability matrix, n-step transition probabilities, steady state. Random walk models; Sensitivity and specificity.

Unit-III

Chi-square test: testing heterogeneity, using enetic experiment, detection of linkage, linkage ratios and its estimation; Analysis of variance: One-way and two-way classification with interaction; Analysis of covariance; Incomplete block designs; Estimation and significance of genotypic and phenotypic variation.

Practical

Expected value and variance of discrete and continuous distributions; Uniform, Binomial, Poisson, Normal, Exponential and Gamma Probability distributions; Hardy-Weinberg Law; Construction of transition probability matrix in Markov Chains; Calculation of sensitivity and specificity; Detection and linkage using Chi-square test; One-way and two-way analysis of variance; Analysis of covariance; Incomplete block designs; Testing of heritability.

Suggested Readings

- *Biswal PC. 2009. Probability and Statistics. PHI Learning Pvt. Ltd.*
- *Kaps M & Lamberson W. 2007. Biostatistics for Animal Science. CABI Publishing.*
- *Narayan P, Bhatia VK & Malhotra PK. 1989. Handbook of Statistical Genetics. Indian Agricultural Statistics Research Institute, New Delhi, India.*
- *Pal N & Sahadeb Sarkar. 2009. Statistics–Concepts and Applications. 2nd Ed. PHI Learning Pvt. Ltd.*

ELECTIVES

Four Modules (Only one to be opted as per chosen elective)

1. Plant Biotechnology
2. Animal Biotechnology
3. MicrobialandEnvironmentalBiotechnology
4. Bioinformatics

(Semester VI): 18 Credit hours

Four electives each of 18 credit hours will be offered to B. Tech. Biotech. Students during VI semester of the degree programme. The students will have to choose only one out of the four electives.

ELECTIVE-I

PLANT BIOTECHNOLOGY

Biotech. 411: Plant Tissue Culture and its Applications (2L+1P)

Theory

UNIT-I

Historical benchmarks of plant cell and tissue culture; Culture media components and modifications; Sterilization techniques; Various types of culture: callus, suspension, nurse, root, meristem; *In vitro* differentiation: Organogenesis and somatic embryogenesis; Plant growth regulators: mode of action, effects on *invitro* culture and regeneration.

UNIT-II

Applications: Micropropagation; Anther and microspore culture; Somaclonal variation; *In vitro* mutagenesis; Production of secondary metabolites; Synthetic seeds; *In vitro* fertilization; Embryorescue in wide hybridization; Endosperm culture; Protoplast isolation, culture and regeneration; Somatic hybridization: cybrids, asymmetric hybrids; *In vitro* germplasm conservation.

Practical

Establishment of callus/ cell suspension cultures; Induction of plant regeneration; Micropropagation– Ex-plant establishment, shoot multiplication, root induction, Hardening and transfer to soil; Monitoring of growth and differentiation of cells, Seed/Embryo culture; Ovary culture, Anther/ pollen culture, Suspension cultures and production of secondary metabolites.

Suggested Readings

- *Bhojwani SS & Razdan MK. 1996.Plant Tissue Culture: Theory and Practice. Elsevier.*
- *Debergh PC & Zimmerman RH. 1991. Micropropagation: Technology and Application. Kluwer Academic.*

- *Dixon RA & Gonzales RA. 2003. Plant Cell Culture: A Practical Approach. Oxford University Press.*
- *George EF, Hall MA & Klerk GJD. 2007. Plant Propagation byTissue Culture. 3rd Ed. Volume Springer Science &B usiness Media.*

Biotech. 412: Principles and Applications of Plant Genetic Transformation (2L+1P)

Theory

UNIT-I

Gene transfer methods: Direct and Indirect; Marker free transformation; *In planta* transformation; Vectors for plant transformation, molecular characterization of transgenic plants using PCR, realtime PCR, Southern, Northern and western analysis; Bioassays with transgenic plants; Evaluation and selection of transgenic events for target trait.

UNIT-II

Genetic engineering of crop plants for useful traits: Over expression, inducible, tissue specific and gene silencing systems; Biosafety concerns and regulatory mechanisms; Commercialization of transgenic products, GMO's, transgenic plants for the production of biopharmaceuticals; Molecular farming of plants for applications in medicine systems, heterologous protein production in transgenic plants; Successful case studies.

Practical

Gene isolation and gene cloning; Gene constructs and their maintenance; *Agrobacterium* mediated genetic transformation; Particle gun mediated genetic transformation. Histochemical GUS assays; PCR screening of putative transgenic plants; Raising transgenic under containment and field conditions.

Suggested Readings

- *Bhojwani SS & Dantu PK. 2013. Plant Tissue Culture: An Introductory Text. Springer*
- *Brown TA. 2007. Gene Cloning & DNA Analaysis: An Introduction. 6th Ed. Wiley-Blackwell Publishing.*
- *Grierson D. 2012. Plant Genetic Engineering. Springer Netherlands.*
- *Lal R & Lal S.1990.Crop Improvement Utilizing Biotechnology.CRCPress.*
- *Primose SB & Twyman RM. 2006. Principles of Gene Manipulation and Genomics.7th Ed. Wiley-Blackwell Publishing.*

Biotech. 413: Applications of Genomics and Proteomics (2L+1P)

Theory

UNIT-I

Structure of genomes: *Arabidopsis*, rice, tomato, pigeon pea, wheat; DNA chips and their usein transcriptome analysis; Mutants and RNAi in functional genomics; Site directed mutagenesis; Transposon tagging; Transient gene expression: VIGS and FACS based, targeted genome editing technologies.

UNIT-II

Bio-informatics in proteomics: Protein 3D structure modelling (Homology modelling and crystallography); Proteome analysis; Protein- protein interaction: FRET, yeast two hybrid and co-immuno precipitation. Applications of genomics and proteomics in agriculture, human health and industry. Metabolomics and ionomics for elucidating metabolic pathways.

Practical

SDS-PAGE; 2D Electrophoresis; Protein characterization through HPLC; Specialized crop based genomic resourses: TAIR, Gramene, Grain genes, Maizedb, Phytozome, Cerealdb, Citrusdb; miRbase.

Suggested Readings

- *Connor DO & Hames BD. 2007. Proteomics: Methods Express. Royal College of General Practitioners.*
- *Pennington SR, Dunn MJ. 2001. Proteomics from protein sequence to function. BIOS Scientific Publishers Ltd.*
- *Singer M & Berg P. 1991. Genes & Genome. University Science Books.*
- *Tropp BE. 2012. Molecular Biology Genes to Proteins.4th Ed. Jones & Bartlett Learning.*
- *Verma PS & Agarwal VK. 2014. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Company Pvt. Ltd.*

Biotech. 414: Molecular Breeding in Field Crops (2L+1P)

Theory

UNIT-I

Principles of plant breeding; Breeding methods for self- and cross-pollinated crops; Heterosis breeding; Limitations of conventional breeding; Development of specific mapping populations.

UNIT-II

QTL mapping using structured populations; Fine mapping of genes/QTL; Map-based gene/QTL isolation and development of gene-based markers.

UNIT-III

Marker assisted selection (MAS): Fore ground and back ground selection; MAS for major and minor genes, Marker assisted pyramiding, Marker assisted recurrent selection; Transgenic breeding; MAS for specific traits with examples; Commercial applications of MAS.

Practical

Working on some genotyping and phenotyping datasets for Linkage mapping using softwares such as Mapmaker, MapDisto and QTL mapping softwares such as WinQTL cartographer; Use of gene based and closely linked markers for foreground selection for target traits in target crops; Marker assisted detection of the transgene.

Suggested Readings

- *Nagat T, Lorz H & Widholm JM. 2008. Biotechnology in Agriculture and Forestry.Springer.*
- *Trivedi PC. 2000. Plant Biotechnology: Recent Advances. Panima Publishers.*

Biotech. 415: Molecular Breeding of Horticultural Crops and Forest Trees (2L+1P)

Theory

UNIT-I

Reproductive biology of major fruit and forest crops; Basic methods of fruit crop improvement; Target traits in major fruit crops; Limitations of fruit crop breeding; Breeding methods of self- and cross-pollinated vegetable crops; Breeding of commercial flower crops.

UNIT-II

Molecular markers for germplasm characterization and genetic diversity analysis; Pseudo test cross mapping strategy in fruit crops; Molecular mapping in vegetable crops; Marker assisted breeding in horticultural crops and forest plants; Micropropagation for variety dissemination; Mutation breeding and characterization of mutants; Genomic resources for marker development; Transgenic approaches with tree crops and utility.

Practical

Modifications in DNA extraction methods for horticultural and forest crops; Agarose gel electrophoresis, and DNA quantification; Map maker; Diversity analysis using UPGMA; Identifying repeat sequences using MISA; Standard Gene cloning methods including construct making with the use of Restriction enzymes; DNA ligases and standard molecular approaches.

Suggested Readings

- *JS Bal. 2013. Fruit Growing.Kalyani Publishers.*
- *Kumar N. 2006. Breeding of Horticultural crops: Principles and Practices. New India Publishing Aagency.*
- *K.L. Chada. 2012. Handbook of Horticulture. ICAR.*
- *Kumar J. Prasad. 2010. Handbook of Fruit Production. Agrobios.*
- *Schnell R J & Priya darshan P M. 2012. Genomics of Tree Crops. Springer.*
- *Singh Jitender. 2014. Basic Horticulture. Kalyani Publishers.*
- *Singh Ranjit. 2012. Fruits. National Book Trust.*
- *Spangenberg G. 2001. Molecular Breeding of Forage Crops. Kluwer Academic Publishers.*
- *Victor Ray Garden, Frederick Charles Bnaford, Herry & Daggett HoDlorIr.1992.*
- *FundamentalsofFruitProduction.McGrawBookCompany.*

Biotech. 416: Epigenetics and Gene Regulation (2L+1P)

Theory

UNIT-I

DNA methylation and histone modifications: DNA methylases, methyl binding proteins and histone modifiers; Epigenetic changes in response to external stimuli leading to changes in gene regulation; Role of DNA methylation in plant development: mutant case studies.

UNIT-II

Introduction to small RNAs: History, biogenesis; *In silico* predictions, target gene identification, methylation of heterochromatin by het associated siRNAs; Gene regulation by small RNA Other classes of siRNAs; Role in epigenetics; Jacob-Monod model; RNA editing, Genome imprinting.

Practical

In silico study of structural components of histone modifiers and DNA methylases of model plants; *In silico* prediction of siRNAs and miRNAs; Small RNAs electrophoresis using PAGE; Blotting of small RNAs on nylon membrane; miRNA target finding; Detection of small RNAs using fluorescent labeled probes; Bisulphite sequencing for methylation; qRT-PCR for quantitative analysis of small RNAs in developmental phases.

Suggested Readings

- *Green& Sambrook. 2014. Molecular Cloning: A Laboratory Manual .4th Ed. VolI, II& III Cold Spring Harbor Laboratory Press.*
- *Mohanpuria P, Kumar V, Mahajan M, Mohammad H & Yadav SK. 2010. Gene Silencing: Theory, Techniques and Applications: Genetics-Research and Issues. Nova Science Publishers.*

ELECTIVE-II

ANIMAL BIOTECHNOLOGY

Biotech. 421: Principles and Procedures of Animal Cell Culture (2L+1P)

Theory

UNIT-I

History, importance and development of animal cell culture techniques; Basic requirements for animal cell culture; Sterilization procedures for cell culture work; Different types of cell culture media, growth supplements, serum free media and other cell culture reagents.

UNIT-II

Different cell culture techniques including primary and secondary cultures; continuous cell lines, suspension culture, organ culture etc; Commonly used animal cell lines: CHO, HeLa, BHK-21, VERO, Sf9, C636; Their origin and characteristic, growth kinetics of cells in culture, differentiation of cells; Characterization and maintenance of cell lines; Applications of animal cellcultures.

UNIT-III

Cryo preservation and revival of cells; Hybridoma technology; Scaling up methods; bioreactors; Overview of insect cell culture; Stem cell culture and its application; Common cell culture contaminants and their management.

Practical

Basic equipments used in animal cell culture laboratories; Washing, packing and sterilization of glass and plastic wares for cell culture; Preparation of media and reagents for cell culture; Primary culture technique of chicken embryo fibroblast; Culture and sub-culturing of continuous cell lines; Viability assay by trypan blue dye exclusion method; Isolation and cultivation of lymphocytes; Cryopreservation of primary cultures and cell lines; Cytopathic effect of viruses on cultured mammalian cells.

Suggested Readings

- *Butler M.2003. Animal Cell culture & Technology. Garland Science.*
- *Freshney RI. 2011. Culture of Animal Cells: A manual of basic technique and specialized applications. 6th Ed. John Wiley & Sons.*

Biotech. 422: Animal Genomics (2L+1P)

Theory

UNIT-I

Genome organization in eukaryotes; Satellite DNA: VNTRs & families, LINE & SINE; Sex determination: Chomosomal basis of sex determination, Molecular markers for sex determination, environmental sex determination; Chromosomal aberrations: Euploidy, Chromosomal Non-disjunction and Aneuploidy, Polyploidy, Induced Polyploidy, Syndromes, Structural aberrations, Robertsonian Translocations, Position Effect, Chromosomal Mosaics, Chromosomal aberrations and evolution.

UNIT-II

Molecular Markers: Markers, Genetic Markers: RAPD, STR, DNA fingerprinting, SSCP, RFLP, SNP, EST; SNP Analysis; karyotyping, Somatic cell hybridization; Radiation hybrid maps; FISH technique; Major Histocompatibility Complex: Concept and its relevance in disease resistance & immune response; Quantitative trait Loci; Marker Assisted Selection: Concept, Linkage Equilibrium, Application in Animal Sciences; Genomic Selection: Concept, Linkage Disequilibrium, Methodologies of economic Selection; Mitochondrial DNA analysis and its application in livestock; Applying DNA markers for breed characterization.

Practical

Extraction of genomic DNA from peripheral blood; Analysis of DNA by agarose or polyacrylamide gel electrophoresis; Checking the quality & quantity of genomic DNA; Restriction digestion & analysis; Sanger Sequencing data analysis; Extraction of mitochondrial DNA; Extraction of RNA from PBMC; Quality checking of total RNA; cDNA synthesis.

Suggested Readings

- *Brown TA. 2006. Genomes. 5th Ed. Wiley-Blackwell.*
- *Dale JW, Schantz MV & Plant N.2012. From Genes to Genomes: Concepts and Applications of DNA Technology. John Wiley & Sons.*
- *Green & Sambrook. 2014. Molecular Cloning: A Laboratory Manual. 4th Ed. VolI,II&III. ColdSpring.*
- *Reece RJ. 2004. Analysis of Genes & Genomes. Wiley.*

Biotech. 423: Embryo Transfer Technologies (2L+1P)

Theory

UNIT-I

History, advantages, limitations and scope of embryo transfer technology; Estrus cycle and its detection in animals; Methodology of super ovulation; Ovum pick up (OPU); Preparation of sperm for *in vitro* fertilization (IVF); Embryo grading and culture; Micromanipulation and immuno-modulation for enhancement of fecundity.

UNIT-II

Different methods of gene transfer and their limitations; embryo splitting; embryo sexing by different methods; production of transgenic livestock by nuclear transfer and its application; regulatory issues (social, ethical, religious and environmental); Cloning of domestic animals; Conservation of endangered species; Characterization of embryonic stem cells and applications.

Practical

Demonstration of estrus detection methods; Estrus synchronization; Superovulation; Oocyte collection from slaughter house ovaries; Grading of oocytes from slaughter house ovaries; collection and preparation of semen samples; *In vitro* fertilization; Collection of embryo susingnon-surgical procedures; Grading and culture of embryos; Embryo sexing by different methods; Embryo splitting; Embryo freezing.

Suggested Readings

- *Gordon I. 2004. Reproductive Technologies in Farm Animals. CABI.*
- *Hafez ESE. 2000. Reproduction in Farm Animals. Lippincott, Williams & Wilkins.*

Biotech. 424: Transgenic Animal Production (3L+0P)

Theory

UNIT-I

History of transgenesis; Isolation of gene, preparation of gene construct; Methods of transgenic animal production: Calcium chloride mediated transfection, lipofection, electroporation, microinjection, nano-delivery.

UNIT-II

Production of gene knockouts: cre-lox, zinc finger nucleases; CRISPR; TALENs; Production of chimeric animals; gene silencing by lentivirus system.

UNIT-III

Stem cell technology: Isolation and characterization of stem cell lines from different sources: embryo, mesenchymal, induced pluripotent stem cell; Introduction to animal cloning; Application of stem cells in transgenesis and animal cloning.

UNIT-IV

Fundamental assays of transgenic products: confirmation of integration of transgene; Validation of transgenic products like isolation of transgenic protein from milk and characterization; Application of transgenics in production of disease resistance models and carcinogenesis. Regulatory issues associated with transgenic animal production.

Suggested Readings

- *Ramadass P.2008.Animal Biotechnology: Recent Concepts and Developments.MJP Publishers.*
- *Ranga MM. 2007.Animal Biotechnology.Agrobios.*
- *Singh BD. 2010. Biotechnology expanding Horizons.Kalyani Publishers.*
- *Singh B. Gautam SK & Chauhan MS. 2014.Textbook of Animal Biotechnology.The Energy and Resources Institute, TERI.*

Biotech. 425: Molecular Diagnostics (2L+1P)

Theory

UNIT-I

Principle and applications of molecular diagnostic tests; Nucleic acid based diagnostics for detection of pathogenic organisms: Application of restriction endonuclease analysis for identification of pathogens; Polymerase chain reaction (PCR) and its variants; Reverse transcriptase polymerase chain reaction (RTPCR); isothermal amplification (LAMP); LCR, nucleic acid sequence-based amplification (NASBA); Real-Time PCR; DNA Probes; Southern blotting; Northern blotting; Protein based assays: SDS-PAGE, Western Blot, Dot-blot, ELISA and lateral flow device.

UNIT-II

Advantages of Molecular diagnostics over conventional diagnostics; sero-diagnostics; DNA array technology; Protein array; tissue array; Biosensors and nanotechnology; Development and validation of diagnostic tests.

Practical

Preparations of buffers and reagents; Collection of clinical and environmental samples for molecular detection of pathogens (bacteria/virus); Extraction of nucleic acids(DNA & RNA) from the clinical specimens; Restriction endonuclease digestion and analysis using agarose gel electrophoresis; Polymerase

chain reaction for detection of pathogens in blood and animal tissues; RT-PCR for detection of RNA viruses; PCR based detection of meat adulteration in processed and unprocessed meats; PCR based detection of pathogens in milk, eggs and meat; Lateral flow assay; ELISA.

Suggested Readings

- *Debnath M, Prasad GBKS & Bisen PS. 2010. Molecular Diagnostics: Promises and Possibilities. Springer Science & Business Media.*
- *Singh BD. 2010. Biotechnology expanding Horizons. Kalyani Publishers.*
- *Viljoen, GJ, Nel LH & Crowther JR. 2005.Molecular Diagnostic PCR Handbook. Springer Science & Business Media.*
- *Wilson K & Walker J.2010. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.*

Biotech. 426: Molecular Virology and Vaccine Production (2L+1P)

Theory

UNIT-I

Properties of viruses; Classification of viruses; Virus replication; Cell transformations, Cultivation of viruses, assay techniques for detection/quantification; Important Animal viruses; Virus-Host interactions; Viral infections; Immune responses to viruses: Interferon and other cytokines; Bio-safety and bio-security principles.

UNIT-II

Properties of an ideal vaccine; Classification of vaccines; Methods of inactivation and attenuation of viruses; New generation vaccines: subunit, synthetic, rDNA, marker and edible; Adjuvants and vaccine delivery systems; Novel immune-modulators and vaccine delivery using nanotechnology; Vaccine preparation: Stabilizers, preservatives and vehicles; Quality control and testing of vaccines; Sero-surveillance and sero-monitoring.

Practical

Processing of clinical specimens for isolation of viruses; Cultivation of viruses in cell cultures and embryonated eggs; Harvesting of virus; Study of cytopathic effects; Titration of virus and estimation of $TCID_{50}$; Haemagglutination and Haemagglutination Inhibition test; Detection of virusby SNT, AGID and ELISA.

Suggested Readings

- *John Carter J & Saunders V. 2007. Virology: Principles and Applications. 2ndEd.Wiley.*
- *Morrow WJW, Sheikh NA, Schmidt CS, Davies DH. 2012. Vaccinology: Principles and Practice. John Wiley & Sons.*
- *Sharma S & Adlakha S. 1996. Textbook of Veterinary Microbiology. Vikas Publishing House Pvt Ltd.*
- *Stephenson J & Warnes R. 1998. Diagnostic Virology Protocols. Springer Science & Business Media.*

ELECTIVE III

MICROBIAL AND ENVIRONMENTAL BIOTECHNOLOGY

Biotech. 431: Microbial Biotechnology (2L+1P)

Theory

UNIT-I

Microbial biotechnology, scope and techniques; Industrially important microorganisms; Gene transfer mechanisms in microbes: Transformation, transduction, conjugation and recombination; Genetic variability in microorganisms; Biotechnological tools to improve the microbial strains with respect to industry and agriculture.

UNIT-II

Biotransformation and biodegradation of pollutants, biodegradation of lignocelluloses and agricultural residues; Biotechnological treatment of waste water, sewage and sludge; Industrial production of alcohols, ethanol, acids (citricacid, aceticacid), solvents (glycerols, acetone, butanol), antibiotics (penicillin, streptomycine, tetracycline), amino acids (lysine, glutamic acid), single cell proteins; Recombinant and synthetic vaccines.

Practical

Isolation and preservation of industrially important microorganisms; Microbial fermentation, production of proteins and enzymes using bacteria, yeast and fungus; Microbial biomassproduction, utilization of plant biomass by recombinant microorganisms; Production of secondarymetabolitesfrommicrobes.

