Course Curriculum
For Undergraduate Programme

in

AGRICULTURAL ENGINEERING

[Four years degree programme of B.Tech. (Agril.Engg.)]

[Effective from July- 2016]





As per recommendation of ICAR, Fifth Dean's committee

Faculty of Agricultural Engineering
BIDHAN CHANDRA KRISHI VISWAVIDYALAYA
MOHANPUR, NADIA-741252, (W.B)

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Bidhan Chandra Krishi Viswavidyalaya

Mohanpur, Dist. Nadia, 741252 (W.B.)

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Preface

Prof. J.P.Gupta
Dean

The agricultural engineering education integrates engineering and agricultural science knowledge and skill to develop technology and/or processes to raise production and productivity of agriculture and other farm produce through efficient utilization of natural resources and conserving the same for future use. The specific activities include, efficient utilization of agricultural inputs through improved implements and machinery ensuring timeliness in farming operations (mechanization), reducing drudgery in agriculture and improving quality of farm produce (processing and value addition). The agricultural engineering education addresses issues relevant to social and technological development of the farmers. The quality and quantum of agricultural inputs and their management techniques and also quality of farm produce and methods of value additions would keep on changing with advancement of industrialization in general and economic upliftment of farmers/ processors in particular. It is in this context that the agricultural engineering education is to be analyzed and course curriculum modified to serve the agriculture and industry.

The new course curriculum includes total course load of 181 credits for the four years duration. The seventh semester includes Student READY (Rural and Entrepreneurship Awareness Development Yojana) programme in which students need to be away from the classroom activities. They may have practical experience in the actual field during this period. The students will have to work for their project work during 8th semester. Two summer training / In plant training of 4 weeks duration each has been introduced at the end of 4th semester and 6th semester. An educational tour with credit has also been included during 7th semester. In general, more emphasis has been given to practical works compare to theory classes. The recommended new curriculum also includes courses on Computer Programming and Data Structures, Auto CAD applications, Applied Electronics and Instrumentation, Entrepreneurship Development and Business Management besides modifying the basic engineering and agricultural engineering courses. This will certainly improve the employment opportunities of the agricultural engineering graduates.

This Course Curriculum was duly discussed and approved in the 38th meeting of the Faculty Council for PG-UG Studies held on 23.09.2016. It was also approved to implement the Course Curriculum from the session commencing from July-2016 to the ensuing batch of B.Tech. (Agril. Engg.) students. During the process of compilation, the encouragement and co-operation obtained from Dr. D. D. Patra, Hon'ble Vice-chancellor & the Chairman, PG-UG Council, Faculty of Agricultural Engineering is highly appreciated. The help and suggestions received from the Faculty Members as well as the Secretary, Faculty Council are also gratefully acknowledged.

Mohanpur dated 04.04.2017 **(J.P.Gupta)**

CONTENT

Background

ICAR constituted the Fifth Deans' Committee on Higher Agricultural Education in India with the following Terms of Reference:

(i) Defining UG & PG degrees for general market needs and for specialist jobs and uniformity in UG and PG degree nomenclature.
(ii) Restructuring of UG programmes for increased practical and practice contents.
(iii) Central assistance for strengthening of higher agricultural Education
(iv) Guidelines for assessing training needs and performance of teaching faculties.
(v) Reforms in governance of SAUs
(vi) Developing a Model DPR for establishment of a college

It was felt that highest priority to agriculture is required for the alleviation of hunger, under nutrition and poverty. It was a general consensus that the country needs creation of skilled, talented, entrepreneurial human resource and knowledge pool, especially of young graduates, along the value chain. Thus course curricula for Agricultural Sciences and their delivery systems should be so designed that the graduates produced become job providers rather than job seekers. Their skill, scale and speed should harness demographic dividends, meet the fast growing demand for quality products and democratically promote inclusiveness. In other words, our educational system and course curricula must be designed and geared to ensure excellence, relevance and high quality of products, zero environment footprint, climate resilience, high efficiency, and competitiveness. In doing so, the voices of the farmers, industries, corporate sectors, NGOs, Civil Society, scientists, teachers and, of course, students must be heard and duly internalized in the curricula.

