B. Tech. Agriculture Engineering Course Structure as per ICAR Vth Dean Committee (Applicable from 2017 batch)

SEMESTER - I				
No.	**Course No**		**Course Name**	**Credit Hours**
1.	LNG	306	English Language	2(1-0-2)
2.	GPT	301	Moral and Value Education	3(3-0-0)
3.	MAS	312	Elementary Mathematics (Ag group)	3(2-1-0)
4.	PHY	313	Engineering Physics	4(2-1-2)
5.	CHEM	314	Engineering Chemistry	3(2-0-2)
6.	SES	401	Principles of Soil Science	2(1-0-2)
7.	CE	402	Surveying and Levelling	3(2-0-2)
8.	ME	303	Engineering Drawing	2(0-0-4)
9.	AGRN	313	Horticultural and field crops	2(1-0-2)
			Total	**24(14-2-16)**

SEMESTER - II				
No.	**Course No**		**Course Name**	**Credit Hours**
1.	MAS	411	Engineering Mathematics-I	3(2-1-0)
2..	LNG	307	Communication Skills, technical writing and Personality Development	3(2-0-2)
3.	ME	304	Workshop Technology and Practices	3(1-0-4)
4.	CE	401	Engineering Mechanics	3(2-0-2)
5.	ENVS	502	Environmental Science and Disaster Management	3(2-0-2)
6.	ME	503	Heat and Mass Transfer	3(2-0-2)
7.	CE	406	Fluid Mechanics and Open Channel Hydraulics	3(2-0-2)
8.	CSIT	428	Computer Programming and Data Structure	3(2-0-2)
			Total	**24(15-1-16)**

SEMESTER - III				
S. No.	**Course No**		**Course Name**	**Credit Hours**
1.	MAS	490	Engineering Mathematics-II	3(2-1-0)
2.	ABM	502	Entrepreneurship Development and Agri-Business Management	3(2-0-2)
3.	CSIT	429	Web Designing and Internet Applications	2(1-0-2)
4.	MAS	511	Statistical Methods	3(2-0-2)
5.	CE	410	Soil Mechanics	3(2-1-0)
6.	ECE	301	Basic Electronics	2(1-0-2)
7.	ME	414	Theory of Machines	3(2-0-2)
8.	FMP	502	Renewable Energy	3(2-0-2)
9.	EE	407	Electrical Machines and Power Utilization	3(2-0-2)
10.	CE	408	Strength of Materials	2(1-1-0)
			Total	**24(15-2-14)**

B. Tech. Agriculture Engineering Course Structure as per ICAR Vth Dean Committee (Applicable from 2017 batch)

SEMESTER – IV				
No.	**Course No**		**Course Name**	**Credit Hours**
1.	CE	409	Building Materials and Structural Design.	3(2-1-0)
2.	ME	413	CAD/CAM Machine Drawing and Computer Graphics	2(1-0-2)
3.	ME	310	Thermodynamics, Refrigeration and Air Conditioning	3(2-0-2)
4.	FMP	404	Tractor and Automotive Engines	3(2-0-2)
5.	IDE	403	Engineering Hydrology	3(2-1-0)
6.	IDE	502	Irrigation Engineering	3(2-0-2)
7.	SES	503	Soil Physics	2(1-0-2)
8.	ME	415	Machine Design	2(2-0-0)
9.	FPE	430	Engineering Properties of Biological Materials	2(1-0-2)
			Total	**23(15-2-12)**
(AET 400) * Skill Development Training-I (Student READY) Registration only (Non gradial)				5(0-0-10)

SEMESTER – V				
No.	**Course No**		**Course Name**	**Credit Hours**
1.	FPE	541	Post-Harvest Engineering of Cereals, Pulses and Oil Seeds	3(2-0-2)
2.	ECE	512	Instrumentation and Control Engineering	3(2-0-2)
3.	FMP	403	Farm Machinery and Equipment-I	3(2-0-2)
4.	FPE	431	Agricultural Structures and Environmental Control	3(2-0-2)
5.	SWCE	501	Soil and Water Conservation Engineering	3(2-0-2)
6.	SWCE	518	Watershed Planning and Management	3(2-0-2)
7.	IDE	505	Drainage Engineering	3(2-1-0)
8.	FMP	505	Renewable Power Sources	3(2-0-2)
			Total	**24(16-1-14)**

SEMESTER – VI				
No.	**Course No**		**Course Name**	**Credit Hours**
1.	FMP	504	Tractor Systems and Controls	3(2-0-2)
2.	FMP	506	Farm Machinery and Equipment-II	3(2-0-2)
3.	FPE	542	Post-Harvest Engineering of Horticultural Crops	2(1-0-2)
4.	SWCE	519	Water Harvesting and Soil Conservation Structures	3(2-0-2)
5.	IDE	520	Groundwater, Wells and Pumps	3(2-0-2)
6.	FMP	507	Field Operation and maintenance of Tractors and Farm Machinery	3(1-0-4)
7.	FPE	543	Dairy and Food Engineering	3(2-0-2)
8.	FMP	610	Bio-energy Systems: Design and Applications	3(2-0-2)
9.	IDE	521	Sprinkler and Micro Irrigation Systems	2(1-1-0)
			Total	**25(15-1-18)**
(AET 500) Skill Development Training-II (Student READY) Registration only				5(0-0-10)