Suggested Readings

- *Glaze AN & Nikaido H. 2007. Microbial Biotechnology: Fundamentals of Applied Microbiology 2nd Ed. Cambridge University Press.*
- *Mohapatra PK. 2006. TextBook of Environmental Biotechnology. International Publishing House Pvt. Ltd.*

Biotech. 431: Bio-Prospecting of Molecules and Genes (3L+0P)

Theory

UNIT-I

Concepts and practices of bioprospecting; Traditional and modern bioprospecting; Geneprospecting; Isolation, synthesis and purification of new bioactive chemicals for laboratory. Clinical and field trials; Intellectual property rights, mechanisms and the legal framework; Patenting of new genes and/or bioactive principles with novel antibiotic, insecticidal or anti-tumour properties.

UNIT-II

Principles of the Convention on Biological Diversity, biodiversity conservation and biotechnology; Development and management of biological, ecological, taxonomic, and related systematic information on living species and systems.

UNIT-III

Bioprospecting of microorganisms and their components; Bioprospecting of biodiversity for new medicines: Identification and collection of material by random and traditional (medicinal) approaches; Screening for particular bio-activities; Elucidation of novel molecular form, processtechnology; Development of techniques for large scale industrial production of the final bioactiveproductanditsmarketavailabilityandaccessibilitytothepublic.

Suggested Readings

- *Mohapatra PK. 2006. Text Book of Environmental Biotechnology. International Publishing House Pvt. Ltd.*
- *Sharma PD. 2012. Ecology and Environment. 11th Ed. Rastogi Publications.*

Biotech. 433: Molecular Ecology and Evolution (3L+0P)

Theory

UNIT-I

Molecular Evolution: Concept, molecular divergence, and molecular clocks; Speciation and domestication; Evolution of Earth and earlier life forms; Primitive organisms, their metabolic strategies, and molecular coding; New approaches to taxonomical classification including ribotyping, Ribosomal RNA sequencing; Molecular tools in phylogeny, classification, and identification.

UNIT-II

Protein and nucleotide sequence analysis; Origin of new genes and proteins; Gene duplication and divergence; Genome evolution, components of genomes, whole-genome duplications, chromosome rearrangements, and repetitive sequence evolution.

UNIT-III

Application of molecular genetics and genomics to ecology and evolution; Assessment of genetic diversity, phylogeny, inbreeding, quantitative traits using molecular tools; Mutations; Regulations of gene expression.

Suggested Readings

- *Beebee, T., & Rowe, G. (2008). An Introduction to Molecular Ecology (2nd Ed). Oxford University Press.*
- *Brown, T. A. (2007). Genome 3. Garland Science Publishing.*
- *Carvalho, G. R. (2002). Advances in Molecular Ecology. IOS Press Netherlands.*

Biotech. 434: Fundamentals of Molecular Pharming and Biopharmaceuticals (2L+1P)

Theory

UNIT-I

Concept of molecular pharming and production of biopharmaceuticals; Mammalian cell culture manufacturing and microbial fermentation; Fermentation and cell culture processing; Protein

purification and processing; Industrial fermentation: batch and continuous cultures, production of biopharmaceuticals, immobilization techniques.

UNIT-II

Biopharmaceutical analytical techniques; Biopharma drug discovery and development; Production of specific vaccines and therapeutic proteins.

Practical

Isolation & purification of proteins from microbes and plants; Production of recombinant proteins in prokaryotes; Analysis of proteins by one and two-dimensional gel electrophoresis; Affinity chromatography; Immunoblotting; Cell culture and immobilization techniques. Visit to biopharmaceutical industry.

Suggested Readings

- *Brown, T. A. (2010). Gene Cloning and DNA Analysis: An Introduction (6th Ed). Wiley-Blackwell Publishing.*
- *Kirkosyan, A., & Kaufman, P. B. (2009). Recent Advances in Plant Biotechnology. Springer.*
- *Primrose, S. B., & Twyman, R. M. (2013). Principles of Gene Manipulation and Genomics. John Wiley & Sons.*

Biotech. 435: Food Biotechnology (2L+1P)

Theory

UNIT-I

Food Biotechnology: Introduction, history, and importance; Applications of biotechnology in food processing: Recent developments, risk factors, and safety regulations; Food spoilage and preservation process; Food and beverage fermentation: Alcoholic and non-alcoholic beverages, food additives and supplements.

UNIT-II

Industrial use of microorganisms; Commercially exploited microbes: Saccharomyces, Lactobacillus, Penecillium, Acetobactor, Bifidobacterium, Lactococcus and Streptococcus; Dairy fermentation and fermented products; Prebiotics and probiotics; Genetic engineering for food quality and shelf life improvement; Bioactive peptides; Labelling of GM foods.

Practical

Isolation, culture, and maintenance of biotechnologically important micro-organisms; Use of laboratory and industrial scale shakers; Batch and continuous cultures; Use of fermentors; Detection of pathogens in food and feed; Detection of GM food; Visit to food processing industry.

Suggested Readings

- *Hui YH & Khachatourians GG. 1995. Food Biotechnology: Microorganisms. Wiley-VCH.*
- *Shetty K, Paliyath G, Pometto A. & Levin RE. 2006. Food Biotechnology. 2nd Ed. CRC Press.*

Biotech. 436: Green Biotechnology (2L+1P)

Theory

UNIT-I

Green Biotechnology: Definition, concept, and implication; Bio-fertilizers and bio-pesticides; Plant growth-promoting rhizobacteria; Production of biofuels, biodiesel, and bioethanol; Biomass enhancement through biotechnological interventions; Generation of alternate fuels in plants; Identification and manipulation of micro-organisms for biodegradation of plastics and polymers; GMOs for bioremediation and phytoremediation, their roles; Strategies for detection and control of soil, air, and water pollutants.

UNIT-II

Carbon sequestration; Methanogenic microbes for methane reduction; Microbes for phytic acid degradation; Genetic Engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation, and nutrient uptake efficiency; Marker-free transgenic development strategies; Development of disease-resistant and pest-resistant crops through biotechnological tools.

Practical

Identification and efficiency assays of micro-organisms for biodegradation and bioremediation; Isolation of Bacillus thurigenesis and plant growth-promoting rhizobacteria; Production of biofertilizers, biopesticides, and biofuel; Assays for removal of oil spillage.

Suggested Readings

- *Kirkosyan A & Kaufman PB. 2009. Recent Advances in Plant Biotechnology. Springer.*
- *Kumar A. 2004. Environmental Biotechnology. Daya Publishing House.*
- *Murray DC. 2011. Green Biotechnology. Dominant Publishers and Distributors.*

ELECTIVE-IV

BIOINFORMATICS

Biotech. 441: Programming for Bioinformatics (2L+2P)

Theory

UNIT-I

Introduction: Operating systems, programming concepts, algorithms, flowchart, programming languages, compiler and interpreter; Computer number format: Decimal, Binary, Octal and Hexadecimal.

UNIT-II

C-Language: History, constants, variables and identifiers, character set, logical and relational operators, data input and output concepts; Decision-making: if statement, if-else statement, for loop, while loop and do-while loop; Arrays and functions, file handling; Programs related to arithmetic operations, arrays and file handling in C.

Practical

UNIT-I

PERL-Language: Introduction, variables, arrays, string, hash, subroutines, file handling, conditional blocks, loops, string operators and manipulators, pattern matching and regular expressions in PERL; Sequence handling in PERL demonstrating string, array and hash.

UNIT-II

Shell Programming: Concepts and types of UNIX shell, Linux variables, if statements, control and iteration, arithmetic operations, concepts of awk, grep and sed; Sequence manipulations using shell scripting.

Suggested Readings

- *Balagurusamy. 2008. Programming in ANSI C. Tata McGraw-Hill Education.*
- *James Tisdall. 2003. Mastering Perl for Bioinformatics. O'Reilly Media.*
- *Tom Christiansen, Brian D Foy, Larry Wall & Jon Orwant. 2012. Programming Perl. 4th Ed. O'Reilly Media.*
- *Kanetkar Yashavant. 2013. Let Us C. BPB Publications.*

Biotech. 442: Bioinformatics Tools and Biological Databases (2L+1P)

Theory

UNIT-I

Introduction: Biological data types, collection, classification schema of biological databases; Biological databases retrieval systems; Sequence and molecular file formats.

UNIT-II

Biological databases: Nucleotide database, protein database, structural database, genome databases, metabolic pathway database, literature database, chemical database, gene expression database, crop database with special reference to BTISNET databases.

UNIT-III

Bioinformatics Tools: Concept of alignment, scoring matrices, alignment algorithms, heuristic methods, multiple sequence alignment, phylogenetic analysis, molecular visualization tools.

Practical

NCBI; Expasy: SwissProt; EBI; Search engines: ENTREZ and SRS; Perform local alignment using all BLAST variants; Multiple sequence alignment using ClustalW; T Coffee; phylogenetic analysis by PHYLIP; MEGA.

Suggested Readings

- *Baxevanis AD, Ouellette BFF. 2001. Bioinformatics: A practical guide to the analysis of genes and proteins. John Wiley and Sons.*

- *Mount DW. 2001. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor.*
- *Xiong J. 2006. Essential Bioinformatics. Cambridge University Press.*

Biotech. 443: Structural Bioinformatics (2L+1P)

Theory

UNIT-I

Introduction to structural databases of macromolecules, natural and synthetic small molecules; Structure of amino acids; Protein structure classification, Ramachandran plot; Experimental structure determination methods; Motifs, domain, profiles, fingerprint, and protein family databases.

UNIT-II

Structural features of RNA, RNA secondary structure predictions; RNA folding; Small RNA prediction.

UNIT-III

Structure prediction: Basics of protein folding, protein folding problem, molecular chaperones; Secondary structure prediction methods and algorithms: Homology, ab initio, and folding-based tertiary structure prediction; Structure validation tools, energy minimization techniques; Introduction to molecular dynamics and simulation, Monte-Carlo methods, Markov chain and HMM; Structure visualization and comparison methods.

Practical

Protein structural classification databases, 3D-Structural databases searching and retrieval, Ramchandran Plot, Structural visualization tools, Tools for protein secondary and tertiary structure prediction; RASMOL, Cn3D, CHIMERA, SWISSPDB viewer, CPH, MODELLER, SWISSModel, EasyModeler, Procheck; GROMAC; SANJIVNI; BHAGIRATH.

Suggested Readings

- *A. Malcolm Campbell & Laurie J. Heyer. 2007. Discovering Genomics, Proteomics, and Bioinformatics. Benjamin Cummings.*
- *Allan Hinchkliffe. 2008. Modeling for Beginners. Wiley.*
- *Creighton TE. 1993. Proteins: Structures and Molecular Properties. W.H. Freeman.*
- *Mount DW. 2001. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor.*
- *Setubal Joao & Meidanis Joao. 1997. Introduction to Computational Molecular Biology. PWS Publishing Company.*

Biotech. 444: Pharmacogenomics (2L+1P)

Theory

UNIT-I

Basic concepts of pharmacogenomics, clinical application, and challenges in pharmacogenomics; Human Genome Project, genetic diseases, personalized medicine, and pharmacogenomics necessity in drug

designing; Prediction of structural changes among sequence variants and genetic analysis; Microsatellites for studying genetic variations; Drug databanks; Gene therapy.

UNIT-II

Drug Design: Study of important drug targets and their variations; Pharmacophore designing, prediction of ADME properties; Computational tool for toxicity prediction; SAR and QSAR techniques in drug designing; Drug receptor interactions; Structural-based drug design; Lipinski's rule in drug design.

Practical

Receptor-Ligand interactions, Pharmacophore development; OSDD; DrugBank; PubChem; molecular representation using SMILES; Chemsketch: 2D and 3D structure; Structure analyses using Chimera/ VMD; Detection of the active site of proteins using various software; bioavailability using Molinspiration; Docking using HEX and AUTODOCK.

Suggested Readings

- *Allan Hinchkliffe. 2008. Modeling for Beginners. Wiley-Blackwell Publishing.*
- *Gerd Folkers, Wolfgang Sippl, Didier Rognan & Hans Dieter. 2003. Molecular Modeling: Basic Principles and applications. Science.*
- *Gupta S.P. 1996. Quantum Biology. New Age.*
- *Lisa B. Combinatorial Library Methods and Protocols.*

Biotech. 445: Metabolomics and System Biology (2L+1P)

Theory

UNIT-I

Metabolomics overview, major metabolic pathways: Glycolysis, Kreb's cycle, oxidative phosphorylation, amino acid, fatty acid, and nucleotide metabolism, their control and integration; Metabolic flux and metabolic profiling; Catalytic mechanisms and enzyme kinetics, Michaelis-Menten kinetics; Conformational change, allosteric regulations, regulation of metabolic pathways; Signal transduction: Inter and intra-cellular communications; Receptor-ligand interaction; Structural components of signal pathways: G-protein, Jak-stat, receptor tyrosine kinase.

UNIT-II

Signal Flow: Pathway to networks, small-scale systems biology experiments; System analysis of complex diseases, system pharmacology; Assembling large data sets in genomics and proteomics, computational analysis of large data sets, building networks; Mathematical representation of cell biological system, time, and space.

Practical

Metabolic pathway databases KEGG, BRENDA, Biosilico, Protein-protein interaction databases, Swiss2DPAGE, E-PCR; Creating networks using Cytoscape, DAVID, MAS3; in silico functional annotation using GO, AGRIGO, PANTHER, BLAST2GO.

Suggested Readings

- *Berg JM, Tymoczko JL & Stryer L. 2002. Biochemistry. 5th Ed. W.H. Freeman and Company.*
- *Fersht A. 1999. Structure and Mechanism of protein science. W.H. Freeman and Company.*
- *Klipp E, Herwig R, Kowald A, Wierling C, Lehrach H. 2006. Systems Biology in practice. Concepts, implementation, and Application. Wiley VCH.*
- *Vaidynathan S, Harrigan GG, Royston Goodacre. 2005. Metabolome analysis: Strategies for system biology. Springer.*
- *Voet D & Voet J. 2002. Biochemistry 3rd Ed. John Wiley and Sons*.

Biotech. 446: Computational Methods for Data Analysis (1L+1P)

Theory

UNIT-I

Introduction to UNIX/LINUX operating system; Knowledge discovery and data mining techniques; Machine learning and pattern recognitions, hidden Markov models; Artificial neural networks, Support vector machines.

UNIT-II

Principal component analysis, ANOVA; AMOVA and different clustering methods; Gene Prediction algorithms and Phylogenyalgorithms; Basics of R statistical package.

Practical

Gene prediction: FGENESH; R statistical package installation and configuration, GUI for R: R-commander, R-studio, RKWard; Analysis of gene expression using R; GNU PSPP, Scilab, QtiPlot.

Suggested Readings

- Gareth James, Daniela Witten, Trevor Hastie & Robert Tibshirani. 2013. An Introduction to Statistical Learning: with Applications in R. Springer.
- Mathur K Sunil. 2010. Statistical Bioinformatics with R. Elsevier..

Semester – VII

Biotech. 491 Student READY - In-house Skill Development Modules	1. Plant Biotechnology 2. Animal Biotechnology 3. Microbial and Environmental Biotechnology 4. Bioinformatics ***To opt only one module as per the chosen elective***	0+20

Semester – VIII

Student READY-Project Formulation, Execution and Presentation (0L+10P)

EvaluationCriteria:

Parameter	Marks Distribution (%)
Project Formulation and Implementation	20
Work Performance	30
Regularity, General Conduct and Discipline	10
Initiative and Creativity	10
Final Presentation	15
Final Project Report	15

Student READY-Entrepreneurial Development in Biotechnology (0L+10P)

Micropropagation; DNA fingerprinting; Genetic purity for maintenance breeding; Markerassisted selection; Haploid production; Database Management skills; Molecular Diagnostics; Recombinant protein production; Animal cell culture and maintenance; Fermentation, Biopharmaproduction; Bioprocessenrichment; Bioremediation; Biofules, etc.

Evaluation Criteria:

Parameter	Marks Distribution (%)
Project Planning, Writing and Presentation	20
Regularity	10
Monthly Assessment	10
Output Delivery	15
Technical Skill Development	15
Entrepreneurial and Business Networking Skills	10
Report Writing	10
Final Presentation	10

6. B.Sc. (Hons.) Community Science

B.Sc. (Hons.) Community Science Programme curriculum for four years will require a total of 167 credits with 32 credits of Basic supporting courses of Science and Humanities, 95 credits of core courses and 40 credits of Student READY Programme for all students. The curriculum of B.Sc. (Community Science) offers the students to gain the requisite knowledge, skills and aptitude in all the areas of this field of science. IARI has adopted an experiential approach in its curriculum that engages the student through teaching, research and extension. They will be trained for employment in research organizations, food and textile industries, dietetic practice, education and child development domains, strategic planning and communication sectors. They will also be prepared to take higher education as their specialization.

Semester wise courses

Course Code	Course Title	Credit Hours
	SEMESTER I	
CSBC 101	General English – I	2 (1+1)
HEX 300	Extension and Rural Development	2(2+0)
HCT 341	Textile Science and Fabric Care	3(2+1)
HFN 337	Principles of Human Nutrition	3(3+0)
HRM 381	Fundamentals of Art and Design	3(2+1)
HHD 353	Fundamentals of Human Development	2(2+0)
AEDM 301	Environmental Studies and Disaster Management	3(2+1)
NSS 201	National Services Scheme	2(0+2)
	TOTAL	**20(14+6)**
	SEMESTER II	
CSBC 104	Technical Writing (English)	2 (1+1)
EECM 252	Women in Agriculture	2(2+0)
TXAD 122	Fundamentals of Clothing Construction	3(1+2)
FSNT 112	Food Science and Processing	3(2+1)
RMCS 132	System Dynamics and Management of Resources	2(1+1)
HDFS 142	Life-Span Development	3(2+1)
CSBC 105	Principles of Biochemistry	3(2+1)
SMCA 107	Agricultural Informatics	3(1+2)
	TOTAL	**21(12+9)**
	SEMESTER III	
EECM 301 or EECM 251	Project Management or Programme Development for Rural Families	3(1+2)
TXAD 221	Techniques of Fabric Construction	3(1+2)
FSNT 211	Community Nutrition and Education	3(2+1)
RMCS 231	Financial Management and Consumer Education	2(2+0)
HDFS 341	Marriage and Family Dynamics	3(2+1)
SMCA 201	Elementary Statistics	3(2+1)
CSBC 202	Fundamentals of Food Microbiology	3(2+1)
FSNT 212	Food and Nutrition Policy and Agriculture	2 (2+0)
	TOTAL	**22(14+8)**
	SEMESTER IV	
RMCS 232	Housing and Space Management	3(2+1)
TXAD 222	Textiles Finishes	2(1+1)
FSNT 213	Normal and Therapeutic Nutrition	3(2+1)
CSBC 203	Communication Skills and Personality Development	3(2+1)

HDFS 343	Developmental Challenges in Children	3(2+1)
FSNT 214	Food Standards and Quality Control	3(2+1)
EECM 253	Extension Training Management	3(1+2)
RMCS 233	Ergonomics and Appropriate Technologies	2(1+1)
	TOTAL	**22(13+9)**
SEMESTER V		
CSBC 302	Economics and Marketing	3(2+1)
TXAD 321	Garment and Accessory Designing	3(0+3)
FSNT 314	Food Hygiene and Sanitation	2(1+1)
CSBC 106	Introduction to Rural Sociology	2(2+0)
HDFS 342	Family Counseling and Child Welfare	3(2+1)
CSBC 301	Elementary Human Physiology	3(2+1)
RMCS 331	Residential and Commercial Space Design	3(2+1)
TXAD 223	Retailing and Merchandizing- Textiles and Apparel	2(2+0)
	TOTAL	**21(13+9)**
SEMESTER VI		
FSNT 311	Clinical Nutrition and Dietetics	3(2+1)
TXAD 322	Traditional Textiles and Costumes of India	3(2+1)
FSNT 313	Food Analysis	3(1+2)
RMCS 332	Entrepreneurship Development and Business Management	3(2+1)
HDFS 242	Educational Psychology and Early Childhood Education	3(2+1)
EECM 351	Information and Communication Technology	3(1+2)
EECM 352	Diffusion and Adoption of Homestead Technologies	3(2+1)
	TOTAL	**21(12+9)**

Student READY Programme

Out of 37 credits of Module I, students are required to choose 20 credits; and from 36 credits of Module II, students are required to choose 20 credits

Module 1- Product Development and Entrepreneurship - 36 weeks

Objective

This module aims to grant practical knowledge to students regarding product development and entrepreneurship, covering all aspects related to income generation through production and sale of clothing and textile and interior decoration products and also the management of their entrepreneurial ventures.

Module 2 - Community Nutrition and Welfare - 36 weeks

Objective

This module aims to impart practical knowledge to students regarding community welfare encompassing all the aspects viz. diet counseling, food preservation, food service and hospitality management, nutraceuticals and health foods, early childhood care, education and counseling for parents and community and multimedia and video production. Students would be ready to conduct and manage community welfare programs independently.