At present in our country, B. Tech. (Agril. Engg.) or B.E. (Agril. Engg.) is the approved required qualification for different jobs in the government sectors. However, departments may have to be created in future as per the needs for specialisation in different aspect of agricultural engineering and as such the PG degree nomenclature should commensurate the required specialisation to avoid recruitment problems.

Taking fourth Deans Committee recommendations related to Agricultural Engineering as the base criteria, the issue was discussed at length. There was unanimous consensus on different aspects such as thorough restructuring of the distribution of different courses as per future challenges and recent developments, more emphasis on basic course of agricultural sciences for increased exposure of the student to the problems and practices of agricultural fields and inclusion of special courses on communication skills and personality development for increased employability of the graduating students. The proposed distribution of courses and credit hours for B. Tech. (Agril. Engg.) programme was discussed at length.

It was also decided to review the course titles/course contents in view of i) the proposed restructuring of B. Tech. (Agril. Engg.) programme, ii) feedback received by different institutes during their interaction with different stakeholders, iii) experience gained by different institutes in implementing the fourth Deans Committee recommendations, iv) recent developments and emerging issues related to different aspects of Agricultural Engineering such as agricultural waste management, micro irrigation, increasing dependence on renewable energy sources etc., and v) employment opportunities for agricultural engineering graduates in different industrial sectors.

History of Agricultural Engineering Education in India and its Present Status

The first programme in agricultural engineering education in India was introduced in 1942 with Bachelor of Science degree at the Allahabad Agricultural Institute, Naini, Allahabad, U.P. The curriculum was developed to train engineers to meet the needs of Indian farmers (i) to mechanize their farms using more efficient tools, implements and machines and (ii) to conserve soil and water for efficient use. The farm equipments were mostly traditional or imported and proper use and maintenance were of primary concerns. The processing of products was mainly confined to dairy products and animal feed.

The second programme in agricultural engineering education in India was established in 1952 with Bachelor of Technology (B.Tech) degree at the Indian Institute of Technology (IIT) Kharagpur, West Bengal. IIT introduced Master of Technology (M.Tech) and Ph.D degrees in agricultural engineering in 1957 and 1962 respectively. IIT provided engineering orientations in course curriculum. Other disciplines like agronomy; soil science and botany were added to the department of Agricultural Engineering to support it. With the establishment of State Agricultural Universities (SAUs) during 1960s on the pattern of Land Grant Universities in the United States, the agricultural education in India was changed significantly. The teaching, research and extension became integral part of the faculties. The first agricultural engineering programme under this new pattern was started in 1962 at the Uttar Pradesh Agricultural University (now GB Pant University of Agriculture and Technology), Pantnagar. Presently, there are about 38 institutions offering degree programmes in agricultural engineering, out of which 28 institutions have programmes leading to master degree and Ph.D degree. These institutions have total annual intake capacity of about 1500 at bachelor, 1000 at masters and 200 at Ph.D degree level. The specializations include Farm Machinery and Power, Soil and Water Conservation Engineering, Irrigation and Drainage Engineering, Post Harvest and Process engineering, Dairy engineering, Renewable Energy and Rural Engineering.

There have been wide variations in the course curriculum from one university to another. Majority of the institutions have entrance test for admission and the eligibility for admission is a (10+2) with science streams. The number of courses varies from 52 to 60 with course credits ranging from 160-185. The evaluation system varies from 100 per cent internal to 100 per cent external examinations. Only a few offer flexibility of electives to suit the aptitude and career preference of students.

Department-wise Course Programme

Department of Farm Machinery and Power

Odd Semesters

Course No.	Title of the Course	Credit Hour
FMP-111	Engineering Mechanics	3(3+0)
FMP-112	Engineering Drawing	2(0+2)
FMP-231	Tractor and Automotive Engines	3(2+1)
FMP-232	Theory of Machines	2(2+0)
FMP-351	Tractor Systems and Controls	3(2+1)
FMP-352	Farm Machinery and Equipment-II	3(2+1)
FMP-353	Machine Design	2(2+0)

Even Semesters

FMP-121	Workshop Technology and Practices	3(1+2)
FMP-241	Auto CAD Applications	2(0+2)
FMP-242	Farm Machinery and Equipment-I	3(2+1)
FMP-243	Renewable Energy Sources	3(2+1)
FMP-361	Tractor and Farm Machinery Operation and Maintenance	2(0+2)
FMP-362	Bio-Energy Systems: Design and Applications	3(2+1)
FMP-48*	Elective Courses	3(2+1)