B. Tech. Agriculture Engineering Course Structure as per ICAR Vth Dean Committee (Applicable from 2017 batch)

Semester-VII			
No.	**Course No**	**Course Name**	**Credit Hours**
Student READY (Rural and Entrepreneurship Awareness Development Yojana)			
1.	AET 600A	10- weeks Industrial Attachment /Internship (Student READY)	15(0-0-30)
2.	AET 600B	10- weeks Experiential Learning On campus (Student READY)	15(0-0-30)
3.	AET600C1	Project Planning and Report Writing (Student READY)	5(0-0-10)
4.	AET600D	Educational Tour (Registration only)	2 (0-0-4)
		Total	**37(0-0-74)**
Educational tour during winter/January break			

SEMESTER – VIII			
No.	**Course No**	**Course Name**	**Credit Hours**
VIII Semester Student READY (Rural and Entrepreneurship Awareness Development Yojana)			
1.	Elective course		3(2-0-2)
2.	Elective course		3(2-0-2)
3.	Elective course		3(2-0-2)
4.	AET 600C2 Project Planning and Report Writing (Student READY)		10(0-0-20)
Total			**19(6-0-26)**
GRAND TOTAL SEM I TO VIII			**200(96-9-190)**

B. Tech. Agriculture Engineering Course Structure as per ICAR Vth Dean Committee (Applicable from 2017 batch)

Detail Course Syllabus of B-Tech Agricultural Engineering

SEMESTER - I				
No.	**Course No**		**Course Name**	**Credit Hours**
1.	LNG	306	English Language	2(1-0-2)
2.	GPT	301	Moral and Value Education	3(3-0-0)
3.	MAS	312	Elementary Mathematics (Ag group)	3(2-1-0)
4.	PHY	313	Engineering Physics	4(2-1-2)
5.	CHEM	314	Engineering Chemistry	3(2-0-2)
6.	SES	401	Principles of Soil Science	2(1-0-2)
7.	CE	402	Surveying and Levelling	3(2-0-2)
8.	ME	303	Engineering Drawing	2(0-0-4)
9.	AGRN	313	Horticultural and field crops	2(1-0-2)
			Total	**24(14-2-16)**

LNG-306 English Language 2 (1-0-2)

Theory: Reading Comprehension: - Factual, formulating, translating global comprehension; language in terms of synonyms; collection in context, introduction to different types of writing descriptive, narrative and exposition, letter writing-formal and informal – speech acts-norms of preparing introductory address, presidential address, vote of thanks.

Practical: Integrated grammar by means of class exercise, common errors in English writing, use of cohesive devices, dialogue practice, orientation to different types of letters, performing different speech acts according to contexts, exercise based on examination like TOEFL, GRE, GATE, MAT, IELTS.

GPT-301 Moral & Value Education 3 (3-0-0)

OBJECTIVES

- To explicitly discuss that is implicitly communicated through Academic disciplines.
- To inculcate Life affirming values based on 'Fear of God as the beginning of wisdom'.
- To focus on specific values in decision making process.

Section I - BASICS

- Integrating 'Heart-Head-Hand'- Story of Sam Higginbottom.
- 'Contextual-Dialogical-Praxiological' character of value education.
- Different Values: Academic-Economic-Social-Material-Moral-Spiritual.

Section II- Biblical Foundation

- Proverbs Chapter 2-4
- Ten Commandments Exodus 20:1-17
- Two Commandments of Jesus Mark 12:29-31
- Sermon on Mount Matthew chapter 5-7
- Lord's Prayer Matthew 6:9-13, Luke11:1-4
- Parable of Good Samaritan Luke 10:29-37
- Parable of Two Brothers Luke 15:11-32

Section III- Formation of Character

- Voice of Conscience
- Virtues Prudence-Justice-Courage-Discipline-Success-Faith-Hope-Love
- Values of Life Marriage- No same-sex marriage- Divorce -Abortion
- Values of Belonging Family-Friends- Faith Community- Nation-World

Section IV-God-Human-Plants-Animals

- Stewardship of Creation
- Biotechnological Advancement
- Exploitation of Animals & Plants & Micro-Organisms
- Environmental Hazards

Section V- Our Constitution

- Fundamental Rights
- Directive Principles of State Policy
- Fundamental Duties
- Enlightened Citizenship: Ten points of Dr. A P J Kalam

Section VI- Interactive Sessions

- Sexual Harassment
- Corruption
- Substance Abuse
- Violence
- Communalism
- Cyber crime

MAS-312 Elementary Mathematics (Ag Group) 3 (2-1-0)

Theory: Algebra: Theory of quadratic equations i.e. ($ax^2 + bx + c = 0$), Binomial theorem (for positive integral index only). Uses of Natural and Common Logarithms, Exponential series, Partial Fractions, Determinants (of order three only), Theory of Matrices (Addition, Subtraction), Product of Matrices, Transpose, Elementary idea of following adjoint, Inverse of matrices by adjoint method, Solution of liner equations, Solution of inequalities, Permutation and combination. Trigonometry: Trigonometry functions, addition and subtraction formula, Double and half angle formula, Laws of sines and cosines, Solution of triangles, Height and distances, Real and complex numbers, Hyperbolic trigonometric functions, De Moiwes theorem.