SEMESTER VII **Student Ready Programme (Experiential Learning Program) 24 weeks with credit load of 0+20**					
Code	**Module I** **Product Development and Entrepreneurship**		**Code**	**Module II** **Community Nutrition and welfare**	
TXAD 700	Apparel Designing Technique-Flat Pattern and Draping	3 (0+3)	HFN 713	Diet and Nutrition Counseling	3 (0+3)
TXAD 701	Retailing and Merchandising-Textiles and Apparel	2(0+2)	HFN 714	Food Preservation and storage	3(0+3)
TXAD 702	Fashion Illustrations	3(0+3)	HFN 715	Food Service and Hospitality Management	3(0+3)
TXAD 703	Computer Aided Designing-Pattern Designing	2 (0+2)	HFN 716	Nutraceuticals and Health Foods	3(0+3)
EECM 701	Print and Electronic Journalism	3(0+3)	EECM 701	Print and electronic Journalism	3(0+3)
EECM 702	Instructional Video Production	3(0+3)	EECM 702	Instructional Video Production	3(0+3)
EECM 703	Web designing and Multimedia production	4(0+4)	EECM 703	Web Designing & Multimedia Production	4(0+4)
EECM 704	Public Relation and Social Marketing	3(0+3)	H D F S 721	Methods and materials for teaching young children	4(0+4)
CSBC 711	Seminar	1(1+0)	C S B C 711	Seminar	1(1+0)
EECM 704	Tourism and Hospitality management	3(0+3)	HDFS 731	Education and Counselling for parents and Community	2(0+2)
EECM 705	Event Management	3(0+3)	H D F S 741	Early Childhood Care, Education and Management	4(0+4)
RMCS 722	Interior Design and Decoration	3(0+3)	HDFS 751	Developmental Assessment of Young Children	3(0+3)
HRM 731	Computer Aided Interior Designing	4(0+4)			
	Minimum of 20 credits to be studied **(Total-37)**		**Minimum of 20 credits to be studied (Total-36)**		
SEMESTER VIII					
	In-plant training / Internship / RAWE		**20 weeks of credit load of 0+20**		

SYLLLABUS

I. Department of Extension Education and Communication Management Core Courses

1. Extension and Rural Development 2(2+0)

Theory

Extension Education- concept and importance, philosophy, principles and objectives. Evolution of extension education- glimpses of pre- and post-independence era. Community: Meaning and definition, types of communities, community and science, community mobilisation- leadership, participation-PRA. Community development programmes- concept, objectives, organization, activities, achievement and failures. Sociology and Rural Sociology- meaning, scope, importance, concepts-structural and functional, differences between rural, urban and tribal societies. Rural development- concept, need, meaning, aim and functions of extension education for rural development. Panchayati Raj Institutions- concept, structure and function. Five-year plans. Current rural development programmes/ Organisations- SGSY, MGNREGA, IAY, ICDS, Total sanitation schemes/ campaigns etc., DWMA, ATMA, ITDA, DRDA, KGMV. Role of ICAR, SAUs, KVKs, DAATTCs and NGOs in rural development.

Suggested Readings

- Ray, G.L. (2003), Extension Communication and Management. Kalyani Publishers. Fifth revised and enlarged edition.
- Dahama, O.P. and Bhatnagar, O.P. (2003). Education and Communication for Development. Oxford and IBH Publishing Co. Pvt. Ltd.
- Sandhu, A.S. (1993) Textbook on Agricultural Communication: Process and Methods. Oxford and IBH Publishing Co. Pvt. Ltd.
- Chitamber, J.B. (2008). Introductory Rural Sociology. New Age International (P) Limited.
- Sachdeva, D. R. and Bhushan, V (2007). An Introduction to Sociology. Kitab Mahal Agency.

2. Project Management 3(1+2)

Theory

Project management: Overview. Project - meaning, concept, types, elements of management. Project proposal- concept, designing, project initiation, resource allocation framework. Market and demand analysis. Environmental appraisal of projects, Environmental impact analysis, technical analysis, financial analysis. Budgeting Terminology of networks. Project management techniques.

Practical

Collection and screening of case studies on project management and report writing, Visit to project - Technology generation project. Visit to Project - Transfer of Technology (ToT). Visit to Project- Women entrepreneurship. Visit to state level and international level funding agencies. Visit to International funded projects. Visit to women and child development project. Visit to agriculture development project, Visit to rural development projects. Designing, planning and preparation of a mini project proposal. Working on project management

techniques: PERT. Working on project management: CPM. Working on project management techniques: WBS. Report writing

3. Extension Training Management 3(1+2)

Theory

Training: Concept, need, definition, importance. Identification of training need. Types of Training. training process, different phases of training and its management. Qualities of a good trainer- communications skills, training skills, motivational skills and handling difficult situations. Adult learning, characteristics of adult learner. Facilitation skills in training, problem and prospects of training. Designing training module: Basic guidelines, steps in module designing. Training methods. Training evaluation: Objectives, principle, steps and indicators of training evaluation. Important training institutions in India

Practical

Visit to state level training institutes, report writing and presentation, Visit to vocational training institutes, report writing and presentation, Hands-on-experience with training need analysis. Writing training objectives. Hands-on-experience on training methods, Familiarization with monitoring and evaluation tools of training, Familiarization with offline and online training module. Preparation of training module, Designing, conducting and evaluation of training pogramme, Analysis of HRD programmes of academic and corporate institutions. Interaction with HRD professionals. Presentation of reports.

Suggested Readings

- Gupta, C.B. (2001). Human Resource Management. Sultan Chand and Sons.
- Dahama, O.P. and Bhatnagar, O.P. (2003). Education and Communication for Development. Oxford and IBH Publishing Co. Pvt. Ltd.
- Lynton, R.P. and Pareek, V. (2008). Training for Development. Vistaar Publications.
- Narwani, G.S. (2002). Training for Rural Development. Rawat Publication.
- Saxena, J.P. and Kakkar, A.T. (2000). Training and Development.

4. Diffusion and adoption of Homestead Technologies 3(2+1)

Theory

Concept and elements of diffusion process. Innovation–decision process, types of innovation– decision, consequences of innovations. adoption: meaning, definition, adoption process, factor affecting adoption and innovation – decision process and constraints. Different terms used in diffusion of innovation and adoption process: Rate of adoption, overadoption, innovativeness, dissonance, rejection, discontinuance. Adopter categories: concept and types. Homestead technology: concept and its relevance to innovation – decision process different channels of communication and their characteristics. Social change: concept, theories, dimensions and factors. Change agents and opinion leader; change proneness – acceptance and resistance to social change. Different homestead technologies with special reference to Home Science.

Practical

Collection of homestead technologies. Adoption in localities- Observation, visit to different entrepreneurs with adopted home stead technologies for business enterprise. Visit to different successful SHGs, Categories of adopters among SHG members. Analysis and presentation of report. Identification of change agents in a locality, Presentation of report

Suggested Readings

- Ray, G.L. (2003) Extension Communication and Management. Kalyani Publishers. Fifth revised and enlarge edition.
- Dahama, O.P. and Bhatnagar, O.P. (2003). education and communication for development. Oxford and IBH Publishing Co. Pvt. Ltd.
- Sandhu, A.S. (1993) Textbook on Agricultural Communication: Process and Methods". Oxford and IBH Publishing Co. Pvt. Ltd.
- Chitambar, J.B. (2008) Introductory Rural Sociology. New Age International (P) Ltd.
- Sachdeva, D. R. and Bhushan, V. (2007) An Introduction to Sociology. Kitab Mahal Agency.

5. Programme Development for Rural Families 3(1+2)

Theory

Planning: nature of planning. Extension programme planning: concept, definition, objectives, principles relevant terms used in programme planning : situation, aims, objectives, problem, solution, project, plan, plan of work, calendar of work etc. Steps in extension programme planning: elaborate discussion. Critical analysis of few major development programmes under five-year plans. Leader and leadership: meaning, definition, identification of leader execution of programme: Environment and rapport building, role of local leader, involvement of local leaders, involvement of local bodies, organizations and extension agencies. Implementation of programme and constraints associated with it. Monitoring and evaluation: concept, meaning, definition.

Practical

Establishing rapport with rural families and identification of leader. Conducting baseline survey of village and household and analysis of information. Different PRA tools, its applications in programme development and exercises. Triangulation of information from conventional and PRA method. Preparation of detailed plan of work for small need-based programme. Implementation of programme Evaluation of programme Documentation Presentation of findings of programme

Suggested Readings

- Sandhu, A.S (2003), Extension Programme Planning, New Delhi : Oxford IBH
- Ray, G.L. (2004), Extension Communication and Management. New Delhi : Kalyani Publishers.
- Reddy, A.A (2001), Extension Education, Baptala: Sri Lakshmi Press.

- Dahama, O.P and Bhatnagar, O.P (2003). Education and Communication for Development. New Delhi : Oxfords IBH
- Sehgal, S. and Raghuvanshi, R.S. (2007) Text Book of Community Nutrition. ICAR: New Delhi.

6. Information and Communication Technology 3(1+2)

Theory

IT and its importance, IT tools, IT-enabled services and their impact on society; computer fundamentals; hardware and software; input and output devices; word and character representation; features of machine language, assembly language, high-level language and their advantages and disadvantages; principles of programming- algorithms and flowcharts; Operating systems (OS) - definition, basic concepts, introduction to WINDOWS and LINUX Operating Systems; Local area network (LAN), Wide area network(WAN), Internet and World Wide Web, HTML and IP; Introduction to MS Office - Word, Excel, Power Point. Audio visual aids - definition, advantages, classification and choice of A.V aids; cone of experience and criteria for selection and evaluation of A.V aids; video conferencing. Communication process, Berlo' s model, feedback and barriers to communication.

Practical

Planning, preparation, presentation of posters, charts, overhead transparencies and slides. Handling of audio-visual equipments. Organization of an audio-visual programme. Exercises on MS Word; MS Excel; MS Power Point; Internet applications- Web browsing, creation and operation of email account; analysis of data using MS Excel. Introduction to World Wide Web (WWW) and its components, creation of scientific website, presentation and management agricultural information through web. Introduction of various programming languages such as Visual Basic, Java, Fortran, C, C++, and their components. Hands on practice on writing small programmes.

7. Women in Agriculture 2(2+0)

Theory

Evolution of agriculture in India, General agricultural production activities, Agricultural and allied sectors in rural India, role of women in agricultural and allied sectors, status of farm women -Social, economic and health status of women in agriculture, Women friendly tools and implements, Gender issues, Women in agriculture Policy, Programmes (government and non- government)and institutions for women in agriculture, Women empowerment in agriculture, Agripreneurship and training to farmwomen. Courses for Student Ready Programme

Courses for Student Ready Programme

1. Print and Electronic Journalism 3(0+3)

Practical

Visit to print and electronic stations for familiarization with equipments, Interaction with personnel of print and electronic media. Report writing on observations and presentation. Planning a press note/ press release for print media, Screening of radio news programmes. Screening of TV news programmes. Exercises on

writing different types of reports for radio. Exercises on writing different types of reports - television formats, Hands-on experience with editing. Planning a press note/ press release for electronic media, Writing and presentation of radio and television news, Orientation to photography and photographic equipment. Hands on training with different types of professional cameras, Writing captions for photographs. Writing and editing photo features for selected photographs and presentation. Familiarization with different online articles. Content creation for online journal. Creating a blog.

Suggested Readings:

- Arvind Kumar (1999). The Electronic Media. Anmol Publications, New Delhi.
- Bhatt, S.C. (1993) Broadcast Journalism. Basic Principles Har Anand Publications, Delhi
- Bhatnagar, R. (2001). Print Media and Broadcast Journalism. Indian Publisher Distributors, Delhi
- Katyal, V.P (2007). Fundamentals of Media Ethics. Cyber Tech Publishers, New Delhi.

2. Public Relation and Social Marketing 3(0+3)

Practical

Visit to Institution under government sector for analyzing the public relations institution. Orientation to different models of PR. Designing PR models. Analysis of the situation to find out the social problems in a community,. Assessment and analysis of the problems. Preparation of report on collected information. Planning for social marketing strategy based on the identified problems. Execution of social marketing programme, Planning for publicity campaign, Execution of publicity campaign. Evaluation of programme and reporting.

Suggested Readings

- Yadava, J.S and Mathur, P. (1998). Issues in Mass Communication: the basic concepts. Volumes 1 and 2. Indian Institute of Mass Communication, New Delhi.
- Douglas, S. (1989). A Social Marketing Perspective on Communication Campaigns in Public Opinion Campaigns. Sage publications, New Delhi.

3. Instructional Video Production 3(0+3)

Practical

Familiarization with instructional video, Writing instructions for instructional video. Familiarization with script. Hands-on-experience with script writing, Familiarization with video and audio formats. Preparation of amateur instructional video. Familiarization with video camera and operation. Hands-on-training with video camera. Production of video – pre-production, production and post production. Projection and evaluation.

Suggested Readings

- Zettl, H. (2005) Television Production Handbook**.** Thomson Learning, USA.
- Millerson, G. and Owens, J. (2008) A Hand book of Video Production. Butterworth- Heinemann, Oxford.
- Millerson, G. and Owens, J. (2009) Television Production. Focal Press, London.

- Zettle, H. (2010). Video Basics. Wadsworth Publishing, Belmont, California.
- Millerson, G. and Owens, J. (2011), Video Production Handbook. 5th ed.
- Vasuki, B. (2013). Video Production. 2nd edition. Oxford University Press.

4. Web designing and Multimedia production 4(0+4)

Practical

Familiarization with different types of websites, Hands-on-experience with Adobe photoshop for designing of website, Hands-on-experience with HTML 4.01 writing for construction of website. Hands-on-experience with Dreamweaver for construction of website. Hands-on-experience with flash for animations of website, Familiarization with cascading sheet styles. Familiarization with web analytics, Practical orientation to Multimedia application. Exposure to multimedia hardware and maintenance-parts and connection, peripheral. Handling multimedia-parts, connections and peripheral. Scanning, retrieval, capturing and navigating skills. Planning and Production of multimedia package, Multimedia authoring tools - CD and DVD writing techniques, Presentation of the prepared Multimedia kit by using LCD Projector.

5. Seminar 1(1+0)

A power point presentation on any topic chosen from the subjects studied from vocational package to be prepared and delivered to the group of staff and students of department. Organization of topic. Presentation of data. Oral presentation. Delivery, language, explanation of figures, Ability to grasp and understand the subject, Depth of understanding the topic.

II. Department of Textile Science and Design Core Courses

1. Textile Science and Fabric Care 3(2+1)

Theory

Textile: definition, forms of textile, importance of textile industry in national economy Classification of textile fibres Properties of textile fibres; primary and secondary properties Molecular structure of textile fibres: Monomers, polymers and their types, polymerization and its types, degree of polymerization and orientation Cotton: Fibre production, fibre varieties and their grading, fibre morphology, physical, chemical and biological properties and end-uses Bastfibres: Flax, jute, hemp and ramie; Fibre production, fibre morphology, physical, chemical and biological properties and end-uses Other bastfibres (ramie, jute, hemp): Fibre production, fibre morphology and physical, chemical and biological properties and end-uses Wool: Fibre production, classification of wool and their labeling, fibre morphology, physical, chemical and biological properties and end-uses Silk: Fibre production and classification, fibre morphology, physical, chemical and biological properties and end-uses Chemical spinning: Wet, melt and dry spinning and common properties of man-made fibres Rayons: Viscose, cupramonium and High Wet Modulus rayons; fibre manufacturing, microscopic structure, physical, chemical and biological properties and end-uses Modified cellulosic fibres: Diacetate and triacetate; fibre manufacturing, fibre microscopic structure, physical, chemical and biological properties and end-uses Synthetic fibres: Nylon, polyester and acrylic; fibre manufacturing, fibre microscopic structure, physical, chemical and biological properties and end-uses Mechanical spinning: Ring spinning method Classification of yarn on the basis of structure- simple and novelty yarns, twist direction, twist amount,

fibre length and end-uses Methods of fabric construction: Weaving, knitting, braiding, tufting, net, lace making, crocheting, macramé, stitch through fabrics, quilted fabrics, laminated fabrics, bonded fabrics, felt, nonwoven and films Stain removal: Classification of stains and methods of removing different stains Laundry: Definition, principles, equipments, laundry methods and dry cleaning Laundry agents: Water, soap, laundry auxiliary, stiffening agents, bleaches and blues Care of textiles: Labeling and labeling Act Labels and tags used in textiles Storage of clothes: Requirements of short term and long term storage, folding and packaging of clothes

Practical

Testing of textile fibres Microscopic view Burning test Solubility test Visual test Study and identification of different types of yarns in the market Study and identification of fabric samples of different construction in the market and thread count Removal of different stains from fabric surface Washing and finishing of garments made of following fibres: Cotton, Wool, Silk, Blends/ synthetic Visit to textile industry.

Suggested Readings

- Cowan, M. L. and Jungerman, M. E. 1969. Introduction to textiles. 6th ed. New York. Appleton-Century – Crofts.325 p.
- Dantyagi, S. 1959. Fundamentals of textiles and their Care. New Delhi. Orient Longman Limited.
- Deulkar, D. and Tarabai.1967. Household textiles and laundry Work. 3rd ed. Delhi.Atma Ram and Sons Ltd.
- Hall, A.J. 1969. A Students Textbook of Textile Science. London. Allman and Son Ltd
- Hollen, N. and Saddler, J. 1968. Textiles. New York. Macmillan Company.
- Joseph, M. L. 1986. Introductory textile science. 5th ed. New York. CBS College
- Publishing.
- Labarthe, J. 1969. Textiles: Origins to Usage. New York. McMillan Company Ltd
- Potter, M.D. and Corbman, B.P. 1967. Textiles: Fibre to fabric. New York. Macmillan Hill Co.
- Stout, E.E. 1970. Introduction to textiles. 3rd ed. New York. John Wiley and Sons, Inc.
- Tortora, P.G. 1978. Understanding textiles. New York. Macmillan Publishing Company.
- Vilensky, L. D. and Gohl, E. P.G. Textile Science. Delhi. CBS Publishers and Distributors.
- Wingate, I. B. 1970. Textile Fabrics and their selection.6th ed. New Jersey. Prentice Hall Inc.
- Wynne, A. 1997. Textiles. London, Macmillan Education Ltd. 310 p.
- Vatsala, R. 2003. Textbook of Textiles and Clothing. New Delhi. Indian Council of Agriculture Research.

2. Techniques of Fabric Construction 3(1+2)

Theory

History of weaving and looms Woven fabrics; simple woven structures and compound woven structures and characteristics of woven fabric Classification of looms on basis of mechanics, means of running loom,

structure and means of weft insertion Parts of loom and loom accessories and their function Mechanism of weaving: primary, secondary and tertiary motions Basic weaves: Plain, twill and satin and their variations Complex weaves: extra yarn fabrics, pile fabrics, leno, damask and jacquard Knitting: Terminology and principle of knitting Knitting machine: Parts and their function and types of knitting machine Knitting stitches:plain, rib and purl and types of knit fabrics Macrame and crochet: Tools and materials. Manufacturing process of felt, properties and end uses

Practical

Observation of fabric structures under magnifying glass Graphical representation of woven design Handloom and its parts Weaving calculations and yarn preparation for plain weave Setting of loom and weaving of plain weave fabric Knitting machine and its parts Sample preparation of different fabric constructions hand knitting; plain, rib, purl knots of macramé stitches of crochet manual felting

Suggested Readings

- Hollen, N. and Saddler, J. 1968. Textiles. New York. Macmillan Company.
- Joseph, M. L. 1986. Introductory Textile Science. 5th ed. New York. CBS College Publishing.
- Labarthe, J. 1969. Textiles: Origins to Usage. New York. McMillan Company Ltd
- Potter, M.D. and Corbman, B.P. 1967. Textiles: Fibre to fabric. New York. Macmillan Hill Co.
- Stout, E.E. 1970. Introduction to textiles. 3rd ed. New York. John Wiley and Sons, Inc.
- Tortora, P.G. 1978. Understanding textiles. New York. Macmillan Publishing Company.
- Vilensky, L. D. and Gohl, E. P.G. Textile Science. Delhi. CBS Publishers and Distributors.
- Wynne, A. 1997. Textiles. London. Macmillan Education Ltd. 310 p.
- Vatsala, R. (2003), Textbook of Textiles and Clothing.New Delhi. Indian Council of Agriculture Research.

3. Textile Finishes 2(1+1)

Theory

Textile finishing: Definition and its importance Classification of textile finishes: Chemical, mechanical, temporary, permanent, durable, renewable, semi permanent, reactive and additive finishes Processes of removing impurities from fabrics: Scouring, desizing, degumming, carbonizing, souring Basic finishes that alter hand or texture: Fulling/milling, felting, singeing, stiffening, decatizing Surface finishes: Bleaching, delustering, calendering, beetling, napping, flocking, burnt out design, acid design, plisse design, tentering, shearing and brushing Functional finishes: Water proof and water repellent finish, shrinkage control, wrinkle resistance, anti- static finish, anti-microbial finish, durable press and flame retardant finish Dyes and pigments, classification of dyes Application of dyes: direct, acid, basic, vat, azoic, mordant, sulphur, reactive and disperse dyes Dyeing techniques and equipment: Solution dyeing, fibre dyeing; tow and stock dyeing, yarn dyeing; skein and package dyeing and piece dyeing Styles of printing: Direct, discharge and resist printing Printing methods and equipment: Block, screen, stencil, roller, heat transfer printing, tie and dye and batik

Practical

Finishing of cotton fabric Scouring Bleaching Mercerization Tying and dyeing of cotton fabric with direct dye Fabric designing by batik technique with napthol dye Printing of cotton fabric using different methods Block Stencil Screen Heat transfer

Suggested Readings

- Hollen, N. and Saddler, J. 1968. Textiles. New York. Macmillan Company.
- Joseph, M. L. 1986. Introductory textile science. 5th ed. New York. CBS College Publishing.
- Labarthe, J. 1969. Textiles: Origins to Usage. New York. McMillan Company Ltd.
- Potter, M.D. and Corbman, B.P. 1967. Textiles: Fibre to fabric. New York. Macmillan Hill Co.
- Stout, E.E. 1970. Introduction to textiles. 3rd ed. New York. John Wiley and Sons, Inc.
- Tortora, P.G. 1978. Understanding textiles. New York. Macmillan Publishing Company.
- Vilensky, L. D. and Gohl, E. P.G. Textile Science. Delhi. CBS Publishers and Distributors.
- Wingate, I. B. 1970. Textile Fabrics and their selection. 6th ed. New Jersey.Prentice Hall Inc.
- Wynne, A. 1997. Textiles. London. Macmillan Education Ltd. 310 p.
- Koushik, C.V and Josico, A.I. 2003. Chemical processing of textiles: Preparatory processes and dyeing.NCUTE. New Delhi.
- Vankar, P.D. 2006. Handbook on natural dyes for industrial applications. New Delhi. National Institute of Industrial Research.
- Shenai, V.A. (2000) Chemistry of dyes and principles of dyeing. Mumbai Sevak Publications.