Electives Courses

FMP-481	Mechanics of Tillage and Traction	3(2+1)
FMP-482	Farm Machinery Design and Production	3(2+1)
FMP-483	Human Engineering and Safety	3(2+1)
FMP-484	Tractor Design and Testing	3(2+1)
FMP-485	Hydraulic Drives and Controls	3(2+1)
FMP-486	Precision Agriculture and System Management	3(2+1)

Department of Soil and Water Engineering

Odd Semesters

Course No.	Title of the Course	Credit Hour
SWE-111	Surveying and Levelling	3(1+2)
SWE-231	Soil Mechanics	2(1+1)
SWE-232	Fluid Mechanics and Open Channel Hydraulics	3(2+1)
SWE-351	Soil and Water Conservation Engineering	3(2+1)
SWE-352	Watershed Planning and Management	2(1+1)
SWE-353	Sprinkler and Micro Irrigation Systems	2(1+1)
SWE-354	Drainage Engineering	2(1+1)

Even Semesters

SWE-121	Theory of Structures	2(1+1)
SWE-122	Strength of Materials	2(1+1)
SWE-241	Building Construction and Cost Estimation	2(2+0)
SWE-242	Watershed Hydrology	2(1+1)
SWE-243	Irrigation Engineering	3(2+1)
SWE-361	Water Harvesting and Soil Conservation Structures	3(2+1)
SWE-362	Groundwater, Wells and Pumps	3(2+1)
SWE-48*	Elective Courses	3(2+1)

Electives Courses

SWE-481	Floods and Control Measures	3(2+1)
SWE-482	Wasteland Development	3(2+1)
SWE-483	Remote Sensing and GIS Applications	3(2+1)
SWE-484	Management of Canal Irrigation System	3(2+1)
SWE-485	Minor Irrigation and Command Area Development	3(2+1)
SWE-486	Precision Farming Techniques for Protected Cultivation	3(2+1)
SWE-487	Water Quality and Management Measures	3(2+1)
SWE-488	Landscape Irrigation Design and Management	3(2+1)
SWE-489	Plastic Applications in Agriculture	3(2+1)

Department of Post Harvest Engineering

Odd Semesters

Course No.	Title of the Course	Credit Hour
PHE-231	Electrical Machines and Power Utilization	3(2+1)
PHE-351	Post Harvest Engineering of Cereals, Pulses and Oil Seeds	3(2+1)
PHE-352	Post Harvest Engineering of Horticultural Crops	2(1+1)

Even Semesters

PHE-121	Web Designing and Internet Applications	2(1+1)
PHE-241	Applied Electronics and Instrumentation	3(2+1)
PHE-242	Engineering Properties of Agricultural Produce	3(2+1)
PHE-361	Computer Programming and Data Structures	3(1+2)
PHE-362	Agricultural Structures and Environmental Control	3(2+1)
PHE-48*	Elective Courses	3(2+1)

Electives Courses

PHE-481	Development of Processed Products	3(2+1)
PHE-482	Process Equipment Design	3(2+1)
PHE-483	Photovoltaic Technology and Systems	3(2+1)
PHE-484	Waste and By-Products Utilization	3(2+1)

Department of Food Engineering

Odd Semesters

Course No.	Title of the Course	Credit Hour
FE-231	Thermodynamics and Heat Engines	3(3+0)
FE-232	Heat and Mass Transfer	2(2+0)

Even Semesters

FE-361	Dairy and Food Engineering	3(2+1)
FE-362	Refrigeration and Air Conditioning	3(2+1)
FE-48*	Elective Courses	3(2+1)

Electives Courses

FE -481	Food Quality and Control	3(2+1)
FE-482	Food Plant Design and Management	3(2+1)
FE-483	Food Packaging Technology	3(2+1)