4. Retailing and Merchandising –Textiles and Apparel 2(2+0)

Theory

Retailing and merchandizing- Terminology, concept and principles Factors affecting merchandizing Role and responsibilities of merchandiser Merchandizing for buying house, departmental stores and export houses. Evolution of retail and retail formats marketing research: Meaning, scope and classification, steps in marketing research Role of marketing research in product planning Sale promotion and promotion mix: advertising, sale promotion technique, personal selling and publicity Pricing methods and pricing of textile Export and Import: Channels of distribution, starting of export and import business and its procedure Organizations involved in export promotion in India WTO and its impact on retailing and merchandizing in textile and apparel industry

Suggested Readings

- Cooklin, G. 1991. Introduction to clothing manufacture. London. Blackwell Science Ltd.
- Easey, M. 1995. Fashion marketing. Oxford (U.K.) Wiley-Blackwell.
- Kotler, P. and Keller, K.L. 2006. Marketing management. 12th ed. New Delhi. Prentice Hall of India Pvt. Ltd.
- Nickles, W.G. 1982. Marketing principles. II ed. New Jersey. Prenctice Hall Inc. Eaglewood Cliffs.

- Phillips, C.F and Duncan, D.J. 1956. Marketing principles and methods. II ed.U.S.A.
- Richard D. Irwin Inc.
- Pradhan, S. 2009. Retailing management. 3rded. New Delhi. Tata McGraw-Hill Publishing Company Ltd.
- Ramaswamy, V.S. and Namakumari, S. 2004. Marketing management- Planning,Implementation and Control. 4thed. New Delhi. Mcmillan India Pvt. Ltd.

III. Department of Apparel Designing

Fundamentals of Clothing Construction 3(1+2)

Theory

Terminology related to clothing construction Sewing tools and equipments required for measuring, drafting, cutting and stitching Selection and preparation of fabric for garment construction Layout of paper pattern, marking, cutting and stay stitching Unit construction method Importance and function of clothes Socio- economic and psychological factors affecting clothing choices Consumer behaviour and motivation Clothing requirements of different age groups: infant, toddler, pre-schooler, school age children, teenager, adolescent, adult and senior citizen Application of elements and principles of art in apparel designing

Practical

Demonstration on: Sewing equipments and tools, sewing machine and its care. Preparation of samples: Hand stitches; basting, slip-stitching, hemming, smocking, over casting, attaching fastener and button holing, mending and patching Machine stitches; seam and seam finishes, pleats, gathers and tucks, stay stitch, under stitching, placket opening Demonstration on taking body measurements Preparation of fabric for cutting, and layout of paper pattern on different fabrics patterns including plain, print, lines, plaid and check. Drafting, cutting and stitching of different garments:

i. Baby frock
ii. Panty
iii. Bloomer
iv. Blouse

Suggested Readings

- Carson, B. 1969. How You Look and Dress. 4th ed. New York. Webster Division, McGraw-Hill Book Company.
- Doongaji, S. and Deshpande, R. Basic Processes and Clothing Construction. 2nd ed. New Delhi. New Raj Book Depot.
- Erwin, M.D. *et.al*. 1979. Clothing for Moderns. 6th ed. New York. Macmillan Publishing Co.
- Gawna, E.J. and Qerke, B.V. 1969. Dress 3rd ed. Illinois. Peoria Chas Bennett Co. Inc.
- Kefgen, M. and Phyllis, T.S. 1971. Individuality in Clothing Selection and Personal Appearance. New York. The Macmillan Company.

- Lewis, V.S. 1979. Comparative Clothing Construction Techniques. Minnesota. Burgess Publishing Company.
- Mansfield, E.A. and Lucas, E.L. 1974. Clothing Construction. 2nd ed. London. Houghton Miffiin Company.
- Sodhia, M. 2004. Advanced drafting and draping. New Delhi. Kalyani Publisher.
- Rosencranz, M.I. 1972. Clothing Concepts- A Social and Psychological Approach. New York. The Macmillan Company Ltd.
- Tate, M.T. and Glisson, O. 1961. Family Clothing. New York. John Wiley and Sons.
- Sannapapamma, K.J. and Jahan, S. TXAD111-Fundamentals of Clothing Construction. ecourse. iasri.res.in.

2. Garment and Accessory Designing 3(0+3)

Practical

Selection of figure template for men, women and children Designing of garments for women using different construction features: collar, sleeve, neckline men using different construction features: shoulder yoke, collar, sleeve, cuff children using different construction features: Yoke, gather, pleats, tucks, shirring, smocking, trimmings Drafting and construction of following garments for women, men and children fancy frock salwar/ pyjama/pyjami kurta (gents)/kameez (ladies) night dress/ gown Accessories: introduction and classification; footwear, hand bags, belt, jewelery, gloves, hats, scarves and umbrella Designing of accessories for women, men and children Selection of designs for construction of accessories Construction of one accessory each for women, men and children

Suggested Readings

- Goldstein, H. and Goldstein, V. 1954. Art in Everyday life. 4th ed. New York. Macmillan Publishing Co., Inc. pp – 515.
- Bhatnagar, P. 2005. Decorative Design History in Indian Textiles and Costumes. Chandigarh. India. Abhishek Publications. 41-43 pp.
- Graves, M. 1951. Art of Colour and design. 2nd ed. New York. McGraw- Hill Company. pp – 438.
- Beitler, E. J. and Lockhart, B. 1961. Design for you. 2nd ed.
- Peacock, J. 2000. Fashion accessories- The complete 20th century source book. London. Thames and Hudson.
- Meadows, C. S. 2003. Know your fashion accessories. NewYork. Fairchild books.

3. Traditional Textiles and Costumes of India 3(2+1)

Theory

Traditional woven textiles of Indi History of woven textiles: Dacca muslin, Brocades, Calico Printing Traditional sareesof India Jamdani, Baluchari, Pochampalli, Patola and Ikat, Kanjivaram, Chanderi, Maheshwari, Bomkai, Sambhalpuri, Vichitrapuri, Paithani, Kota Doria, Gadwal, Irkal, Venkatagiri, Narayanpet, Kasavu, Tanchoi and Brocade Sarees. Traditional woven and embroidered shawls of India: Shawls of Kashmir, Himachal Pradesh, Gujarat, North Eastern States and other states. Printed and painted

textiles Printed textiles Block printed textiles: Dabuprinting, Bagruprinting, Sanganeriprinting, Bagh printing Tie and dyed textiles of Rajasthan and Gujarat. Painted textiles: Kalamkari, Madhubani, Warli, Patchitra, Phad and Pichhavai. Embroideries of different states of India: Kashida of Kashmir, Chamba Rumal, Chikankari and Zari work of Uttar Pradesh, Phulkari and Bagh of Punjab, Embroideries of Gujarat, Kantha of Bengal, Manipuri Embroidery, Kasuti of Karnataka, Embroidery and Rabari work of Bihar, Pipli work of Orissa Importance of traditional textiles in textile and apparel industry Importance and market scenario of traditional Indian textiles and their impact on modern textiles industry. Geographical Indications obtained for traditional Indian textiles

Practical

Documentation of motifs of traditional Indian embroideries. Sample preparation of traditional Indian embroideries Documentation of woven textiles of India. Creative projects in the adaptation of traditional motifs and designs in contemporary textiles through collection of samples, sketches and development of scrap book Visit to museum and art galleries

Suggested Readings

- Bhatnagar, P. 2005. Decorative Design History in Indian Textiles and Costumes. Chandigarh, Abhishek Publication.
- Chattopadhyay, K. 1977. Indian Embroidery. New Delhi, Wiley Eastern Limited
- Harney, J. 1997. Traditional Textiles of Central Asia. London.Thomesand Hudson Ltd.
- Krishna, R A. 1966. Banaras Brocades. New Delhi. Crafts museum.
- Lubell, C. 1976. Textile Collection of the World. Vol. 2. London. United States publication.
- Mehta, R J. 1970. Master Piece of Indian Textiles. D. B. Taraporevale Sons and Co. Private Ltd.
- Treasure of Indian Textiles. 1980. Calico Museum. Ahmedabad.Marg Publication Bombay.

Courses for Student Ready Programme

1. Apparel Designing Techniques- Flat Pattern and Draping 3(0+3)

Practical

Designing and styling using flat pattern technique Moving, dividing and combining darts: Pivot and slash method Converting darts into seam lines Adding fullness by gathers, pleats and tuck Construction of different types of yokes collars: full roll collar, convertible collar, sailor collar, chines collar, polo collar sleeves: set-in sleeve and its variations, raglan sleeve, kimono sleeve skirts: 'A' line, pleated and gathered Preparation of basic block using draping techniques Construction of formal dress for teenager using draping technique Development of commercial pattern for a prepared dress: pattern envelope, patterns and instructions for use. Visit to fashion institute.

Suggested Readings

- Bane, A. 1972. Flat Pattern Design. New York. McGraw Hill Book.
- Bray, N. 1986. Dress Pattern Designing. The Basic Principles of Cut and Fit. 5th ed. USA. Blackwell Science Inc.

- Helen, I.B. 1965. The Theory of Fashion Design. New York. John Wiley and Sons.
- Erwin, M.D. 1970. Practical dress design: Principles of Fitting and Pattern and Marking.
- USA. The Macmillan Company.
- Hollen, N.R. 1975. Pattern Making by the Flat-Pattern method. 4th ed. Minnesota Burgess Publishing Company.
- Pepin, H. 1942. Modern Pattern Designs. New York. Funk and Wagnalls Company Inc.
- Warden, J.A. Golding, M.A. and Stam, J.Y. 1969. Principles for Creative Clothing. New York. John Wiley and Sons.
- Helen, J.A. 2009. Pattern making for Fashion Design. New Delhi. Dorling Kindersley India Pvt. Ltd.

2. Principles of Textiles Designing 3(0+3)

Practical

Motif and its geometry Motif as basic unit of design: selection of components of motif, motif development, symmetrical and asymmetrical motifs and their arrangements Patter arrangement with motif in different repeats Geometry involved in basic textile designing- translation, rotation, reflection and glide reflection Geometrical motifs Developing geometrical motifs Use of monochromatic, analogous and complementary colour scheme in developed motif Arrangement of patterns with developed geometrical motifs Abstract motifs Developing abstract motifs Use of monochromatic, analogous and complementary colour scheme in developed motif Arrangement of patterns with developed abstract motifs Stylized motifs Developing stylized motifs Use of monochromatic, analogous and complementary colour scheme in developed motif Arrangement of patterns with developed stylized motif Natural motifs Developing natural motifs Use of monochromatic, analogous and complementary colour scheme in developed moti Arrangement of patterns with developed natural motifs Ethnic and Traditional motifs Using ethnic and traditional motifs for creating designs Application of suitable colour schemes in the developed designs Sketching and rendering of different types of border patterns Sketching and rendering of patterns for apparels Sketching and rendering of patterns for home textiles Preparation of swatch book of fabric samples of different types of structural and decorative designs Field visit to printing and textile design centre

Suggested Readings

- Goldstein, H. and Goldstein, V. 1954. Art in Everyday life. 4th ed. New York. Macmillan Publishing Co., Inc. pp – 515.
- Bhatnagar, P. 2005. Decorative Design History in Indian Textiles and Costumes. Chandigarh, India. Abhishek Publications. 41-43 pp.
- Graves, M. 1951. Art of Colour and design. 2nd ed. New York. McGraw- Hill Company. pp – 438.
- Beitler, E. J. and Lockhart, B. 1961. Design for you. 2nd ed. New York. Johan Wiley and Sons, Inc. pp – 247.

- Wilson, J. 2001. Hand Book of Textile Design: Principles, Processes and Practice. CRC Press, Cambridge. Woodhead Publishing Limited. Pp.152.
- Evans, H. M. and Dumesnil, C. D. 1982. An Invitation to Design. New York. Macmillan Publishing Co., Inc. pp – 358.
- Miller, J. 2003. The style sourcebook. London. Octopus Publishing. pp 92-108.

3. Fashion Illustrations 3(0+3)

Practical

Drawing eight head figure using geometric body shape Proportion: proportion of body parts, proportion of head, face and feet according different age group, sketching figures of different age group based on head theory Facial expression in illustration-eyes, nose and lips Basics of drawing legs, hands and arms of children, men and women's hand Front, ¾ and profile faces of adult and child (Male and Female) Adult and child (Male and Female)figures in different poses Sketching of garment features: collars, neckline, fasteners, sleeves, pockets, cuffs and hemline Sketching of added fullness: frills, flounce, gathers, pleats Sketching of accessories: hats, shoes, boots, belts and purses Designing of garments for adult and child -Male and Female Illustration of fabric design and texture using different media -water colour, pencil colour, collage, poster colour and crayon colour

Suggested Readings

- Greenwood, M. and Murphy, M.F. 1978. Fashion innovation and marketing. New York, Macmilan Publishing Company.
- Stone, E. and Sample, J.A. 1985. Fashion merchandising- An Introduction. IV Ed., New York, MacGraw-Hill Book Company.
- Bina, A. 2012. Fashion Sketchbook. IV Ed. New York. Fairchild books.
- Ireland, P.J. 1970. Fashion Design Drawing. London. B.T. Batsford Ltd.
- Ireland, P.J. 1980. Basic Fashion Design. London. B.T. Batsford Ltd.
- Ireland, P.J. 1974. Fashion Drawing for Advertising. London. B.T. Batsford Ltd.
- Kathryn, K.C. and Munslow, J. 1997. Illustrating Fashion. Oxford. Blackwell Science.
- Riegelman, N. 2009. 9 heads: A guide to drawing fashion. Boston. Pearson education.

4. Computer Aided Designing- Pattern Designing 2(0+2)

Practical

Introduction to pattern making software Basics of pattern making tools Standard tool bar Piece tool bar Seam tool bar Edit tool bar Tool kit Rotate tool bar Internals Segment tool bar Grading tool bar Darts/Pleats Fabric and Stripes Basics of pattern making menus File menu Edit menu Piece menu Grading menu Point menu Segment menu Dart menu Pleat men Seam menu Walk menu Tool menu Help menu Creating and grading basic patterns Bodice front and back Sleeve Skirt front and back

Suggested Readings

- Manual of Pattern Making Software

IV. Department of Family Resource Management and Consumer Science Core Courses

System Dynamics and Management of Resources 2(1+1)

Theory

Systems approach to management. Motivating factors of management- value as, goals and standards, origin, classification and role , Resources – definition, types , guidelines for use of resources and factors affecting, management of household resources and situation, Management process- planning - importance, types, characteristics and techniques, organizing; controlling- definition, phases and factors, evaluating- definition and types of evaluating. Time - tools of time management, and process of time management. Decision making process - types, steps in decision making and factors affecting decion making. Money - management process, types and sources of income, steps in making budget, controlling budget and evaluation of budget.

Practicals

Identification of individual and family values, identification of immediate, short term and long-term goals of individual and family. Standards for individual and family goals. Decision making by individuals and families. Applying decision making process, group work presentation on types of decision- and decision-making process. Listing out human and non – human resources, listing community resources. Application of management process to organize an event – planning, organization, evaluation. Management of personal time record for a week. Presentation of personal time record.

Suggested Readings:

- Mann, M.K. (2004). Home Management for Indian Families, Kalyani Publisher Ludhiana
- Nickell, P. and Dorsey, J.M. (1970). Management of Family Living. Wiley Eastern, New Delhi
- Vargeese, M.N. Ogale, N.N. and Srinivasan, K. (1992). Home Management, Wiley Eastern, New Delhi.
- Krishna Oberoi (2006). Resource Management for Better Homes. R.K. Offset, Delhi.
- Bhargava, Bela. (2005). Family Resource Management and Interior Decoration. Apple Printer and V. R. Printers, Jaipur.

2. Fundamentals of Art and Design 3(2+1)

Theory

Introduction and objectives of interior decoration. Elements of art and their importance in interior decoration. Principles of design and their application to enrich the interiors Colour: sources of colour, properties of colour, emotional effect of colour, colour schemes, colour theories, colour plans for interiors Furniture – types of furniture, materials and finishes of furniture, factors affecting the selection of furniture, care and maintenance of furniture, furniture arrangement, paints to be considered while selecting the furniture. Wall – classification, types of building walls,functional characteristics of walls, types of wall treatments, exterior and interior wall finishes. Floor importance, types of floor covering, care, maintenance and selection of floor covering. Windows – importance, its functional and decorative

treatments. Accessories – classification, application of principles of design and decoration in the selection/development of accessories, and their placement.

Lighting – importance, types of lighting and its application. Flower arrangement – materials used, principles involved, types, practical utility and care. Table setting – linens, tableware etc. required for table setting, table etiquettes.

Practical

Learning elements of art and principles of design. Development of motif and design through art principles. Colour – colour schemes, values and intensity scale, colour wheel. Furniture – care and arrangement of furniture. Accessories – preparation and placements of accessories. Flower arrangement. Learning different types of table setting and napkin folding. Window treatment. Lighting, fixtures and then utility. Market survey – different types of wall and floor coverings.

Suggested Readings

- Dorothi, *et al.,* (1980). Introduction to Interior Design. New York: Mc Millan.
- Faulkner and Faulkner. (1975). Inside Today's Home. New York: Holt, Rinehart and Winston.
- Gewther, M. (1970). The Home, its Furnishings and Equipment U.S.A. Mc. Graw Hill.
- Mike, L. (1986). The Complete Interior Decoration. United Kingdom: Mc Donald.
- Ruth, M. (1975). The Home and its Furnishings, U.S.A.: Mc. Graw Hill.
- Seetharaman P. and Sethi M. (2002). Interior Design and Decoration. CBS Publishers and Distributors. New Delhi.

3. Financial Management and Consumer Education 2(2+-0)

Theory

Concepts, importance, objectives and major aspects of family finance. Income concepts: productive income, hidden income, money income, real income, psychic income. Family – as income producing and utilizing unit, factors affecting in the use of family income. Analyzing income: income profile, methods of handling income, account keeping. Family budget: steps of budget making, factors influence on budget making, advantages of budget making, Engel's law of consumption, standard of living. Credit-needs types, use and source, planning for financial security of families, credit institution. Savings and Investment- types of savings / investment, Saving institution and its importance, criteria for judging family investments. Taxation- objectives, characteristics and classification. Consumer – definition and role, concept of consumer and consumer economics. Market and merchandising – types of market, definition and importance of merchandising. Consumer problems in rural and urban areas: unfair trade practices, adulteration, faulty weights and measures. Consumer rights and responsibilities. Consumerism and consumer protection- history of consumer movement in the developed and developing countries, growth of consumerism, consumer protection Act and Govt. legislation and order, NGO's for consumer protection and welfare. Standard and standardization and legislative measures for regulating quality. Sources of consumer information – advertisements, labels, packaging etc. Consumer and environment.

Suggested Readings

- Bhargava, Bela. (2005). Family Resource Management and Interior Decoration. Univ. book home Pvt. Ltd. Jaipur.
- Khetarpaul, N and Grover, I. (2004). Consumer Guide for Home Maker – Udaipur: Agratech Pub Academy.
- Maneesha Shukul and Veena Gandotra. (2006). Home Management and Family Finance. Dominant Publishers and Distributors, New Delhi.
- Mann, M.K. (2004) Home Management for Indian Families. Kalyani Publishers, New Delhi.
- Rice, Nickel and Tucker. (1976). Management in Family Finance. John Wiley and Sons., New York
- Seetharaman P. Sethi M. (2002). Consumerism Strategies and Tactics. CBS Publishers and Distributors. New Delhi.
- Tiwari, O.P. (2000). Consumer Protection Act Allahabad: Allahabad Law Agency.
- Verghese, M.N. Ugale, W. N. and Srinivasan, K. (1997). Home Management, New Delhi: New Age International.

4. Housing and Space Management 3(2+1)

Theory

Housing and its importance, characteristics and effect of insufficient housing. Factors to be considered in selection of family housing, selection of site, housing needs at different stages of family life cycle. Housing problems – rural and urban housing problems in India. Housing legislation and regulation - Building Act 1984, Defective Premises Act 1972, Disability Discrimination Act 1995, Environment Protection Act etc. Housing policies - government and non-government housing policies and housing schemes. Housing standards – sanitary facility, food preparation and refuse disposal, space and security, thermal environment, illumination and electricity, structure and material, interior air quality, water supply, lead based paints, access, site and neighbourhood, sanitary condition and smoke detectors. Types of house planning – floor plan, site plan, cross sectional plan, perspective plan, elevation plan and landscape plan. Housing finance – government and non- government finance institutes. Advantages and disadvantages of renting and owning a house. Technology in housing – advance technology in housing construction, low cost building technology, low cost building materials. Economy in housing construction – principles of house planning (orientation, privacy, grouping, roominess, sanitation, ventilation, flexibility, circulation, economy, furniture requirement). Ergonomics and housing - space management and Interior types based on functional needs – interior for youth, elderly and other special needs, functional design of areas in interior.

Practical

Learning architectural symbols. Drawing of house plans for different income levels and activity groups. House plan for renovation according to needs of residents. Designing of kitchen, bathroom etc. for special needs. Market survey to study the available building materials in the local market.

Suggested Readings

- Cherunilam, F. and Heggade, O. (1987). Housing in India. Mumbai: Himalaya Publishing.
- Dorothy Stepat – Devan, Kathryn Camp Logan, Darlene M. Kness, Laura Szekely. Macmillan Publishing Co., Inc, New York.