Inter-Departmental Courses of Agricultural Engineering

Course No.	Title of the Course	Credit Hour
FAE-121	Environmental Science and Disaster Management	3(2+1)
FAE-351	In-plant training-I (Student READY) Registration only	5(0+5)
FAE-471	10- weeks Industrial Attachment /Internship (Student READY)	10(0+10)
FAE-472	10- weeks Experiential Learning On campus (Student READY)	10(0+10)
FAE-473	In-plant training-II (Student READY) Registration only	5(0+5)
FAE-474	Educational Tour (Registration only)	2 (0+2)
FAE-481	Project Planning and Report Writing (Student READY)	10(0+10)
Department of Mathematics		
MATH-111	Engineering Mathematics-I	3(3+0)
MATH-121	Engineering Mathematics-II	3(3+0)
MATH-231	Engineering Mathematics-III	3(3+0)
Department of Agro-Meteorology & Physics		
PHY-111	Engineering Physics	3(2+1)
Department of Agricultural Chemistry & Soil Science		
CHM-111	Engineering Chemistry	2(1+1)
SOIL-111	Principles of Soil Science	2(1+1)
Department of Agronomy		
AGRO-111	Principles of Agronomy	3(2+1)
Horticulture		
HORT-121	Principles of Horticultural Crops and Plant Protection	2(1+1)
Department of Agricultural Economics		
ECO-121	Entrepreneurship Development and Business Management	3(2+1)
Department of Extension Education		
EXT-121	Communication Skills and Personality Development	2(1+1)

Semester-wise Course Programme

Course No.	Title of the Course	Credit Hour
Semester-I		
MATH-111	Engineering Mathematics-I	3(3+0)
PHY-111	Engineering Physics	3(2+1)
CHM-111	Engineering Chemistry	2(1+1)
SOIL-111	Principles of Soil Science	2(1+1)
AGRO-111	Principles of Agronomy	3(2+1)
FMP-111	Engineering Mechanics	3(3+0)
FMP-112	Engineering Drawing	2(0+2)
SWE-111	Surveying and Levelling	3(1+2)
	Total	**21(13+8)**
Semester-II		
MATH-121	Engineering Mathematics-II	3(3+0)
HORT-121	Principles of Horticultural Crops and Plant Protection	2(1+1)
EXT-121	Communication Skills and Personality Development	2(1+1)
ECO-121	Entrepreneurship Development and Business Management	3(2+1)
FMP-121	Workshop Technology and Practices	3(1+2)
FAE-121	Environmental Science and Disaster Management	3(2+1)
SWE-121	Theory of Structures	2(1+1)
SWE-122	Strength of Materials	2(1+1)
PHE-121	Web Designing and Internet Applications	2(1+1)
	Total	**22(13+9)**
Semester-III		
MATH-231	Engineering Mathematics-III	3(3+0)
FMP-231	Tractor and Automotive Engines	3(2+1)
FMP-232	Theory of Machines	2(2+0)
SWE-231	Soil Mechanics	2(1+1)
SWE-232	Fluid Mechanics and Open Channel Hydraulics	3(2+1)
PHE-231	Electrical Machines and Power Utilization	3(2+1)
FE-231	Thermodynamics and Heat Engines	3(3+0)
FE-232	Heat and Mass Transfer	2(2+0)
	Total	**21(17+4)**

Course No.	Title of the Course	Credit Hour
Semester-IV		
FMP-241	Auto CAD Applications	2(0+2)
FMP-242	Farm Machinery and Equipment-I	3(2+1)
FMP-243	Renewable Energy Sources	3(2+1)
SWE-241	Building Construction and Cost Estimation	2(2+0)
SWE-242	Watershed Hydrology	2(1+1)
SWE-243	Irrigation Engineering	3(2+1)
PHE-241	Applied Electronics and Instrumentation	3(2+1)
PHE-242	Engineering Properties of Agricultural Produce	3(2+1)
	Total	**21(13+8)**
In-plant training-I Summer break June-July after 4th Semester (Student READY)		
Semester-V		
FMP-351	Tractor Systems and Controls	3(2+1)
FMP-352	Farm Machinery and Equipment-II	3(2+1)
FMP-353	Machine Design	2(2+0)
SWE-351	Soil and Water Conservation Engineering	3(2+1)
SWE-352	Watershed Planning and Management	2(1+1)
SWE-353	Sprinkler and Micro Irrigation Systems	2(1+1)
SWE-354	Drainage Engineering	2(1+1)
PHE-351	Post Harvest Engineering of Cereals, Pulses and Oil Seeds	3(2+1)
PHE-352	Post Harvest Engineering of Horticultural Crops	2(1+1)
FAE-351	In-plant training-I (Student READY) Registration only	5(0+5)
	Total	**27(14+13)**
Semester-VI		
FMP-361	Tractor and Farm Machinery Operation and Maintenance	2(0+2)
FMP-362	Bio-Energy Systems: Design and Applications	3(2+1)
SWE-361	Water Harvesting and Soil Conservation Structures	3(2+1)
SWE-362	Groundwater, Wells and Pumps	3(2+1)
PHE-361	Computer Programming and Data Structures	3(1+2)
PHE-362	Agricultural Structures and Environmental Control	3(2+1)
FE-361	Dairy and Food Engineering	3(2+1)
FE-362	Refrigeration and Air Conditioning	3(2+1)
	Total	**23(13+10)**
In-plant training-II in Summer break June-July after 6th Semester (Student READY)		