- Faulkner, R. and Faulkner, S. (1975). Inside Today's Home. New York: Rinehart and Winston.
- Mathur, G.C. (1993). Low Cost Housing in Developing Countries. New Delhi: Mohan Primlani, Oxford and IBH.
- Tessis Agan, M.S. (1970). The House. New Delhi: Oxford and IBH

5. Ergonomics and Appropriate Technologies 2(1+1)

Theory

Work-worker and workplace relationship, work simplification techniques, principles of ergonomics, Household drudgery- definition, Drudgery reduction. Household equipment- introduction, definition, classification and base materials used in construction. Impact of household equipments on work, worker and environment, equipment design and its effect on body posture. Energy – definition, classification and sources, causes of energy crisis and solutions, status of energy crises in India and abroad. Renewable and non renewable energy saving technologies, ways and methods in the reduction of energy consumption in household, farm and community.

Practical

Use and care of common household appliances- refrigerator, washing machine, vacuum cleaner, oven etc. Demonstration of solar household technologies, biogas, zero energy cool chamber etc. Motion Studies – process chart, operational chart etc.

Suggested Readings

- Grandjean, E. (1981). Ergonomics of the Home Taylor and Francis Ltd. New York.
- Grandjean, E. and Kroemer, K.H.E. (1999). Fitting the Task to the Human a Text Book of Occupational Ergonomics. Taylor and Francis, New York.
- Peet, I.J and Arnold, M.G. (1993). Household Equipment. John Wiley, New York.
- Science and Technology for Women. (1993). Complied by Center of Science for Village. Waradha. Department of Science and Technology, New Delhi.
- Singh, S. (2007). Ergonomics Integration for Health and Productivity. Himanshu Publication, Udaipur, New Delhi.
- Steidle, Roze and Bratton. (1968). Work in the Home. John Wiley and Sons Inc. New York.
- Swanson, Bettye. (1983). Introduction to Home Management Macmillan Publishing Co. Inc. New York.
- Varghese, M.N., Ogale, N.N. and Srinivasan, K. (1992). Home Management. Wiley Eastern, New Delhi.

6. Entrepreneurship Development and Business Management 3(2+1)

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes / competencies. Concept, need and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities,

types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning – spotting of opportunity-scanning of environment – identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- Good policies, scheme for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management / accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries. Interaction with successful entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies

Suggested Readings

- Vasant Desai. (2011). Entrepreneurial Development Potential beyond Boundaries; Himalaya Publishing House.

7. Residential and Commercial Space Design 3(2+1)

Theory

Design and space organization analysis of independent house of different income groups. Design and space organization analysis of apartments and flats. Understanding on building bye laws, regulations and specifications essential for building, and service management. Selecting materials and finishing scheme for interiors. Estimation of cost of fittings, fixtures, furniture, lighting and materials for interior finishing. Estimation of cost of fittings, fixtures, furniture, lighting and materials for commercial buildings. Appraisal on space needs in commercial buildings. Study of commercial interiors for business establishments, hotels/restaurants, hospitals, educational buildings, public service buildings Specifications writing-writing detailed clause by clause specification for materials pre and post execution, tests, mode of measurements, manufacturers details and specifications etc.

Practical

Develop conceptual drawings and floor plans for various income groups. Develop layouts of furniture, lighting, electrical and plumbing for various income groups. Practical applications of design and space organization of apartments and flats and analysis. Cost estimation for designing interiors of various income groups. Planning of ergonomic work layout for a small project (1000 sq.ft.). Planning of ergonomic work layout for hills areas and commercial areas. Evolving interior decoration details with material sample for the

small project. Evolving interior decoration details with material sample for hills areas. Evolving interior decoration details with material sample for the a large commercial area. Presentation of the detailed work done for small projects. Presentation of the detailed work done for hill areas. Presentation of the detailed work done for large commercial projects.

Suggested Readings

- Bonda P. and Sonsnowchik K. (2007). Sustainable Commercial Interiors. John Wiley and Sons Publication.
- Carol Simpson, Estimation for Interior Designers, Watson Guptill, Rev. Sub edition, 2001.
- Crafti. (2004). The office – Designing for Success. 2004. Images Publication
- Francis, D. (1997). The New Office. Conran Octopus Publication
- Harmon. S and Kennon, K. The Codes guidebook for Interiors. Fifth Edition. John Wiley and Sons Publication.
- Leibing W. Ralph(1999). Architectural Working Drawings ,4th edition John Wiley and sons, New York .
- Piotrowski, C. and Rogers, E. (1999). Designing Commercial Interiors. Second Edition. John Wiley and Sons Publication.

Courses for student READY programme

1. Event Management 3(0+3)

Practical

Identifying practical situations for event management, conceptualizing goal and objectives, Overall show management. Exhibit sales and promotion. Attendance promotion. Contract negotiations. Festivals (Diwali, religious ceremonies). Social gathering. Conference/ workshop/seminar/congress programming. SWOT analysis of event. Portfolio preparation; presentation and projection for work. Project report on visit to different types of organizational settings like hotel, guest house, hostel, small offices, clubs, fast food centers for management and organization of events. Project planning. Programme planning and execution. Project development. Event accountancy. Event communication and sponsorship. Event marketing and advertising. Live event management. Visit to different organizations/ hotels etc. Project preparation and report presentation.

Suggested Readings and Visits

- Aditya, Suvarna. (2003). Event Management Development Institute. I.E.S. Management College. 4th Floor, 791, S.K.Marg, Opp. Lilavati Hospital, Bandra (W), Mumbai - 400 050.
- Kit, Potions, H.P. Bhuson. (1998). Festival and Special Event Management. . IBM Cooperation, 60 Renfrew Drive, Suite 105, Markham, Ontario, Canada L3R0E1.
- National Institute of Event Management. Ground Floor, Nandavan Building, Corner of Vallabhbhai Road and Ansari Road, Vile Parle (W), Mumbai.
- Sulekha, Narayna. (2001). International Institute of Event Management. SNDT Women's University, Juhu Campus, Juhu Tara Road, Santacruz (W), Mumbai - 400 049.

2. Interior Design and Decoration 3(0+3)

Practical

Application of elements and principles of interior design and Decoration Preparation of utility and decoration articles by using various painting/printing techniques Calligraphy Use of floor decoration in interiors Flower arrangement and decoration for different areas and occasions Stationery designs; cover designs for books, magazines, illustrations, lettering construction etc. Accessories; various types, materials and techniques; pottery, collage, handicrafts, utility articles, paper mache items, paper sculpture, poster making, greeting cards, fabric painting, glass painting, gift wrapping etc.

Suggested Readings

- Dorothi, S. *et al.* (1980). Introduction to Interior Design. New York: Mc Millan.
- Faulkner and Faulkner. (1975). Inside Today's Home. New York: Holt, Rinehart and Winston.
- Gewther, M. (1970). The Home, its Furnishings and Equipment U.S.A. Mc. Graw Hill.
- Mike, L. (1986). The Complete Interior Decoration. United Kingdom: Mc Donald.
- Ruth, M. (1975). The Home and its Furnishings, U.S.A.: Mc. Graw Hill.
- Seetharaman P. Sethi M. (2002). Interior Design and Decoration. CBS Publishers and Distributors. New Delhi.

3. Computer Aided Interior Designing 4(0+4)

Practical

Use of computer in daily sphere and interior decoration. Basic knowledge to start: Installation Explore Auto CAD window. Concepts of Auto CAD window. Opening auto cad through keyboard, mouse and getting acquainted with main screen, tool bars, dialog box, cancel command, handling files. Drafting settings and setting preferences. Co-ordinate system and input methods, concept of isometrics. Function and toggle keys, command prompt. Draw commands – lines, multiline and pool lines. Draw commands – arc, circle and ellipse. Edit commands – trim, extend, stretch. Edit commands – rotate, mirror, break, offset. Edit commands – object properties, colour. Edit commands polyline filleting, chamfering. Layers – new, name, line weight, line type and style, changing properties. Text style and editing. Dimensioning style and editing. Hatching concept, inquiry tools, introduction to dimension style. Creation of 2d floor plan line, offset, trim, erase. Add on to the floor plan – stretch, extend, mirror, copy, move, rectangle, circle, arc, fillet, chamfer. Get organized with layers – creation of new layers, layer names, colours to layers, line types, weight, freeze. Introduction to 3d modelling – co-ordinate systems, primitive solids objects – slice, revolve, rotate, aligning, filleting, chamfering, perspective view editing. Rendering – material, light effects, backgrounds, fog, landscapes, image creation. Render the images and save them with different image files in BMP, TGA and JPEG. Camera animation of walk through, seeing the preview files and then converting the same to a movie file as AVI, editing movies files and uniting to single file.

Suggested Readings

- Aptech, Ltd. (2002). Auto CAD – A Beginners Companion. Tata Mc Graw-Hill Series, New Delhi.
- Frey, D. (2002). Auto CAD-2000. BPB Publications, Conaught Place, New Delhi.

- Srivastava, P. and Pushker, R. (2003). Multimedia an Education Tool. Advanced Publishing Concept, New Delhi.

V. Department of Food Science and Nutrition Core Courses

1. Principles of Human Nutrition 3(3+0)

Theory

Historical development of nutrition. Relationship of nutrition to health, growth and human welfare; Definitions of terms used in nutrition- Recommended dietary allowances; balanced diet; health; functional food; phytochemicals; nutraceuticals; dietary supplements. Energy- Units, sources and requirements, fuel value of foods, methods of measuring energy value of food, energy requirement of body, physical activity and thermogenic effect of food, BMR- methods of measurement, factors affecting BMR. Digestion and absorption of carbohydrates, fats and proteins. Carbohydrates- Types, functions, sources, requirement, health conditions affected by carbohydrates, significance of dietary fibre. Lipids- Types, functions, sources, requirement, health problems associated with lipids Proteins- types, functions, sources, requirement, quality evaluation, improvement, deficiency disorders and protein energy malnutrition. Vitamins- Classification, functions, sources, requirement, deficiency and toxicity of the following- (i) Fat soluble vitamins-A, D, E, K; (ii) Water soluble vitamins – C, B Complex (thiamine, riboflavin, niacin, B2, B3 and folic acid). Minerals- Classification, functions, sources, requirements, deficiency and toxicity of calcium, phosphorus, iodine, fluorine, iron, sodium, potassium, chloride, copper and zinc; bioavailability and factors affecting calcium and iron. Water, Functions, sources, distribution in body, water and electrolyte balance.

Suggested Readings

- Agarwal, A and Udipi, S. (2014). Text Book of Human Nutrition. Jaypee Medical Publication, Delhi.
- Sehgal, S. and Raghuvanshi, R.S. (2007). Text Book of Community Nutrition. ICAR Publication.

2. Food Science and Processing 3(2+1)

Theory

Food groups, food guide pyramid and its importance, foods as a source of nutrients Objectives of cooking, processing, preservation, methods of cooking with their merits and demerits. Effect of cooking and heat on nutritive value of foods. Cereals, millets and pulses: Composition and nutritive value, types, storage, processing. Cereal cookery. Gluten and factors affecting the gluten formation, cereal starch, gelatinization, dextrinization. Pulse cookery. Effect of cooking, factors affecting cooking quality, toxic constituents in pulses. Nuts and oilseeds- Composition and nutritive value, types, storage, oil extraction, processing, toxic constituents and role in cookery. Milk and milk products: Composition and nutritive value, properties, processing and packaging, effect of heat, acid, enzymes, microbes, processed and indigenous milk products and their quality, role in cookery.

Eggs- Structure, composition and nutritive value, storage, evaluation of quality of egg, role of egg in cookery. Flesh foods- Structure, composition and nutritive value, types, storage, evaluation of quality and selection of meat, fish and poultry, methods of cooking, brief description of ageing, tenderization and curing. Vegetables and fruits. Composition and nutritive value, types, storage, selection, post-harvest changes,

effect of processing, preservation and cooking on different pigments of both fruits and vegetables. Sugar and its products: Composition and nutritive value, type, function, properties, stages in sugar cookery, role of sugar in cookery. Fat and oils. Composition, nutritive value, types, role in cookery and importance in daily diet. Spices and herbs. Types and its use. Beverages and appetizers. Classification, use in everyday lives with special reference to tea, coffee, cocoa and alcoholic drinks. Leavening agents, classification and functions. Processed and convenience foods. Ready to eat foods, frozen foods, dehydrated foods, instant food mixes.

Practical

Laboratory conduct and responsibilities; knowledge of different food stuffs in English, Hindi and local language. Terms used in cookery, weights and measures; identification and use of different kitchen items and equipments. Identification and listing of various food groups; market survey of processed and preserved foods. Cereal cookery. Preparation of plain rice (open and pressure cook), lime-rice, pulao, paratha, chapatti, upma and halwa. Pulse cookery. Preparation of plain dal, dal with green, pakoras, sambar. Preparation of cereal and pulse combined recipes- Idlis, adai. Nuts and oilseeds. Preparation of chikki, til ladoos, thandai, fish in mustard paste Milk cookery. Preparation of curd and paneer. Egg cookery. Selection of egg, preparation of boiled egg, scrambled egg, poached egg. Meat and fish cookery. Preparation of meat and fish based items. Fruits and vegetables cookery: Preparation of sauces, pickles, squash, chips. Sabjis and salad Sugar cookery. Preparation of fudge and fondent. Process of caramalization; demonstration of 1-thread and 2-thread consistency. Fats and oils. Preparation puris, cakes and biscuits. Appetizers. Preparation of red tea, white tea, coffee, eggnog. Visit of food industries.

Suggested Readings

- Potter, N.N. (1996). Food Science. The AVI Publishing Company, Inc., Westport, Connecticut.
- Sehgal, S., Grewal, R.B., Kawatra, A. and Kaur, Y. (1997). Practical Aspects of Food Preservation. Directorate of Publications. Haryana Agricultural University, Hisar.
- Khadder V., (1999), Text book of Food, Storage and Preservation. Kalyani Publishers, New Dehi.
- Kalia, M. and Sood, S. (2010). Food Preservation and Processing. Revised Edition, Kalyani Publishers, New Delhi.
- Jood, S. and Khetarpaul, N. (2002). Food Preservation. Geeta Somani Agrotech Publishing Academy, Udaipur.
- Sivasankar, B. (2002). Food Processing and Preservation. PHI Learning Pvt. Ltd. Delhi.

3. Normal and Therapeutic Nutrition 3(2+1)

Theory

Determination of nutritional requirements: recommended dietary allowance, calorie consumption unit, food exchange list method. Maternal nutrition. Physiological changes and nutritional requirements during pregnancy and lactation. Infancy. Growth, development and nutritional requirement, importance of breast feeding, weaning and supplementary foods. Pre- school children. Growth and development, food habits and nutritional requirements. School age child and adolescents. Growth and development, food habits and nutritional requirements. Geriatric nutrition. Physiological and

psychological changes during old age, nutritional requirements and consideration for diet planning. Importance and modification of normal diet to therapeutic diets, Methods of feeding. Normal and artificial. Aetiology, symptoms and dietary management in acute and chronic fevers. Typhoid, influenza, tuberculosis. Aetiology, symptoms and dietary management in gastrointestinal disorders. Diarrhoea, constipation, peptic ulcer. Aetiology, symptoms and dietary management in liver diseases. Hepatitis, jaundice, cirrhosis of liver. Aetiology, symptoms and dietary management in cardiovascular disease. Atherosclerosis and hypertension. Aetiology, symptoms and dietary management in diabetes mellitus Problems of weight control. Overweight and obesity, dietetic management and prevention.

Practical

Standardization of serving size portions. Planning and preparation of diets for different age groups- Infancy, preschool age, school age, adolescent, adult, old age. Planning and preparation of diets for pregnant and lactating women. Planning and preparation of diets for special occasion. Birthdays, festivals, packed lunches. Planning and preparation of diets for following diseased condition- diarrhea, constipation, hepatitis, hypertension, diabetes, mellitus, overweight/ obesity.

Suggested Readings

- Raghuvanshi, R.S. and Mittal, M. (2014). Food Nutrition and Diet Therapy. Westvills Publication Delhi.
- Agarwal, A and Udipi, S. (2014). Text Book of Human Nutrition. Jaypee Medical Publication Delhi.

4. Clinical Nutrition and Dietetics 3(2+1)

Theory

Clinical Nutrition- Introduction, nutritional status and disease, common deficiency diseases, pathogenesis of nutritional deficiency diseases - macronutrient and Micronutrient, protein calorie malnutrition, vitamin A deficiency, anemia, iodine deficiency disorders, gastro intestinal tract diseases- Introduction, different organs and diseases, diagnostic procedure, diseases of mouth and oesophagus, diseases of stomach and duodenum, diseases of small and large intestine, diverticulitis, malabsorptive syndrome and tropical sprue Diarrhoea- Symptoms of diarrhea pathogenesis and diagnosis of constipation, diseases of liver, pancreatitis, chronic obstructive pulmonary disease, diabetes mellitus cardio vascular disease: risk factors, lipo and apo proteins, role of nutrients in preventing atherosclerosis, major enzymes used for diagnosis, congestive heart failure, hypertension. renal disease. Functions of the kidney, nephritis, urinary calculi, types of renal failure, dialysis. Cancer. Causes of cancer cell development, impact of tumor on host metabolism, systematic effects of cancer. Burns. Physical destruction of skin, metabolic aberrations, alteration

in nutritional requirement, interaction between nutrients, infection and drugs.

Practical

Estimation of albumin, glucose, ketone bodies, creatinine and creatine in urin.e Determination of bile pigments in urine Analysis of bile salts in urine Analysis of blood glucose level. Estimation of total protein, albumin, haemoglobin. Estimation of blood urea. Estimation of total cholesterol, HDL, LDL, TG in blood. Assignment and presentation.

Suggested Readings

- ICCIDD/UNICEF/WHO. (2001). Assessment of IDD and monitoring their elimination. A guide for programme managers.
- Bamji, S.M., Rao, P.N., and Reddy, V. (2003). Textbook of Human Nutrition. Oxford and IBH Publishing Co Pvt Ltd.
- Bhavana, S. (1999). Nutrition and clinical care. New Delhi Commonwealth Publishers.
- Gibney M.J, Margetts BM, Kearney J.M and Arab L. (2004). Public Health Nutrition. Publishers Blackwell Science.
- Jean-FZ. (2005). Clinical Nutrition. UK Blackwell Publishing Company.
- Jim M. and Stewant TA (2007). Essentials of Human Nutrition. 3rd edn. New York, Oxford University Press.
- Miguel, A.G. and Eduard, C. (2005). Clinical Nutrition. UK, Blackwell Publishing Company.
- Weinsier and Butterworth (1981). Hand Book of Clinical Nutrition. London, C V Mosby Company.

5. Food Analysis 3(1+2)

Theory

Sampling and sampling techniques. Proximate analysis- Moisture, ash, crude fat, crude fibre, crude protein and carbohydrates by difference. Principles and methods of food analysis. Basic principles: Refractometry, polarimetry, densitometry, HPLC, GLC, spectrophotometry,electrophoresis, automatic amino acid analyzer. Determination of starch. Test for unsaturation of fats, rancidity of fats. Quantitative analysis of protein by Biuret method, Ninhydrin method, Lowry's method and Dye-binding method Bioassays for protein quality of grains Chemical, microbiological, flurometric and colorimetric methods of analysis of fat soluble and water soluble vitamins Principles and methods for estimation of minerals: Atomic absorption spectroscopy, colorimetric, titrimetric and gravimetric methods Methods for determining physical and rheological properties of food.

Practical

Proximate analysis: Moisture, ash, crude fat, crude fibre, crude protein and carbohydrate by difference. Demonstration of kjelplus, fibreplus, sox-plus. Estimation of sugar content of fruit and reducing and non-reducing sugars in cereals. Estimation of starch content of cereals Determination of iodine value and saponification number of fats Estimation of minerals, iron, calcium and phosphorus Estimation of vitamins. Ascorbic acid, thiamine, beta-carotene. Protein quality analysis, in-vitro method Physical test for grain quality and rheological properties of foods.

Suggested Readings

- AOAC. (2000). Association of Official Analytical Chemists. Washington, DC.
- Pearson, D. (1973. Laboratory Techniques in Food Analysis. Butterworths and Co., London
- Pomeranz and Yeshajahu. (1987). Food Analysis Theory and Practice. 2nd ed. AVI Publ. Company, Westport.

- Joslyn, M.A. (1970). Methods in Food Analysis: Physical, Chemical and Instrumental Methods of Analysis. Academic Press. New York
- NIN. (2003). A Manual of Laboratory Techniques.

VI. Department of Food Policy and Public Health Nutrition Core Courses

1. Community Nutrition and Education 3 (2+1)

Theory

Malnutrition- Definition and causes, PEM, Marasmus, Kwasiorkor, vicious cycle of malnutrition. Assessment of nutritional status. Clinical signs and symptoms, nutritional anthropometry, biochemical tests, biophysical tests, diet survey methods. Major nutritional problems prevalent in India and the state of Protein energy malnutrition, anaemia, vitamin A deficiency, iodine deficiency disorders, obesity, hypertension, atherosclerosis, diabetes mellitus. National programmes and role of national and international agencies. In improving nutritional status of the community. Integrated Child Development Service (ICDS), supplementary Nutrition Program (SNP), Applied Nutrition Program (ANP), Mid Day Meal Program (MDMP), Vitamin A Prophylaxis Program, Anaemia Prophylaxis Programme. Food and Agricultural Organization (FAO), World Health Organization (WHO), United Nations Children's Fund (UNICEF), UNDP, CARE and other Voluntary and Government Agencies. Nutrition education- Objectives and methods, principles.

Practical

Assessment of nutritional status of an individual/community using anthropometry and dietary survey. A) Preparation of schedule B) Survey work C) Analysis of data D) Writing of report. Visit to local health centre to identify clinical signs and symptoms of nutritional problems. Identification of adulterants in common foods. Visit to an ICDS Block. Development of audio visual aids- radio script; popular article; chart/posters leaflets etc. Planning, implementation and evaluation of nutrition education for a target group.

Suggested Readings

- Sehgal, S. and Raghuvanshi, R.S. (2007) Text Book of Community Nutrition. ICAR, New Delhi.

2. Food and Nutrition Policy and Agriculture 2(2+0)

Theory

Food situation in India and in the world, food production and consumption trends, food balance sheets. Role of nutrition in agricultural planning and national development. Linkages between agricultural practices, Food production, food distribution and nutritional status. Food crop failure and malnutrition, poverty and vicious cycle of low food production. Agricultural development and its effect on food availability. Effect of food production and economic policies on food availability. impact of physical resources, farming systems, cropping system, inputs and manipulation, agricultural marketing system, post harvest processing of foods on food and nutrition situation. Food distribution systems. Food security. Concepts and definitions agriculture and food security, nutrition and health urbanisation and food

security, food systems and food security, macroeconomic policies Employment and cash income, markets and food prices. Effect of urban agriculture on the nutritional status of vulnerable groups Innovative approaches to enhance local food production and improve food distribution systems. Innovative and effective approaches to manage health risks of urban agriculture. Implications for urban policies and programmes. Food and nutrition security at national and household level; nutrition policy implementation; nutritional impact of agricultural programmes, food price control and consumer subsidy; contribution of national and international organization for agricultural development.

Suggested Readings

- Bhatia MS. (1991). Agricultural Statistics at a Glance. Ministry of Agriculture, Govt. of India, New Delhi.
- Census (1981, 1991, 2001).
- India (2001). A Reference Annual. Publication Division, Ministry of Information about Broad casting, Govt. of India.
- UNICEF (1999). The State of World's Children. Oxford University Press.

3. Food Hygiene and Sanitation 2(1+1)

Theory

Meaning and Principle of food hygiene. Water Requirement and use, sources of water supply, water pollution, purification of water, portable water and its quality-Criteria and standards,hardness of water and its treatment, defluoridation of water. Food hygiene: Contamination of foods from various sources. Green plants and fruits, animals, sewage, soil, air and water and their health hazards. Food spoilage. Perishable, semi perishable and non perishable foods. Sanitary procedures for preparation, handling and storage of foods. Food poisoning caused by bacteria: *Salmonella, Staphylococcal poisoning, Botulinum, Clostridium perfringens and B.cerus*. Sources, incubation period, mechanism of action. Investigation of Food Poisoning, prevention and control. Food Poisoning caused by agents other than microorganism. Poisonous plants, animals, chemicals, metals and pesticides etc.

Practical

Identification of micro organism, preparation of slides, preparation of media. Collection of water samples. Testing of water for: (i) Physical quality (ii) Bacteriological quality. Survey of hygienic and sanitary condition in food shops/food vendors. Report writing.

Suggested Readings

- Adams M.K. and Moss M.O. (2000). Food Microbiology, New Delhi: Panima Corp.
- Longree K.L. and Blaker G.C. (1982). Sanitary Techniques in Food Service. New York: John Wiley and Sons.
- Park, K. (1997). Textbook of Preventive and Social Medicine. 1st Ed. Jabalpur: Banarsidas Bhanot.

4. Food Standards and Quality Control 3(2+1)

Theory

Importance of quality control and assurance. Food laws and regulations. Prevention of Food Adulteration Act, Fruit Product Order, Agmark, Essential Commodity Act, Consumer Protection Act, Bureau of Indian Standards, Codex Standards. Specifications and application of food standards for raw materials and food products Food additives. Preservatives, coloring agents, antioxidants, emulsifying agents, leavening agents and stabilizing agents Various methods for the assessment of quality of different foods Selection of sensory panel and sensory evaluation of food products. Food safety, risks and hazards Assessment and prevention of food adulteration. Food packaging and packaging material.

Practical

Sensory and nutritional evaluation of some finished products. Detection of adulterants and preservatives in products.

Suggested Readings

- Potter, N.N. (1996). Food Science. The AVI Publishing Company Inc., Westport, Connecticut.
- Jellinek, G. (1985). Sensory Evaluation of Foods: Theory and Practice. Ellis Honwood Ltd. Chichester, England.
- Manual of Food Standards and Quality Control. (2014). Dept. of Foods and Nutrition, CCS HAU, Hisar.
- Swaminathan, M. (1999. Food Science, Chemistry and Experimental Foods. 2nd ed. The Banglore Printing and Publishing Co., Bangalore.
- Many, N.S. and Shadaksharswamy, M. (1996). Food Facts and Principles. 2nd ed. New Age International Pvt. Limited, New Delhi.
- Kalia, M. and Sood, S. (2010). Food Preservation and Processing. Revised edn. Kalyani Publishers, New Delhi.

Courses for Students READY Programme

1. Diet and Nutrition Counseling 3(0+3)

Practical

Planning and preparation of diets using exchange lists. Processes and technique of counseling Diet planning in fever and infection Diet planning in GI disorders Diarrhea, constipation, gastritis, ulcerative colitis Diet planning in liver disease. Diet formulation in diabetes millitus. Diet planning in heart diseases. Diet planning in kidney diseases Diet planning in food allergies and gout Diet modification for prevention and treatment of cancer Diet in trauma and burns. Diet in obesity and underweight. Diet for old age people. Setting up a unit for nutrition counseling. Role play exercises for counseling. Supervised counseling of patients/clients. Visit to hospitals with therapeutic kitchen setup.

Suggested Reading:

- Antia, P. (1986). Clinical dietetics and nutrition. Oxford Univ. Bombay
- Moris, E.S. (1994). Modern Nutrition in Health and disease. Leaned Febiger, USA

- Aronson. V. (1986). Effective Nutrition Counselling. Van Nostrand Reinfold, New York.
- Bamji, M.S. (2003). Textbook of Human Nutrition. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- Mahan and Stump. (2003). Kraus's Food Nutrition and Diet Therapy. 11th ed. Saunders Publishing.
- Mahan L.K. and Raymond, J. L. (2011). Krause's Food and the Nutrition Care Process. 13th ed. Saunders Publishing.
- Sardesai, V. (2011). Introduction to Clinical Nutrition. CRC Press.

2. Food Preservation and Storage 3(0+3)

Practical

Market survey of raw and preserved foods. Preparation of preserved products. Squash, cordial, crush, jams, jellies, marmalade, candy, preserves, murabbas, pickles with and without oil, chutneys, ketchup, sauces, candies, toffees, cheese and syrup. Shelf life and sensory evaluation of developed products Demonstration on canning and bottling of fruits and vegetables. Demonstration on storage of food grains. Visits to food processing and preservation units, canning and bottling units, grain storage institute dairy plant and FCI godown.

Suggested Readings

- Potter, N.N. (1996). Food Science. The AVI Publishing Company, Inc., Westport, Connecticut.
- Sehgal, S., Grewal, R.B., Kawatra, A. and Kaur, Y. (1997). Practical Aspects of Food Preservation. Directorate of Publications. Haryana Agricultural University, Hisar.
- Vijay K., (1999), Text book of Food, Storage and Preservation, Kalyani Publishers, New Dehi.
- Kalia, M. and Sood, S. (2010). Food Preservation and Processing. Revised Edition, Kalyani Publishers, New Delhi.
- Jood, S. and Khetarpaul, N. (2002). Food Preservation. Geeta Somani Agrotech Publishing Academy, Udaipur.
- Sivasankar, B. (2002). Food Processing and Preservation. PHI Learning Pvt. Ltd. Delhi.

3. Food Service and Hospitality Management 3(0+3)

Practical

Contribution of food service institutions in meeting socioeconomic and dietary needs. Menu planning for industrial canteen, hospital canteen, cafeteria, snack bar, residential hostel. Standardization of recipes suitable for fast food outlet, industrial canteen, hospitals, college hostel. Multiplication of standard recipes for quantity food production, quantity food management, portioning and fixing of cost. Visit to canteen attached to hospital and dietary department cafeteria, 3 star hotel/restaurant, 5 star hotel / restaurant, industrial canteen. Presentation of report on hospital canteen, cafeteria, 3 star hotel / restaurant, 5 star hotel / restaurant in terms of organizational set up, production, preparation and service. Practical exercise on planning, preparation and service in a cafeteria, snack, bar fast food outlet. Management of

cafeteria – preparation, costing and fixing of price for meal items. Evaluation of management process and report presentation.

Suggested readings

- Sethi and Malhan. (1993) Catering Management: An Integrated Approach. Wiley Eastern.
- West, Wood and Hanger.
- Food Service in Institutions. John Willey.

4. Nutraceuticals and Health Foods 3(0+3)

Practical

Market survey for dietetic foods. Planning, preparation, nutrient calculation and acceptability of dietetic foods with preference to locally available food stuff. High/low energy, high/low protein high/low fibre low sodiumlow cholesterollow dycemic index low fluid, high fibre and low fat. RUTF (Ready to use therapeutic foods) for under nutrition in preschool and school age children. Food for sports person in intensive activities and endurance activities. celiac disease, Food for lactose intolerance Food for senior citizens (with dental problem, with flatulence, digestive disorders, physical and nervous diseases.

Suggested Reading

- Brigelius-F., J. and Joost HG. (2006). Nutritional Genomics: Impact on Health and Disease. Wiley VCH.
- Cupp, J. and Tracy, T.S. (2003). Dietary Supplements: Toxicology and Clinical Pharmacology. Humana Press.
- Gibson, G.R. and William CM. (2000). Functional Foods - Concept to Product.
- Goldberg I. (1994). Functional Foods: Designer Foods, Pharma Foods. 1st ed. Springer US
- Losso, J.N. (2007). Angi-angiogenic Functional and Medicinal Foods. CRC Press.
- Manson, P.(2001). Dietary Supplements. 2nd ed. Pharmaceutical Press.
- Campbell J.E. and Summers JL. (2004). Dietary Supplement Labelling Compliance.
- Neeser, J.R. and German BJ. (2004). Bioprocesses and Biotechnology for Nutraceuticals. Chapman and Hall.
- Robert, E.C. (2006). Handbook of Nutraceuticals and Functional Foods. 2nd edn. Wildman.
- Shi J. (2006). Functional Food Ingredients and Nutraceuticals: Processing Technologies. CRC Press.
- Webb, GP. (2006). Dietary Supplements and Functional Foods. Blackwell Publ.
- Robert. E.C. (2002). Hand book of Neutraceuticals and Functional Foods, CRC, Press.
- Goldber, I. (1999). Functional foods: Designer foods, Pharma foods and Nutraceuticals, An Aspen Publications.
- Ghosh, D., Baghchi Debasis and Konishi Tetsuya. 2014. Clinical Aspects of Functional Foods, CRC Press.
- Swaminathan, M. (2004). Essential of Foods and Nutrition. Vol.I and II BAPCO, Bangalore.
- Srilakshmi B. (2002). Dietetics. New Age International, New Delhi.

Department of Human Development and Family Studies Core Courses

1. Fundamentals of Human Development 2(2+0)

Theory

Human development as a field of study. History of study of human development, scope and importance of study of human development from a life-span perspective. Relationship of the discipline of human development with other disciplines of study. Latest issues in human development. Growth and Development. Definition of growth and development difference between growth and development, determinants of human growth and development; principles of human growth and development Genetic basis and concepts associated with human life; stages of human development; domains of human development and its characteristics. Theories of human development: naturalism. environmentalism, maturational, need, ecological, ethological, cognitive, social, psychoanalytical, language and moral research involving humans. Definition of ethics and research, practical and ethical principles and concerns in research with human subjects. Ethical trends and challenges. Origins of scientific inquiry, research designs and methods of data collection- their merits and demerits, variables, hypothesis, sampling, operational

definitions.

Suggested Readings :

- Berk, E. L. (2013). Exploring life span development.3rded. McGraw Hill, New York.
- Santrock, J. (2012). Life span development. 14thed. McGraw Hill, New York.
- David, M.T., Garavan, L. and Dooley, M. 2012. Fundamentals of human eesource development. *SAGE Publications Ltd*
- James, M. and Nelson. (2009). Fundamentals of human development, religion, and spirituality. Oxford Higher Education.
- Papalia, D.E. and Olds, SW. (2008). Human development. 11thed. McGraw Hill. New York.
- Harris, J.R. and Liebert, R.M. (1987). The child. Prentice Hall, Inc.
- Parke, R.D. (Ed). (1984). Review of child development research. Volume 7: The family. University of Chicago Press, Chicago.
- Garbarino, J. (1982). Children and families in the Social Environment. Aldine, New York.
- Bronfenbrenner, V. (1979). The ecology of human development. Cambridge, Harvard Univ. Press.
- Hall, Calvin S and Lindzey. G. (1978). Theories of personality. John Wiley and Sons.
- Munsinger, H. (1971). Fundamentals of child development. Holt, Reinhart and Winston, Inc.

2. Life-Span Development 3 (2+1)

Theory

Prenatal, perinatal and postnatal stages- Issues and scientific concepts associated with conception, pregnancy, prenatal development, labour/ birth, postnatal life infancy- physical, motor, social, emotional, cognitive and language characteristcs. Antecedent influences for infancy growth and development.

Early Childhood- Physical, motor, social, emotional, cognitive and language characteristcs. Antecedant influences for early years growth and development, Stimulating approaches for optimising development. Middle childhood- Physical, motor, social, emotional, cognitive and language characteristcs. Antecedant influences for growth and development during middle childhood, Adolescence- Physical, motor, social, emotional, cognitive and language characteristcs. Antecedant influences for growth and development during adolescence. Adulthood- Physical, motor, social, emotional, cognitive and language characteristcs. Antecedant influences for growth and development during adulthood. Stimulating approaches for optimising development. Old age- Physical, motor, social, emotional, cognitive and language characteristcs. Antecedant influences for growth and development during old age. Stimulating approaches for optimising development. Recent issues in growth and development from infancy to old age.

Practicals

Observational visits to well baby clinic to observe full term and preterm babies. Case study of individuals in different stages of development- Infancy, early childhood, school age, adolescence, adulthood and old age. Critical analysis of case study reports; preparation of resource files.

Suggested Readings:

- Laura, B.E. (2013). Exploring life span development. 3rded. McGraw Hill, New York.
- Santrock, J. (2012). Life span development. 14thed. McGraw Hill, New York.
- Papalia, D.E. and Olds, S. W. (2008). Human development. 11thed. McGraw Hill, New York.
- Grinder, R.E. (1993). Adolescence. John Wiley and Sons, New York.
- Schaimberg, L.B. (1988). Child and adolescent development. Macmillan publishing company, New York.
- Papalia, D.E. and Olds, S.W. (1978). Human Development. McGraw-Hill, New York.
- Gordon, K.J. (1975). Human development: A transactional perspective. Harper and Row Publishers, New York.

3. Marriage and Family Dynamics 3 2+1)

Theory

Marriage- Definition, goals/functions, types/forms of marriage in India, rituals and ceremonies of marriage in different religions of India readiness for marriage– Definition, importance, areas of readiness for marriage. Identifying characteristics of readiness for marriage Mate selection- meaning, mode/methods of mate selection. Field of mate selection. Theories of mate selection. Ways of mate selection in tribal India. Factors responsible for wrong mate selection. Guidelines for mate selection, engagement and its importance. Marital roles and behaviours- Definition and importance of marital roles, marriage as status and role transition, determinants of marital role behaviour, concept related to gender roles, changing gender roles, factors responsible for change in gender roles, role conflict marital adjustment- definition, Areas of marital adjustment, factors influencing marital adjustment, types of marital relations and adjustments, marital adjustment over the family life cycle, obstacles in marital adjustment, Improving marital adjustment, marital adjustment techniques, general techniques of resolving differences, marital success, criteria of marital success marital dissolution: definition, types (Voluntary and Involuntary), factors responsible for

an increase in the rate of legal marital dissolution, factors responsible for refraining from divorce after marriage failure, social process of marital failure and divorce, separation distress and factors affecting it, no-fault divorce, consequences of divorce, children's response to divorce, children as weapon against divorce, adjustment to divorce family. Definition, functions, forms/types of family. Family structure and relationships in India- Pattern of changes in family structure and relationships in India, familial (education and employment of women) and Extra Familial Factors (technology, peer group, society) responsible for the changes and consequences of these changes on the family life and society. Family life cycle- Definition, importance of studying family life cycle, developmental tasks, stages of family life cycle, developmental tasks of stages of family life cycle, typical and alternative forms of families- Characteristics of Single parent families, female headed families, childless families, adoptive families, dual earner families, reasons behind alternative form of family and its merits and demerits, alternatives to marriage- singlehood, heterosexual cohabitation/ consensual union, homosexual union, reasons behind it and its merits and demerits family stress – Definition, types/ categories of stressors, variables affecting family's response to stress, Hill ABCX Model/ theory of family stress, causes of family stress, effects/ impact of family stress, manifestations/ recognising symptoms of family stress, stress coping strategies, correlates of family stress. Family crises- Definition, when does stress becomes a crisis, hill's ABCX. Theory of family crisis, conditions for crisis, what happens in a crisis? Stages of a crisis, characteristics of crisis events, effects of crises, factors which affect meeting the crises, adjustment to crises, general things to do in times of crises. Laws and acts regarding marriage, adoption, divorce and inheritance in India. Counselling (premarital, marital and family)- objectives, importance, areas of counselling, types, process and effects.

Practical

Study on motives of marriage, selection of partner; visit to marriage bureau and family counselling center. Comparative study on nuclear and joint families, atypical families and alternative forms of families. Marital roles and adjustments, family crisis and coping; Roles across family life cycle.

Suggested Readings:

- Benokraitis.V.N. (2014). Marriage and families. 8th ed. Pearson publication.
- Ahuja, R. (2005). Indian social system. Rawat publication. New Delhi.
- Kumar, R. (2000). Violence against women. Anmol publication pvt ltd., New Delhi.
- Goode, W.J. (1989). The family. New Delhi: Prentice Hall of India Private Limited.
- Adams B.N. (1980). The family: A sociological interpretation. 3rded. Rand McNally College Publishing Company, Chicago.
- Nye, I. (1973). The family: Its structure and interaction. MacMillan Publishing Company, New York.
- Kenkel, W.F. (1973). The family in perspective. Meredith Corporation, New York.
- Gordon Michael (ed). (1972). The nuclear family in crises. The search for an alternative. New York: Harper and Row Publishers.
- Hate, C.A. (1969). Changing status of woman. Allied publishers, New Delhi.
- Kapadia. K.M. (1966). Mariage and family in India. 3rded. Oxford university press, Kolkata.

4. Educational Psychology and Early Childhood Education 3(2+1)

Theory

Educational psychology- Meaning, nature, scope and importance of educational psychology, history of its evolution, abroad and in India, recent trends and challenges in educational psychology concept of learning- definition, essential features, types of learning, laws of learning, principles of learning learning traits- sensation, perception, imagination, attention and memory, remembering and forgetting, intelligence- reasoning and thinking, temperament, problem solving, information processing learning environment- reinforcement- definition, types of reinforcements, schedules of reinforcement, importance of reinforcement in learning, punishment- meaning, functions, types, essentials of good punishment, effect of punishment on learning, motivation- definition, types, modes of motivation (contingency contract, token economy) relationship of motivation with learning and performance discipline- meaning, social attitudes towards it, need for discipline, wholesome and unwholesome functions of it, essentials in discipline, techniques of discipline, factors influencing choice of disciplinary techniques, evaluation of disciplinary techniques, theories for classroom teaching and its applicability – learning theories of Jerome Bruner, Robert Gagne, Jean Piaget, Erik Erikson, Lev Vygotsky, Lawrence Lohlberg performance evaluation – meaning of evaluation/ testing, eays of evaluation of student's performance. Types of tests used in classroom evaluation. Advantages and abuses of testing and tests. Meaning, characteristics and significance of early childhood years. Programme planning in ECE- Steps and types of programme planning, activities to promote all round development of preschool children- cognitive, language, socio-emotional and motor development, role, qualities and responsibilities of an early childhood personnel.

Practicals

Analysing effect of reinforcement, motivation, discipline on learning. Application of theories of classroom teaching. Application of different methods of evaluating performance and interpretation. Observation and recording of activities in ECE center. Developing and conducting activities to promote all round development- Gross and fine motor skills, cognitive skills, language skills, creativity and socio emotional skills. Preparation of suitable teaching learning material used for preschool children.

Suggested Readings

- Mertens, M.D. (2014), Research and evaluation in education and psychology. Sage publication.
- Papalia, D.E. and Olds, S. W. (2008). Human development. 11thed. McGraw Hill. New York.
- Mazur, J.E. (1989). Learning and behaviour. Prentice Hall, New Delhi.
- Klausmier, H.J. (1985). Educational psychology. Harper and Row, New York.
- Dubious, N.F. (1979). Educational psychology and instructional decisions. Dorsey press

5. Family Counseling and Child Welfare 3(2+1)

Theory

Concept, nature, scope, principles and need of family counselling, trust areas in family counselling- educational, vocational, social, personal, premarital and marital, problems in family counselling, methods of handling problems, approaches to evaluate family counselling, counselor's self-awareness

and growth. Situation analysis of child, women, youth, elderly, disabled and reserved category in India and in the world- Census, Issues and challenged, determining factors for the present status, impact of present status on the family and society at large. Child welfare- definition, need, constitutional, provisions for children, legislations pertaining to children, schemes/projects and policies for children, other activities of child welfare, women welfare- definition, need, constitutional, provisions for women, legislations pertaining to women, schemes/projects and policies for women youth welfare- definition, need, constitutional provisions for youth, legislations pertaining to youth, schemes/projects and policies for youth elderly welfare- definition, need, constitutional, provisions for elderly, legislations pertaining to elderly, schemes/projects and policies for elderly disabled/ exceptional pupil welfare- definition, need, constitutional, provisions for disabled, legislations pertaining to disabled, schemes/projects and policies for disabled reserved category welfare- definition, need, constitutional provisions for reserved category, legislations pertaining to reserved category, schemes/projects and policies for reserved category national and international organizations and agencies working for child, women, youth, elderly and disabled welfare: UNICEF, WHO, CARE, DWACRA, NIPCCD, CIF etc.