Course No.	Title of the Course	Credit Hour
Semester-VII Student READY (Rural and Entrepreneurship Awareness Development Yojana)		
FAE-471	10- weeks Industrial Attachment /Internship (Student READY)	10(0+10)
FAE-472	10- weeks Experiential Learning On campus (Student READY)	10(0+10)
FAE-473	In-plant training-II (Student READY) Registration only	5(0+5)
FAE-474	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)		
DEPT	Elective course	3(2+1)
DEPT	Elective course	3(2+1)
DEPT	Elective course	3(2+1)
FAE-481	Project Planning and Report Writing (Student READY)	10(0+10)
	Total	**19(6+13)**
Grand Total (I to VIII semesters)		**181(89+92)**

Elective Courses

	Elective Courses (Any 3 courses)	**9 (6+3)**
FMP-481	Mechanics of Tillage and Traction	3(2+1)
FMP-482	Farm Machinery Design and Production	3(2+1)
FMP-483	Human Engineering and Safety	3(2+1)
FMP-484	Tractor Design and Testing	3(2+1)
FMP-485	Hydraulic Drives and Controls	3(2+1)
FMP-486	Precision Agriculture and System Management	3(2+1)
SWE-481	Floods and Control Measures	3(2+1)
SWE-482	Wasteland Development	3(2+1)
SWE-483	Remote Sensing and GIS Applications	3(2+1)
SWE-484	Management of Canal Irrigation System	3(2+1)
SWE-485	Minor Irrigation and Command Area Development	3(2+1)
SWE-486	Precision Farming Techniques for Protected Cultivation	3(2+1)
SWE-487	Water Quality and Management Measures	3(2+1)
SWE-488	Landscape Irrigation Design and Management	3(2+1)
SWE-489	Plastic Applications in Agriculture	3(2+1)
PHE-481	Development of Processed Products	3(2+1)
PHE-482	Process Equipment Design	3(2+1)
PHE-483	Photovoltaic Technology and Systems	3(2+1)
PHE-484	Waste and By-Products Utilization	3(2+1)
FE -481	Food Quality and Control	3(2+1)
FE-482	Food Plant Design and Management	3(2+1)
FE-483	Food Packaging Technology	3(2+1)

Semester-I		
MATH-111	**Engineering Mathematics-I**	**3(3+0)**
PHY-111	**Engineering Physics**	**3(2+1)**
CHM-111	**Engineering Chemistry**	**2(1+1)**
SOIL-111	**Principles of Soil Science**	**2(1+1)**
AGRO-111	**Principles of Agronomy**	**3(2+1)**
FMP-111	**Engineering Mechanics**	**3(3+0)**
FMP-112	**Engineering Drawing**	**2(0+2)**
SWE-111	**Surveying and Levelling**	**3(1+2)**
	Total	**21(13+8)**

MATH-111	Engineering Mathematics-I	3(3+0)

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).

Suggested Reading

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.

PHY-111	Engineering Physics	3(2+1)

Theory

Dia, Para and ferromagnetism-classification. Langevin theory of dia and paramagnetism. Adiabatic demagnetization. Interference of light, Super position principle, Young,s Experiment, Formation of Fringes, Constructive and destructive interference, Newton's Ring. Thin films, wedge shaped films, 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. Surface tension, Capillarity, Crystal structure of materials, Bravai's Space Lattice, Miller Indices, Atomic radius, Unit cell, Co-ordination number, Lattice constant, Viscosity, Poiseuille's equation, Laminar & turbulent flow, Reynolds number, , Pressure measuring devices. Manometers, 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 T_c 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 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 refractive index of liquid and wave length of light, through Newton's ring. Young's double slit experiment. To determine the surface tension and coefficient of Viscosity of liquid. To determine the slit width from Fraunhofer diffraction pattern using laser beam; To study LCR circuit; To find the wave length of light by prism.

Suggested Reading

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.

CHM-111	Engineering Chemistry	2(1+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, nuclear radiation, and analytical applications of radioactive materials. Enzymes and their use in the manufacturing of ethanol and acetic acid by fermentation methods. Lubricants: properties. mechanism. classification and tests. 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 V_{max} and verification of Beer Lambert Law: Determination of calorific value of fuel.

Suggested Reading

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.
Rakshit P C. 2004 *Physical Chemistry*. Sarat Book Distributers, Kolkata.
Palit S R. *Elementary Physical Chemistry.* Book Syndicate Pvt Ltd., Kolkata

SOIL-111	Principles of Soil Science	2(1+1)

Theory

Nature and origin of soil; soil forming rocks and minerals, their classification and composition, soil forming processes, 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; 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; Determination of gypsum requirement of sodic soils; Determination of water quality parameters.

Suggested Reading

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.

AGRO-111	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 Reading

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.

FMP-111	Engineering Mechanics	3(3+0)

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.

Suggested Reading

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.

FMP-112	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 Reading

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.

SWE-111	Surveying and Levelling	3(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 Reading

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.

Semester-II		
MATH-121	**Engineering Mathematics-II**	**3(3+0)**
HORT-121	**Principles of Horticultural Crops and Plant Protection**	**2(1+1)**
EXT-121	**Communication Skills and Personality Development**	**2(1+1)**
ECO-121	**Entrepreneurship Development and Business Management**	**3(2+1)**
FMP-121	**Workshop Technology and Practices**	**3(1+2)**
FAE-121	**Environmental Science and Disaster Management**	**3(2+1)**
SWE-121	**Theory of Structures**	**2(1+1)**
SWE-122	**Strength of Materials**	**2(1+1)**
PHE-121	**Web Designing and Internet Applications**	**2(1+1)**
	Total	**22(13+9)**

MATH-121	Engineering Mathematics-II	3(3+0)

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.

Suggested Reading

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.

HORT-121	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 Reading

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.

EXT-121	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 Reading

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.

ECO-121	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 Reading

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.

FMP-121	Workshop Technology and Practices	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. 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, 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 Reading

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.

FAE-121	Environmental Science and Disaster Management	3(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 Reading

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.

SWE-121	Theory 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 Reading

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.

SWE-122	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 indeterminate 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 Reading

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.

PHE-121	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 JavaScript, 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 Reading

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.

Semester-III		
MATH-231	**Engineering Mathematics-III**	**3(3+0)**
FMP-231	**Tractor and Automotive Engines**	**3(2+1)**
FMP-232	**Theory of Machines**	**2(2+0)**
SWE-231	**Soil Mechanics**	**2(1+1)**
SWE-232	**Fluid Mechanics and Open Channel Hydraulics**	**3(2+1)**
PHE-231	**Electrical Machines and Power Utilization**	**3(2+1)**
FE-231	**Thermodynamics and Heat Engines**	**3(3+0)**
FE-232	**Heat and Mass Transfer**	**2(2+0)**
	Total	**21(17+4)**

MATH-231	Engineering Mathematics-III	3(3+0)

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.

Suggested Reading

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.

FMP-231	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. 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.

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 Reading

Liljedahl J B and Others. Tractors and Their Power Units.
Mathur ML and RP Sharma. A course in Internal Combustion Engines.
Heitner Joseph. Automotive Mechanics : Principles and Practices.
Ganesan, V. Internal Combustion Engines , McGraw Hill.

FMP-232	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 analysis 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 Reading

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.

SWE-231	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. Permeability factors affecting, Falling and constant head methods of determination of coefficient of permeability. 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 Reading

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.

SWE-232	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 hemispherical 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 Reading

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.