Practicals

Visits to organisations offering counseling to families. studying the areas of family counseling, identifying the families which are in need of counseling, conducting counseling sessions to families, presentation of reports. Visits to various government and non government organisations working for the welfare of the children, Presentation of reports.

Suggested Readings

- NIPCCD. (1994). Child in India: A statistical profile. NIPCCD, New Delhi.
- Randhawa, M.S. (1991). The Rural and urban aged. National Book Organization, Unit IX, New Delhi.
- Saraswathi, S. (1991). Youth in India. ICSSR, Govt. of India, New Delhi.
- TISS (1994). Enhancing the role of family as agency for social and economic development. TISS Bombay. Vol. II, Part II.
- UNICEF. (1990). Children and women in India: A situation analysis. Unit VI, VII.
- Marasimhan, S. (2001). Employment of women. Sage publication. New Delhi.
- Boraian, P.M (2008). Employment of rural women. Concept publishing company. New Delhi.
- Mehta, L.P and Jaiswal, S.S. (2001). Child labour and the laws. Deep and Deep publication. New Delhi.
- Devi, L. (1998). Child and family welfare. Anmol publication. New Delhi.
- Devaisia, L. (1991). Girl child in India. Ashish publishing house. New Delhi.
- Down, W.S. (2006). Child welfare and family services.8thedi. Pearson education publishers.
- Pecora, J.P. (2009). The child welfare challenge: Policy, practice and research. Aldine transaction publisher.

6. Developmental Challenges in Children 3(2+1)

Theory

Special needs and special education: Definition of special needs children and special education, terminologies for children with special needs, history of special education, current trends and issues in special education, legislation and litigations of special education labelling- definition and its effects. Mainstreaming- definition, models of mainstreaming, problems in implementing mainstreaming, effect of mainstreaming on children with special needs mental retardation-definition, classification, prevalence, causes and measurement of mental ritardafoon, their psychological and behavioral characteristics and educational considerations for MR children, managing child in school learning disabilities- definition, prevalence, causes and measurement of LD, psychological and behavioural characteristics of LD children, educational considerations for LD children, managing child in school emotional disorders- definition, classification, prevalence, causes and identification of ED, psychological and behavioural characteristics of ED children, educational considerations for ED children, managing child in school communication disorders- definition, speech production, speech disorders, language disorders, multiple disorders (disorders associated with cerebral palsy, hearing impairment, cleft palate or cleft lip, MR, ED and LD), prevalence, Causes of CD, identification, psychological and behavioural characteristics of CD children, educational considerations for CD children, managing child in school hearing impairment- definition, anatomy and physiology of ear, classification, prevalence causes, measurement of HI children, psychological and behavioural characteristics of HI children, educational considerations for HI children, managing child in school visual impairment- definition, classification, prevalence, anatomy and physiology of eye, causes and measurement of VI children, psychological and behavioural characteristics of VI children, educational considerations for VI children, managing child in school physical impairment- definition, classification, prevalence, neurological impairments, musculoskeletal conditions, congenital malformations, accidents, diseases and other conditions, psychological and behavioural characteristics of PI children, educational considerations for PI children, managing child in school giftedness- definition, prevalence, Origins of giftedness, Screening and identification of giftedness, Psychological and behavioural characteristics of gifted children, attitudes towards gifted children, educational considerations for gifted children, managing child in school. Rights and provisions for children with special needs in India. Intervention- concept, methods, steps and process, intervention strategies for children with special needs, role of professionals, need and importance of family centered intervention.

Practicals

Observational visits to institutes for children with special needs. Identification of children with special needs in the local community. Developing educational material on identification of children with special needs, organising education programmes for families of children with special needs, planning, recreational and vocational activities for children with special needs; Presentation of case study reports.

Suggested Readings

- Berdine, W.H. and Blackhurst, A.E. (1985). An introduction to special education. 2nd ed. Harper Collins, Lexington.
- Hallahan, D.P. and Kauffman, J.M. (1991). Introduction to exceptional children. 5th ed. Allyn and Bacon, Boston.

- Loring, J. and Burn, G. (Eds.). (1978). Integration of handicapped children in society. Routledge and Kegan Paul, London.
- Werner, D. (1994). Disabled Village Children (Indian edition). Voluntary Health Association of India, New Delhi.
- Philip, M. and Duckworth, D. (1985). Children with disabilities and their families: A review of research. Berks: NFER-NELSON Publishing Co., Windsor.
- Achenbach, T.M. (1982). Developmental psychopathology. 2nd ed. John Wiley, New York.
- Tinberger, N. and Tinberger, E.A. (1983). Autistic children: New hope for a cure. Allen and Unwin, London.
- Hegarty, S. (2002). Education and children with special need. Sage publication. New Delhi.
- Rozario, J. and Karanth, P. (2003). Learning diability in India. Sage publication. New Delhi.
- Prasad, J. and Prakash, R. (1996). Eduaction of handicapped children, problems and solution. Kanishka publication distribution. New Delhi.

Courses for student READY programme

1. Methods and Materials for Teaching Young Children 4(0+4)

Practicals

Orientation on different methods and materials used for teaching young children. Survey of available different kinds of literature appropriate for infancy through early childhood. Visit to Organization and Children's libraries for development of literature, Reporting on different kinds of literature appropriate for infants and preschool children. Developing stories appropriate for infancy through early childhood- A Folk tale, A Fairy tales, A Personal story etc., Carry out discussions on developed stories, Collection and Observation of different techniques of story telling. Identifying and analyzing the different techniques of story telling, Practicing techniques of effective story telling, Identifying methods of development of creativity -Analyzing situations/ conditions that foster creativity-Preparation of art file with different forms of paintings and printing appropriate for infancy through early childhood- Preparation of collage, murals and models appropriate for infancy through early childhood -Art activities (Painting and graphics, Tearing, cutting, pasting and collage, murals, modeling, printing, blocks, sand and mud, water)- preparation of each medium of art activity for young child's development, types/variations in art activities, identification of different types of creative expressions in young children- creating songs with music and rhythm movements appropriate for infancy through early childhood- making simple musical instruments with indigenous material- preparation of different types of puppets -practicing musical activities- learning basic manipulation skills: use of music, voice modulation and sound effects. Making sets and backgrounds- Identifying different types of creative dramas- Scripting for short puppet show and creative dramas, planning and implementing activities to promote creative expressions among young children through a variety of media i.e. painting, printing, modelling, cutting, pasting, blocks, puppetry, music movement, drama and language, Developing resource file, Organising an Exhibition and evaluation of materials developed.

Suggested Readings

- Blackie, Pamela. (1972). Drama. Macmillan, London.
- Contractor, M. (1984). Creative drama and puppetry in education. National Book Trust of India, Delhi.
- Currell, D. (1985). The complete book of puppet. A and C. Black, London.
- Garretson, R. (1966). Music in childhood education. Meredith Publishing Company, New York.
- Hendrick, J. (1980). Total Learning for the Whole Child. The C V Mosby, St. Louis.
- Kaul, V. (1991). Early childhood education programme. NCERT, New Delhi.
- Kaul, V. and Bhatnagar, R. (1992). Early childhood education: A trainer's handbook, NCERT, New Delhi.
- Lacper, S., Witherspoon, R. and Day, B. (1984). Good schools for young children. Mac Millan, New York.
- Maxim, G. (1985). The very young. Wadsworth Publishing Company, Belmount, California.
- Murlidharan, R. and Asthana, S. (1991). Stimulation activities for young children. NCERT, New Delhi.
- Robinson, H. (1983). Exploring teaching. Allyn and Bacon, London.
- Swaminathan, M. (1984). Play activities for young children, UNICEF, New Delhi.

2. Education and Counseling of Parents and Community 2(0+2)

Practicals

Orientation on need and importance of parent and community education. Understanding recent issues and challenges. Parent-Child Relationships and its impact on children. Studying various methods of parent and community education. Visit of local community to identify parents of normal and exceptional children, rapport building, identifying families with problems and conducting case studies, acquiring familiarization with the tests and techniques used for the assessment of troubled families, identification of areas and issues for parent education, developing parent education programmes, Planning, conducting and evaluating parenting education programmes, Wisconsin model of community education, study on communication barriers- differences between men and women, conducting sessions in the community on communication skills and effective human communication, studying on various approaches and techniques of counselling, organising counseling sessions for individuals, couples, parents and families of normal and exceptional children by using appropriate therapies – cognitive behavioural therapy (CBT), rational emotive behavioural therapy (REBT), client centered and existential therapies etc, establishing and managing the resource centre for parents and local community, implementing and evaluating the programmmes developed.

Suggested Readings

- Epstein, L.J. (2010). School, family and community Partnership: Preparing educators and Improving School, Westview press.

- Tett, L. (2006). Community education: Lifelong learning and social inclusion (Policy and practice in education). Dunedin Academic Press.
- Campbell, D. (2003). Group parent education: Promoting parents learning and support. Sage publication.

3. Early Childhood Care, Education and Management 4(0+4)

Practicals

Visits to nursery schools/ ECCE centers for observation of material, space, personnel, finance, documentation, orientation on areas of development during early childhood period- – planning and implementing activities for physical and motor development, language development, cognitive development, socio-emotional development and creativity , planning theme based developmentally appropriate programmes for crèche, Nursery, LKG and UKG children, preparing yearly and weekly plans for pre-primary education programmes, implementation of prepared plans, visit to different types of ECE centers - based on funds and resources and philosophy and function styles, observation of records and reports maintained in ECE center, organizing parent teacher conferences/ meetings, planning parental participation in ECE programme, celebration of annual day of ECCD center, orientation on management of ECCE programmes- planning, organizing, staffing, leading, monitoring and controlling for quality, designing the activity corners in ECE center- arranging and equipping the classroom – block center, language and art center, creative art and construction center, science and collection center, math and manipulative material center, pretend and play center, sand and water center, outdoor nature center, preparing ECCE project proposal, budget preparation for ECE center, preparation of brochures, leaflets, communication documents for parents and public, evaluation of daily, weekly and monthly schedule of activities prepared, reporting on monitoring and evaluation of classroom arrangements, cleanliness, record keeping etc, planning and organizing field trips, identification of preprimary children with mild behavioural problems – planning and execution of strategies of children with mild behavioural problems, evaluation of strategies planned for children with mild behavioural problems. Presentation of reports.

Suggested Readings

- Hildebrand, V. (2014). Management of child development centers. 8thed. McMillan publishing. New York.
- Mohanty, J. and Mohanty, B. (2007). Early childhood care and education (ECCE). Deep and Deep publishing pvt ltd.
- Agarwal, C.J. (2007). History and philosophy of pre-primary and nursery education. DOABA house, New Delhi.
- Singh, B. (2004). Preschool education. APH publishing corporation, New Delhi.
- Rao, K.V.and Islam-ul-Khurshid. (1997). Early childhood care and education. Ajay Verma for Common Wealth publishers, New Delhi.
- Gill, S. (1993). Child care programmes in India: Changing trends. In Saraswathi, S.S. and Kaur, B. Sage Publication. Unit II, New Delhi.
- Roopnarine, J.L. and Johnson, J.E. (1993): Approaches to early childhood education. Macmillan Publishing Co., New York.

- Beaty, J.J. (1992). Skills for preschool teachers. Macmillan Publishing Co.
- Kaul, V. (1991). Early childhood education programme. National Council for Educational Research and Training, New Delhi.
- Bamahas, A.S., Anandlakshmy, S., Chandra and Bose, A. (1988). Profile of the Child in India. Ministry of Social Welfare, New Delhi.
- Lawton, J.T. (1988). Introduction to child care and early Childhood Education. Oxford and IBH, Calcutta.
- Bose, A. (1987). Encyclopaedia of social work in india. Ministry of Welfare, Government of India, New Delhi.
- Cole, Luella. (1987). A History of education. Holt: Rinehart and Winston, New York.
- National policy on education. (1986). Ministry of Human Resource Development, New Delhi.
- Dutta, Vrinda (1985). Home away from home. M.S. Swaminathan Foundation, Madras.
- Dass, J.R. and Carg, V.C. (1985). Impact of pre-primary education: Dropout, stagnation and academic performance. Education Department, Municipal Corporation, New Delhi.
- Pareek, U. et al. (1985). Behavioural processes in organizations. Oxford Publications, New Delhi.
- Raja, Moonis and Nangia, S. (1985). Atlas of the child India. Concept publishing company, New Delhi.
- Decker, C.A. and Decker, J.R. (1984). Planning and administering early childhood programmes. Charles E. Merrill, Columbus.
- Spodak, Bernard (1982). Handbook of research in early childhood education. The Free Press, New York.
- Leeper, S.H. Skipper, S.D. and Witherspoon, R.L. (1979). Good schools for children. Macmillan Publishing House, New York.
- Naik, Chitra (1978). Growing up. Kosbad Hill. Gram BalShikshan Kendra, Thane.
- Boegehold, B., Harriet, K., Hook, U. and Klopt. G. (1977). Education before five. Bank Street College of Education, New York.
- Indian association for preschool education (1976). New approaches to child education: Children in rural and tribal settings. 12th annual conference of IAPE.
- Sri Ram, R. (1974). Social support services for women delivery systems. In Barooah, R. capturing complexity. Sage Publication, New Delhi.
- Shirley, M.G. and Kilmer, S. (1973). Contemporary pre-school education. John Wiley and sons Inc., New York.
- Spodek, Bernard. (1972). Teaching in the early years. Prentice Hall of India Pvt limited, New Delhi.
- Read, K. (1966). Nursery school: A human relations laboratory. Oxford IBH Calcutta.

4. Developmental Assessment of Young Children 3(0+3)

Practicals

Orientation on Screening and developmental assessment of young children for various developments through different tools and techniques. Exploring existing areas, approaches and tools in developmental screening; Orientation on formal and informal measures in assessment, special considerations and ethical issues in assessing various areas of developments of Toddlers, Infants, Preschoolers and Pre-Primary school children. Conducting tests for Neonatal assessment – APGAR and Gestational age, Neonatal Behavioural Assessment Scale (BNBAS), Conducting tests for Infant and Toodler hood assessment - Anthropometry, Developmental Screening Test, Bayley's Scale of Infant Development (BSID), Vineland social Maturity scale etc. Screening and assessment of preschool and Preprimary school children- Stanford Binet Intelligence Scale, Weschler Scale of Intelligence for Preschool and Primary School Children, Vineland Social Maturity Scale, Adaptive Behaviour Scale; DAS II; Thematic Apperception Test (TAT), Children's Apperception Test (CAT), Raven's Coloured Progressive Matrices (RCPM); Pea body Picture Vocabulary test, PramilaPathak's Mental and Motor Growth of Indian babies; Ecological assessment of Preschool and Preprimary school children- HOME Inventory; Informal measures like Time sampling, event sampling, sociogram, Anectodtal records, Case studies etc; Assessment of readiness skills of pre-primary school children- Auditory perception, Visual perception skills, Writing skills, reading skills, arithematic skills, discriminatory skills, tests for preschool children; Presentation of reports; Conducting education programmes for parents on the developmental status of their children. Identifying the intervention needs of developmentally delayed child; Planning and implementation of intervention programmes and preparation of material; Evaluation of effectiveness of intervention program planned for developmentally delayed child. Presentation of reports.

Suggested Readings

- Minds, L. (2014). Assessing young children. 5thed. Pearson publication.
- Losardo, A. (2011). Alternative approaches to assessing young children. 2nded. Brooker publishing.
- Anastasi, A. (1997). Psychological testing.7thed. Pearson publishers.

BASIC SUPPORTING COURSES

1. General English 2(1+1)

Theory

Word-Formation Prepositions Idiomatic Expressions Conditional Sentences and Modal Verbs Synthesis and Transformation Essay Writing (5 topics to be discussed) Precise writing Study of Prose and short stories from BRIGHTER ENGLISH book of short stories, plays, poems and essays by C.E. Eckersley, Orient Llongman, New Delhi, 1984) The Bachelor of Arts by R.K. Narayan Pre-final examination

Practical

Based on Lectures Language work : the prescribed lessons having a bearing on the topics covered in lectures. Identification of phonetic sounds and symbols Stress and Intonation Listening Comprehension Conversation Practice

Suggested Readings:

- Allen, W. Standard. 1962 Living English Structure, Orient Longmans, London.
- Jones, Daniel. 1993. Everyman's English Pronouncing Dictionary, University Book Stall, New Delhi.
- Jones, Daniel. 1970. An Outline of English Phonetics, Arnold, London.
- George, H.V. 1970. Common Errors in English Learning, M/s Newbury House, London.
- Sharma, S.D. 1984. A textbook of Spoken and Written English, Vikas, Delhi.

2. Technical Writing (English) 2(1+1)

Theory

Nature of technical style vs. general style, writing process (prewriting, drafting, rewriting and editing). Effect of diction, sentence- structure and paragraphs on style; manuscript form, numbers, abbreviation, hyphenation of compound terms, decimal system of numbering headings, equations, documentation, sentence correction. Paragraph writing- Definition, requirements of a good paragraph (Unity, coherence and emphasis), topic sentence, various orders to develop a paragraph (Inductive, deductive, question to answer, exposition, time order, comparison and contrast, enumeration, space order). Report writing- Definition and cardinal characteristics of report, analyzing the report. Report formats- Blank form, letter form, memorandum form and general survey report. Technical correspondence- General principles of technical correspondence, parts of a letter (Heading, address, salutation, body, complimentary closing, signature), type of letters (letters giving instructions, inquiries and answers to inquiries, complaints and adjustments, letter urging action, applications and resumes). Proposal writing- Definition and kinds of proposal, division of formal proposal (Front matter, letter of transmittal, title page, summary or abstract, table of contents, statement of request and body). Writing scientific and semi-technical articles-Source material, topic selection, literature review, tables, figures, footnotes, bibliography.

Practical

Exercise on identification of phonetic sounds, symbols, consonants, pyre vowels, diphthongs, organs of speech, place of articulation and manner of articulation (Voiceless and voiced sounds).Writing of a technical report, paragraph, formal correspondence, proposal and scientific and semi-technical articles.

Suggested Readings

- Strunk, Jr.; William and White, E.B. (1967). The elements of style. New York: Macmillan.
- Leegget, G. C.; Mead, D. and Charvat, W. (1988). Essentials of grammar and composition. New Delhi: Prentice- Hall (Indian reprint).
- Sherman, T.A. and Simon, S. J. (1990). Modern technical writing. New Jersey: Prentice-Hall.
- Alvarez, J.A. (1980). The elements of technical writing. New York: Harcourt.
- Connor, J.D. (1992). Better English pronunciation. New Delhi, University Book Stall.
- Jones, D. and Glimson, A.C. (1997). English pronouncing dictionary, London.
- Bansal, R.K. and Harrison, J.B. (1983). Spoken English, Orient Longman, New Delhi.
- Krishnamohan and Banerjee, M. (1990). Developing Communication Skills. MacMillan India Ltd, New Delhi.

3. Elementary Statistics 3(2+1)

Theory

Introduction to statistics; definitions, functions, uses and limitations Classification and tabulation of data; qualitative and quantitative classification, discrete and continuous variables, frequency tables, grouped and ungrouped data. Diagrammatic representation of data; One, Two and Three dimensional diagrams with applications. Graphical representation of data; Histogram, frequency polygon, frequency curve, ogives. Measures of central tendency; Introduction to basic concepts of logarithms, AM, GM, HM, median. mode with merits, demerits and uses, relationship between AM, GM and HM, quartile deviation, mean deviation from AM, median and mode, variance, standard deviation, coefficient of variation. Measures of dispersion; range coefficients, inter quartile range, quartile deviation, coefficient of quartile deviation, mean deviation from AM, median and mode, variance, standard deviation, coefficient variation. Moments; Raw moments, Central moments for grouped and ungrouped data, relationship between raw moments and central moments. Measures of skewness and kurtosis; definitions of symmetrical distribution, skewness and kurtosis, relationship between mean, median and mode and between quartiles for symmetrical and skewed distributions. Probability theory; introduction to simple problems of permutations and combinations, definition of random experiment sample space, events, mutually exclusive and equally likely events. Definition of probability, simple problems based on probability, addition and multiplication theorem of probability, conditional events and independent events, Correlation and linear regression analysis; definition of correlation its types, scatter diagrams, Karl Pearson's formula of correlation coefficients, properties of correlation coefficient, definition of regression, regression equations of Y on X and of X on Y, relationship between correlation coefficient and regression coefficients. Problems based on correlation and regression. Tests of significance; basic definitions, hypothesis, null and alternative hypothesis, tests statistic, testing of hypothesis, one sample t-test and two sample fisher's t-test. Chi-square test of goodness of fit and Chi-square test of independence of attributes. Discrete and continuous probability distributions; definition of random variable, discrete and continuous random variables probability distribution of random variable, concepts of discrete and continuous probability distribution, basic concept of binomial theorem, binomial distribution, Poisson distribution, normal distribution and applications. Analysis of variance; definition of analysis of variance, assignable and nonassignable factors, analysis of one way classified data. Introduction to sampling methods; definition of population, random sample, sampling versus complete enumeration, use of random number table for selecting a simple random sample, simple random sampling with and without replacements.