Lal Jagadish 1985. Fluid Mechanics and Hydraulics. Metropolitan Book Co.Pvt. Ltd., New Delhi.

PHE-231	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 Reading

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.

FE-231	Thermodynamics and Heat Engines	3(3+0)

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.

Suggested Reading

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.

FE-232	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 Reading

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.

Semester-IV		
FMP-241	**Auto CAD Applications**	**2(0+2)**
FMP-242	**Farm Machinery and Equipment-I**	**3(2+1)**
FMP-243	**Renewable Energy Sources**	**3(2+1)**
SWE-241	**Building Construction and Cost Estimation**	**2(2+0)**
SWE-242	**Watershed Hydrology**	**2(1+1)**
SWE-243	**Irrigation Engineering**	**3(2+1)**
PHE-241	**Applied Electronics and Instrumentation**	**3(2+1)**
PHE-242	**Engineering Properties of Agricultural Produce**	**3(2+1)**
	Total	**21(13+8)**
In-plant training-I Summer break June-July after 4th Semester (Student READY)		

FMP-241	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 Reading

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.

FMP-242	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 Reading

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.
Srivastava, A.K. C EGoering & Rohrbach. Engineering Principles of Agricultural Machines.

FMP-243	Renewable Energy Sources	3(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 Reading

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.
Tiwari, G.S. and Ghosal, S.K. Fundamental of Renewable Energy Sources.

SWE-241	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 Reading

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.

SWE-242	Watershed Hydrology	2(1+1)

Theory

Hydrologic cycle, precipitation and its forms, rainfall measurement and estimation of mean rainfall, frequency analysis of point rainfall. Mass curve, hyetograph, depth-area-duration curves and 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 Reading

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.

SWE-243	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 Reading

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.

PHE-241	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 Reading

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.

PHE-242	Engineering Properties of Agricultural Produce	3(2+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 Reading

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.

Semester-V		
FMP-351	**Tractor Systems and Controls**	**3(2+1)**
FMP-352	**Farm Machinery and Equipment-II**	**3(2+1)**
FMP-353	**Machine Design**	**2(2+0)**
SWE-351	**Soil and Water Conservation Engineering**	**3(2+1)**
SWE-352	**Watershed Planning and Management**	**2(1+1)**
SWE-353	**Sprinkler and Micro Irrigation Systems**	**2(1+1)**
SWE-354	**Drainage Engineering**	**2(1+1)**
PHE-351	**Post Harvest Engineering of Cereals, Pulses and Oil Seeds**	**3(2+1)**
PHE-352	**Post Harvest Engineering of Horticultural Crops**	**2(1+1)**
FAE-351	**In-plant training-I (Student READY) Registration only**	**5(0+5)**
	Total	**27(14+13)**

FMP-351	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. 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. Study of tractor static equilibrium, tractor stability especially at turns. Determination of maximum drawbar pull.

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 Reading

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.

Sharma, D.N. and Mukesh S. Farm Machinery Design and Problems, Jain Brothers.

FMP-352	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 Reading

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.
Srivastava, A.K. C EGoering & Rohrbach. Engineering Principles of Agricultural Machines.

FMP-353	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 riveted joints. 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 Reading

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.

SWE-351	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 Reading

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.

SWE-352	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 Reading

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.

SWE-353	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 Reading

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.

SWE-354	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 Reading

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.

PHE-351	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. 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 Reading

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.

PHE-352	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 Reading

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.

Semester-VI		
FMP-361	**Tractor and Farm Machinery Operation and Maintenance**	**2(0+2)**
FMP-362	**Bio-Energy Systems: Design and Applications**	**3(2+1)**
SWE-361	**Water Harvesting and Soil Conservation Structures**	**3(2+1)**
SWE-362	**Groundwater, Wells and Pumps**	**3(2+1)**
PHE-361	**Computer Programming and Data Structures**	**3(1+2)**
PHE-362	**Agricultural Structures and Environmental Control**	**3(2+1)**
FE-361	**Dairy and Food Engineering**	**3(2+1)**
FE-362	**Refrigeration and Air Conditioning**	**3(2+1)**
	Total	**23(13+10)**
In-plant training-II in Summer break June-July after 6th Semester (Student READY)		

FMP-361	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. 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.

Suggested Reading

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.

FMP-362	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 Reading

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.

SWE-361	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. 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 Reading

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.

SWE-362	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 Reading

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.

PHE-361	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 Reading

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.

PHE-362	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 and construction 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.

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 Reading

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.

FE-361	Dairy and Food Engineering	3(2+1)

Theory

Deterioration in food products and their controls, Physical, chemical and biological methods of food preservation. 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. 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.

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 Reading

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.

FE-362	Refrigeration and Air Conditioning	3(2+1)

Theory

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

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 Reading

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.

Semester-VII ***Student READY (Rural and Entrepreneurship Awareness Development Yojana)***		
FAE-471	**10- weeks Industrial Attachment /Internship (Student READY)**	**10(0+10)**
FAE-472	**10- weeks Experiential Learning On campus (Student READY)**	**10(0+10)**
FAE-473	**In-plant training-II (Student READY) Registration only**	**5(0+5)**
FAE-474	**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)***		
DEPT	**Elective course**	**3(2+1)**
DEPT	**Elective course**	**3(2+1)**
DEPT	**Elective course**	**3(2+1)**
FAE-481	**Project Planning and Report Writing (Student READY)**	**10(0+10)**
	Total	**19(6+13)**

Elective Courses

	Elective Courses (Any 3 courses)	**9 (6+3)**
FMP-481	**Mechanics of Tillage and Traction**	**3(2+1)**
FMP-482	**Farm Machinery Design and Production**	**3(2+1)**
FMP-483	**Human Engineering and Safety**	**3(2+1)**
FMP-484	**Tractor Design and Testing**	**3(2+1)**
FMP-485	**Hydraulic Drives and Controls**	**3(2+1)**
FMP-486	**Precision Agriculture and System Management**	**3(2+1)**
SWE-481	**Floods and Control Measures**	**3(2+1)**
SWE-482	**Wasteland Development**	**3(2+1)**
SWE-483	**Remote Sensing and GIS Applications**	**3(2+1)**
SWE-484	**Management of Canal Irrigation System**	**3(2+1)**
SWE-485	**Minor Irrigation and Command Area Development**	**3(2+1)**
SWE-486	**Precision Farming Techniques for Protected Cultivation**	**3(2+1)**
SWE-487	**Water Quality and Management Measures**	**3(2+1)**
SWE-488	**Landscape Irrigation Design and Management**	**3(2+1)**
SWE-489	**Plastic Applications in Agriculture**	**3(2+1)**
PHE-481	**Development of Processed Products**	**3(2+1)**
PHE-482	**Process Equipment Design**	**3(2+1)**
PHE-483	**Photovoltaic Technology and Systems**	**3(2+1)**
PHE-484	**Waste and By-Products Utilization**	**3(2+1)**
FE -481	**Food Quality and Control**	**3(2+1)**
FE-482	**Food Plant Design and Management**	**3(2+1)**
FE-483	**Food Packaging Technology**	**3(2+1)**

FMP-481	Mechanics of Tillage and Traction	3(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, Modelling 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 application of computer 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 Reading

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.

FMP-482	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 Reading

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.

FMP-483	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 Reading

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.

FMP-484	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 Reading

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.

FMP-485	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 Reading

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.

FMP-486	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 Reading

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.

SWE-481	**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 Reading

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.

SWE-482	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 Reading

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**.**

SWE-483	**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 Reading

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.

SWE-484	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 Reading

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.

SWE-485	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 Reading

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.

SWE-486	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 Reading

Singh Brahma and Balraj Singh. 2014. Advances in protected cultivation, New India Publishing Company.

Sharma P. 2007. Precision Farming. Daya Publishing House New Delhi.

SWE-487	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 Reading

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.

SWE-488	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 Reading

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.

SWE-489	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 Reading

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.

PHE-481	**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 Reading

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.

PHE-482	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 Reading

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.

PHE-483	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 Reading

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.

PHE-484	**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 Reading

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.

FE -481	**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 Reading

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.

FE-482	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 Reading

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.

FE-483	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 Reading

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.

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21.	Mr.Bikram Sharma	Jr. Superintendent (Store)	9874862311 (M)
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32.	Mr Ajit Mondal	F.W., Gr.-II	9903036475 (M)
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