Practicals

Graphical representation of data Diagrammatic representation of data Measures of central tendency (Ungrouped data) with calculation of quartiles, deciles and percentiles Measures of central tendency (Grouped data) with calculation of quartiles, deciles and percentiles Measures of dispersion (Ungrouped data) Measures of dispersion (Grouped data) Moments, measures of skewness and kurtosis (Ungrouped data) Moments, measures of skewness and kurtosis (Grouped data) Correlation and regression analysis Application of one sample t-test Application of two sample Fisher's t-test Chi-square test of goodness of fit Chi-square test of independence of attributes Analysis of variance one way classification Selection of random sample using simple random sampling

Suggested Readings:

- Elhance, D. N. Fundamentals of Statistics
- Agarwal, B. L. Basic Statistics
- Kapoor and Saxena Mathematical Statistics
- Singh and Verma Agricultural Statistics
- Hall and Knight Higher Algebra

4. Agricultural Informatics 3(1+2)

Theory

Introduction to computers, anatomy of computers, memory concepts, units of memory, operating system, definition and types. Application of MS-Office for creating, editing and formatting a document, data presentation, tabulation and graph creation, statistical analysis, mathematical expressions. Database-Concepts and types, creating database, uses of DBMS in health and nutrition. Internet and World Wide Web (WWW)- Concepts, components and creation of web, HTML, XML coding.

Practical

Study of computer components, accessories, practice of important DOS commands. Introduction of different operating systems such as windows, Unix, Linux, creating files and folders, file management. Use of MS-WORD and MS Powerpoint for creating, editing and presenting a scientific document, handling of tabular data, animation, video tools, art tool, graphics, template and designs. MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data, handling macros. MS-ACCESS: Creating database, preparing queries and reports. Introduction to World Wide Web (WWW) and its components, creation of scientific website, presentation and management of health information through web.Use of smart phones and other devices for health warning signs and dietary management. Hands on practice on preparation of decision support system.

5. Principles of Biochemistry 3(2+1)

Theory

Recapitulation of basic chemistry and biology Water, pH and buffers, Acid-base balance Cellular constituents, Structure and function : Amino acid and proteins Carbohydrates Lipids and bio membranes Nucleic acids Dissolved molecules – Vitamins and minerals Enzymes, function, properties, mechanism Metabolism of cellular constituents Basic concepts of Bioenergetics Carbohydrates metabolism Glycolysis and glycogenolysim HMP pathway TCA Cycle Electron transport chain Photosynthesis Gluconeogenesis Lipids metabolism Beta-oxidation Ketone bodies Fatty acid synthesis Amino acid metabolism General reactions of nitrogen assimilation and excretion Biosynthesis of DNA, RNA and Protein Replication Transcription Translation and genetic code Regulation of gene expression

Practicals

Preparation of buffers and pH determination; Preparation of colloids Qualitative and quantitative tests of carbohydrates, lipids and proteins Tests of enzyme action; Experiments on potato oxidase, urease, salivary

amylase Paper chromatography of amino acids or carbohydrates ascending and descending Determination of starch, sugar; analysis of proximate constituents in food.

Suggested Readings:

- Conn, EE and Stumpf, PK. 1987. Outlines of Biochemistry. John Wiley.
- Nelson, DL and Cox, MM. 2004. Lehninger Principles of Biochemistry. 4th Edn. MacMillan.
- Voet D, Voet JG and Pratt, CW. 2007. Fundamentals of Biochemistry. John Wiley
- Jayaram. T. 1981. Laboratory manual in biochemistry, New Delhi: Wiley Estern Ltd.
- Plummer D. 1988. An Introduction to Practical Biochemistry. 3rd ed. Tata McGraw Hill, New Delhi.
- Hames B.D., Hooper N.M. and Houghton J.D. 1997. Instant Notes in Biochemistry. BIOS Scientific Publishers.

6. Environmental Studies and Disaster Management 3(2+1)

Theory

Multidisciplinary nature of environmental studies- Definition, scope and importance. Natural resources- Renewable and non-renewable resources and their associated problems. Forest resources- Use and over-exploitation, deforestation, timber extraction, mining, dams and their effects on forest and tribal people. Water resources- Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources- Use and exploitation, environmental effects of extracting and using mineral resources. Food resources- World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. Energy resources-Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Land resources- Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources, equitable use of resources for sustainable lifestyles.

Ecosystems- Concept, structure and function of an ecosystem. Producers, consumers and decomposers, energy flow in the ecosystem, ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of forest, grassland, desert and aquatic ecosystems. Biodiversity and its conservation- Introduction, definition, genetic, species, ecosystem diversity and biogeographical classification of India. Value of biodiversity- Consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, national and local levels, India as a mega-diversity nation. Hot-sports of biodiversity. Threats to biodiversity- Habitat loss, poaching of wildlife, man-wildlife conflicts, endangered and endemic species of India. In-situ and Ex-situ conservation of biodiversity.

Environmental pollution- Definition, cause, effects and control measures of air, water, soil, marine, noise and thermal pollution and nuclear hazards. Solid waste management- Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.

Social issues and the environment- Unsustainable to sustainable development, urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics-

Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment protection acts- Air (Prevention and control of pollution) act, water (Prevention and control of pollution) act, wildlife protection act, forest conservation act, Issues involved in enforcement of environmental legislation, public awareness. Human population and the environment- Population growth, variation among nations, population explosion. Role of Information Technology in environment and human health.

Natural disasters- Meaning and nature, types (floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves, global warming, sea level rise, ozone depletion) and effects. Man-made disasters- Nuclear, chemical, and biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. Disaster management- International strategy for disaster reduction at national and global levels; National disaster management framework- Financial arrangements, role of NGOs, community– based organizations and media, central, state, district and local administration, armed forces in disaster response, police and other organizations. Feeding the people struck by the disaster, managing house and dress need during disaster.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain, visit to a local polluted site-Urban/rural/industrial/agricultural. Study of common plants, insects, birds and study of simple ecosystems i.e. pond, river, hill slopes, etc. Case-studies.

Suggested Readings:

- Bharucha, E. (2005). Text book of environmental studies. University Grants Commission, University Press, New Delhi.
- Kapur, A. (2005). Disasters in India: Studies of grim reality. Rawat publication, Jaipur.
- Chauhan, B.C. (2008). Environmental studies. University Science Press, New Delhi.
- De, A.K. (2010). Environmental chemistry. Willey Eastern ltd. New Delhi.
- Singh, S. and Singh, J. (2013). Disaster Management. Pravilika Publication Allahabad.

7. Fundamentals of Food Microbiology 3(2+1)

Theory

Major groups of microorganisms associated with food Sources of microbial contamination in food factors effecting growth and survival of m.o. in foods Physical methods to control microorganisms. Chemical methods to control microorganisms Food Fermentations Traditional fermented foods of India and other Asian countries Probiotics, prebiotics and synbiotics Fermented foods based on milk Fermented foods based on meat Fermented foods based on grains Fermented foods based on fruits and vegetables Fermented beverages Role of microorganisms and food spoilage Spoilage organisms of milk Spoilage organisms of meat Spoilage organisms of grains Spoilage organisms of fruits and vegetables Principles of food preservation. Food poisoning and food borne infections Microbial toxins Indicator organisms Rapid methods for detection of microorganisms.

Practical

Microscopic examination of bacteria, and yeast and molds Preparation of media Methods of sterilization Isolation of microorganisms. Purification of microorganisms Maintenance of microorganisms Detection of faecal coliform, MPN of coli forms Microbiological examination of milk Microbiological examination of grains Microbiological examination of fruit and vegetables

Suggested Readings:

- Stanier Ingraham and Wheels and Painter. 1992. General Microbiology. 5th ed.
- Kapoor, T. and Yadav. 1991. An Introduction to Microbiology.
- Pelczar, *et al.* 1996. Microbiology, 5th edn.

8. Elementary Human Physiology 3(2+1)

Theory

Physiological process, structural and functional basis of human body, skeletal system, joints and muscular system Functions of brain and spinal cord. nerve impulse reflex action and sense organs Composition and functions of blood and lymph, heart and course of blood circulation, blood pressure, pulse and heart sounds. Respiratory apparatus, mechanism of respiration, respiratory rates, volume and transport of gases Physiology of kidney and skin Physiology of digestion, digestive enzymes and their functions, functions of liver, absorption from the intestine. The location, secretions and function of various endocrine glands Male reproductive organs and their functions Female reproductive organs and their functions Pregnancy, persecution and milk secretion Pre-Final Examinations

Practicals

Skeletal system of mammal (rabbit) Hematology- R.B.C., W.B.C., T.L.C., D.L.C. and estimation of hemoglobin in mammalian blood Heart beat and heart sound, blood pressure measurement Respiratory quaotient, inspiration, expiration and measurement of O_2 and CO_2 at various partial pressure in lungs. Reproductive cycle-menstruation and estrous cycles, mating behavior and fertility test

Suggested Readings:

- Arthur J. Vanders. Human Physiology- The mechanisms of body function, Tata McGraw Hill Publishing Company, New Delhi.
- Samson Wright. Applied Physiology. 10th edn. Revised by Keele, C.A. and Neil, B. Oxford University Press, New York.
- C. Guyton. Text Book of Medical Physiology. 5th ed. W.B. Saunders Company- Philadelphia, London.

9. Communication Skills and Personality Development 3(2+1)

Theory

Communication skills- Process of communication, verbal and nonverbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and

bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Role of ICT in communication. Recent advances in communication- Print and electronic, internet, e-mail, fax, mobile, interactive video and teleconferencing, computer, e-governance.

Meaning and definition of personality; Theoretical perspectives on personality- Behavioural trait and humanistic personality pattern; moulding the personality patterns. Personality development- Self perception, self concept, self esteem and gender stereotyping, persistence and changes in personality determinants (physical, intellectual, emotional, social, educational and family). Aspirations, achievements and fulfillment. Dressing for formal and informal occasions.

Practical

Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations. Developing questionnaire to study impact of physique, educational institutions, aspirations on personality; developing questionnaire to study social prescriptions, gender and family on personality, aspirations and achievements. Collecting data through the questionnaires on small samples. Report writing and presentation. Case study of an individual suffering with personality disorders.

10. Economics and Marketing 3(2+1)

Theory

Terms and definitions in Economics; Consumption, demand and supply. Factors affecting production. Gross Domestic Product (GDP) – Role of poultry sector in National GDP. Marketing- Definition, marketing process, need for marketing, role of marketing, marketing functions, classification of markets, marketing of various channels, price spread, marketing efficiency, integration, constraints in marketing of agricultural produce, market intelligence, bank norms, insurance, SWOT analysis, crisis management. Techno-economic parameters for preparation of

projects and basic guidelines for preparation of project report.

Practical

Techno-economic parameters for preparation of project. Preparation of bankable projects for various agricultural products and its value added products. Identification of marketing channel, calculation of price spread, identification of market structure and visit to different markets.

11. Introduction to Rural Sociology 2(2+0)

Theory

Rural sociology- Meaning, scope and significance. Structural differentiation in terms of difference and characteristics of rural and urban societies. Planned social change- Approaches to rural planning, improvement and transformation and their shortcomings. Indian rural development programs (IRDPs). Indian rural social stratification: Castes- Basic notions, changes and its role in economy and policy, difference between caste and class, backward classes and implementations of constitutional provisions.

Indian rural institutions: Social- Family and marriage (Nature, forms and changes), Economic-political: Land relations and changes; rural poverty: its manifestations and causes. Socio-religious: Functional significance of beliefs, traditions and customs. Rural social changes - Processes and factors of transformation. Status of women in rural India and their role in rural and agricultural development.

Suggested Readings

- Chitambar, J.B. (1973). Introductory rural sociology. New York, John Wilex and Sons.
- Desai, A.R. (1978). Rural sociology in India. Bombay, Popular Prakashan, 5th Rev. ed.
- Doshi, S.L. (2007). Rural sociology. Delhi Rawat Publishers.
- Jayapalan, N. (2002). Rural sociology. New Delhi, Altanic Publishers. Sharma, K.L. (1997). Rural society in India. Delhi, Rawat Publishers.

12. National Service Scheme 2(0+2)

The course aims at evoking social consciousness among students through various activities viz. working together, constructive and creative social work, increasing knowledge about self and community, contribution in solving social problems, to be skillful in executing democratic leadership, developing skill in programme development, to be able for self employment, reducing gap between educated and uneducated, arousing desire to help weaker sections of society.

Practical

NSS: Orientation of students in national problems, study of philosophy of NSS, fundamentals rights, directive principles of state policy, socio-economic structure of Indian society, population problems, brief of five-year plan. Functional literacy, non-formal education of rural youth, eradication of social evils, awareness programmes, consumer awareness, highlights of consumer act. Environment enrichment and conservation, health, family welfare and nutrition.

NCC: Introduction to NCC, defense services, system of NCCtraining, foot drill, sizing, forming up in three ranks, open and close order march, dressing, getting on parade, dismissing and falling out, saluting, marching, arms drill, shoulder arm, order arm, present arm, guard of honour, ceremonial drill, weapon training – rifle bayonet, light machine gun, sten machine carbine, introduction and characteristic stripping, assembling and cleaning, loading, unloading and firing. Field craft, visual training, targets, judging distance, fire discipline and fire control orders, battle craft, field signals, description of ground, section formation, section battle drill, scouts and patrols, ambush, field engineering, map reading, conventional signs, grid systems, use of service protractor, prismatic compass and its use, self-defense, general principles, precautions and training, attacks and counter attacks, marching and searching, first aid, hygiene and sanitation, civil defense, leadership and NCC song.

7. EXAMINATION AND EVALUATION

The examination system will be comprising of Quiz, Mid-term, Assignment, End-term, and Practical including viva-voce examination. The setting of question paper and evaluation of the answer copies of various examinations would be both internal and external as suggested in the5th Dean's Committee Report.

1. Marks and Weightage

1.1. The distribution of marks against various components of examinations and evaluationpattern will be as follows:

SN	Component	Weightage (%)	Setting up of question paper	Evaluation of answer copies
1	End-term Theory	50	External	Internal
2	Mid-term, Quiz, Assignment, Practical,Viva-voce	50	Internal	Internal

1.2. The distribution of weightage against various components of the internal components areas follows:

SN	Course type	Component	Weightage (%)	Setting up of questionpaper	Evaluationof copies
1	Courses with Theory and Practical	Mid-term exam	25	Internal	Internal
		Quiz	5	Internal	Internal
		Assignment	5	Internal	Internal
		Practical	15	Internal	Internal
2	Courses with Theory only	Mid-term examination	35	Internal	Internal
		Quiz	5	Internal	Internal
		Assignment	10	Internal	Internal
3	Courses with Practical only	Practical	100	Internal	Internal

2. Guidelines for the Examinations

1.1 Before start of a semester, list of the courses to be offered along with the course leader and associate instructors will be notified by each division/Hub.

1.2 Each course leader will prepare the class schedule based on the Academic Calendar issued by the Graduate School and will upload it on the portal.

1.3 Course leader will also prepare lesson plan unit/topic-wise and submit a copy to the Examination Cell, IARI, New Delhi. The study materials and power-point presentations (PPTs) are also to be uploaded in the Graduate School Portal before conducting a class.

1.4 The class schedule would clearly mention the date of Quiz, Mid-term, and End- Term examinations as per Academic Calendar and follow it strictly. Project work may be given wherever necessary, and the marks may be given in the Assignment caterory.

3. Quiz Examination

3.1. For each subject, at least two Quiz examinations will be held- one before Mid-term examination (after completion of 4-5 lectures) and the other before End-term examination (4-5 lectures post mid-term exam). One of the two Quiz examinations should be conducted unannounced.

3.2. The Quiz examination will be held during normal class time. Setting of questions, conduction of Quiz, and evaluation of the answer copies will be done by the course leader and faculties associated with the course.

3.3. Each Quiz should not be of less than 10 marks. Final weightage for Quiz will be 5% only.

3.4. The date of the announced Quiz will be as per academic calendar while the date of theunannounced Quiz will be decided by the concerned course leader.

4. Mid-Term Examination

1.1 Mid-term exam will be conducted by the IARI and respective Academic Hubs as per academic calendar. Should there be any change, the Graduate School will notifya fresh date for conducting the examination.

1.2 The course leader will prepare the question paper in consultation with the facultiesassociated with the course and conduct the mid-term examination.

1.3 Total marks for mid-term exam should not be less than 30. The duration of the examshould be adjusted depending on marks. For 30 marks, the duration of the examination should be 1 hour only.

1.4 Mid-term exam will be held on a common place under the supervision of invigilators unrelated to the subject of the exam. However, the course leader or anyother faculties associated with the subject of exam shall be made available to address any issues, clarifications, etc. related to the question paper.

1.5 Mid-term examination copies will be evaluated by all the faculties associated with the concerned course.

5. End-Term Examination

1.1 The End-Term Examination will be held as per Academic Calendar. Should there be any change in the date, the Graduate School will notify it and the examination will be conducted accordingly.

1.2 Question paper for the End-term theory examination will be set by an external examiner.

1.3 Soon after the start of the semester, the Examination Cell of IARI, New Delhi willask the Course Leaders of the ongoing courses to submit a list of 3 external examiners for setting question papers. While selecting the external examiners, preference should be given to the faculties engaged in teaching/guiding of studentsin the same discipline or same/similar courses.

1.4 The external examiner should be from outside IARI, New Delhi. Preference shouldbe given to the faculties in the rank of Associate Professor (or its equivalent) or above for setting the question papers.

1.5 With the approval of the Dean & Jt. Director (Edn.), the Examination Cell will collect two sets of question papers from the external experts; one set will be used immediately for conducting the end-term exam and the other set will be reserved for make-up/repeat exam or other eventualities.

1.6 The experts will be provided with the course syllabus and the lesion plan to set thequestions giving corresponding weightage to the number of lectures delivered on atopic. The paper should cover the entire syllabus.

1.7 Total marks for end-term examination will be 100 and the duration will be 3 hours.

1.8 The end-term examination paper will have Objective (30%) and Descriptive (70%)questions. The Objective Type questions will include True/False, Fill in the gaps, Matching, Simple multiple choice, Multiple choice with pairs of options, Assertion/Reasoning, Sequence of items, etc.

1.9 A nominal honorarium (at least Rs.1500.00 for two sets) will be given to the external experts for setting two sets of question papers.

6. Practical Examination

1.1 The Practical Examination will be conducted by the course leader and the associatedfaculties as per exam schedule communicated by the Graduate School.

1.2 The Practical Examination will have both written and practical activities including specimen identification, slides preparation and observation under microscope, lab tests, etc. and the viva-voce.

1.3 Total marks for Practical Examination will be 50.

1.4 The evaluation of the answer copies will be done by the concerned faculties.

1.5 The practical examination will be conducted by concerned course leader and otherfaculties associated with the course.

1.6 As part of the Practical Examination, each course will have the viva-voce examination, which will be conducted by the course leader and the facultiesassociated with the course.

7. Make-Up/ Repeat/ Grade Improvement Examination

1.1 If a student fails to appear in an examination (mid-term, end-term or practical) dueto medical or some other reason(s), the student may appear for a make-up examination after obtaining approval from the Graduate School.

1.2 To be eligible for make-up examination under medical ground, the student has to take medical leave from the institute doctor/ institute approved doctor on the day orprior to the day of the examination.

1.3 To be eligible for make-up examination because of other activities (such as participating in a competition representing the institute, graduate school activities, etc.), student must have an office order from the competent authority to this effect with a mention of his/her name on it.

1.4 For permission of make-up examination, the students have to apply through the concerned course leader and Hub coordinator (in case of students from any of the Academic Hubs) to the Dean and Jt. Director (Edn.) with supporting documents (medical certificate, office order, etc.). Upon satisfaction, the Dean and Jt. Director (Edn.) will grant permission for make-up examination and the Graduate School willissue office order to this effect.

1.5 The Examination Cell will notify the date of the make-up examination and accordingly, the concerned course leader will conduct the make-up examination.

1.6 For mid-term and practical make-up examination, the question paper will be set by the concerned course leader and the associated faculties; however, for the end-term make-up examination, the Examination Cell, IARI, New Delhi will supply the question paper(s).

1.7 Students appearing in make-up/repeat examinations will not be eligible for the Gold Medal or any such academic awards offered by the institute.

1.8 If a student wishes to improve the grade to reach the minimum Overall Grade Point Average (OGPA), he/she can appear in the make-up end-term examination with due approval of the Dean and Jt. Director (Edn.). The student will be allowed to appear only once in any two subjects where he/she scored the least.

1.9 Repeat examination will be conducted for the students who fail in a subject(s).

1.10 The make-up/grade improvement/repeat examination will be conducted within 2 months from the last mid-term/end-term/practical examination held.

8. Grading System

1.1 A 10.00 points grading system (10.00 =100%, 9.80=98.00%, etc.) will be followed to evaluate the students.

1.2 The minimum Grade Point Average (GPA) for passing a subject would be 5.00.

1.3 A student getting less than 50% marks in a subject (GPA <5.00) will be treated as Fail and F-grade will be recorded for that subject.

1.4 The minimum Overall Grade Point Average (OGPA) required for obtaining a Bachelor's degree would be 5.50.

9. F- GRADE CLEARANCE (REPEAT EXAMINATION)

1.1 A student who fails in a subject(s) and gets F grade in a semester will be promoted to the next semester; however, he/she has to appear in the repeat examination conducted by the Graduate School and pass in that/those subject(s) in one attempt.

1.2 The repeat examination will be conducted by the Examination Cell, IARI, New Delhi within 2 months from the start of the new semester.

10. SUBMISSION OF GRADES

1.1 Each course leader has to upload the Grade to the Academic Portal within 10working days from the date of end-term exam of the subject.

1.2 The Graduate School will declare the result within 15 working days of completionof the semester.

11. ATTENDANCE REQUIREMENT

1.1 To be eligible to appear in the end-term examination of a subject, 85% attendance separately for theory and practical classes, as applicable, will be essential.

1.2 An 85% attendance will also be required separately for the academic or institutional activities/ events, etc. organized by the Graduate School/Hub where students were asked to attend.

1.3 Upon applying through proper channel with supporting documents, the Dean andJt. Director (Edn.) may grant maximum 10% relaxation to the attendance of a student on medical or some other grounds.

ISBN: 978-93-83168-77-4

THE YELLOW BOOK

For more information, contact:

Dean & Joint Director (Edu)
The Graduate School
ICAR-Indian Agricultural Research Institute
New Delhi 110012

9 789383 168774

www.iari.res.in