Coordinate Geometry: Distance between two points, Area of triangles, Straight lines (Parallel and at right angles) Calculus: Elementary Differentiation and Integration.

PHY-313 Engineering Physics 4 (2-1-2)

Theory: Dia, Para and ferromagnetism-classification. Langevin theory of dia. and paramagnetism. Adiabatic demagnetization. Weiss molecular field theory and ferromagnetism. Curie-Weiss law. Wave particle quality, de-Broglie concept, uncertainty principle. Wave function. Time dependent and time independent Schrodinger wave equation, Qualitative explanation of Zeeman effect, Stark effect and Paschan Back effect, Raman spectroscopy. Statement of Bloch's function. Bands iii solids, velocity of Bloch's electron and effective mass. Distinction between metals. insulators and semiconductors. Intrinsic and extrinsic semiconductors, law of mass action. Determination of energy gap in semiconductors. Donors and acceptor levels. Superconductivity, critical magnetic field. Meissner effect. Isotope effect. Type-I and II superconductors, Josephson's effect DC and AC, Squids. Introduction to high 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 determine the value of specific charge (e/m) for electrons by helical method; To study the induced e.m.f. as a function of velocity of the magnet; To obtain hysteresis curve (B-H curve) on a C.R.O. and to determine related magnetic quantities; To study the variation of magnetic field with distance along the axis of a current carrying circular coil and to detuning the radius of the coil; To determine the energy band gap in a semiconductor using a p-n Junction diode; To determine the slit width from Fraunhofer diffraction pattern using laser beam; To find the numerical aperture of optical fiber: To set up the fiber optic analog and digital link; To study the phase relationships in L.R. circuit; To study LCR circuit; To study the variations of thermo emf of a copper-constantan thermo-couple with temperature; To find the wave length of light by prism.

Suggested Readings:

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

CHEM-314 Engineering Chemistry 3 (2-0-2)

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

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

Suggested Readings:

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

SES-401 Principles of Soil Science 2 (1-0-2)

Theory: Course Objective – To develop basic understanding in students about soil forming processes and soil as natural body/medium for storage and movement of water, gases, heat, nutrients. To develop student understanding of the general physical and chemical properties of soil. Course Content – Soil as three-phase system, Definition of soil, soil forming rocks and minerals, weathering of rocks and minerals, soil formation processes, factors of soil formation, soil profile and its development. Soil Physical Properties-Texture, Textural classification of soils, Stoke's law and its limitations, Soil structure, Formation and types of soil structure, Bulk Density, Particle density, Porosity, Types of Soil Water, Soil Moisture Tension/Water potential, Saturation, Soil water movement, Soil Temperature, Soil Air, Aeration and its importance. Soil Chemical Properties, Soil Reaction-Soil pH, Saline, Saline Alkali, Alkali Soils and their management, Colloidal Properties of the Soil- Soil organic matter and Humus formation; Clay minerals: Colloidal properties, 1;1, 2:1 lattice structures; Cation exchange properties of soils as contributed by organic and inorganic colloids. Diffuse Double Layer, Stern layer theory, Flocculation and dispersion; Soil Classification – Soil Taxonomic orders.

Practical: Techniques of soil sampling, preparation of soil samples for analysis. Determination of Bulk Density and particle density of soil, soil moisture content. Determination of Soil Texture. Study of soil profile, Identification of Rocks and Minerals. Si O2 determination, Hcl extraction of soil. Gravimetric determination of sulphate. Organic matter / Carbon determination. Determination of cation exchange capacity of soil. Determination of Ca, Phosphorus, and Iron Nitrogen, Potassium, Soil pH, Gypsum requirement, lime requirement of soils, Electrical conductivity, SAR. Determination of water-soluble anions chlorides, carbonates, bicarbonates.

CE-402 Surveying and Leveling 3 (2-0-2)

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.

References:

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 VidyarthiGriha, Prakashan, Pune.

ME-303 Engineering Drawing 2 (0-0-4)

Practical: Introduction of drawing scales; First and third angle methods of projection. Principles of orthographic projections; References planes; Points and lines in space and traces of lines and planes; Auxiliary planes and true shapes of oblique plain surface; True length and inclination of lines; Projections of solids (Change of position method, alteration of ground lines); Section of solids and Interpenetration of solid surfaces; Development of surfaces of geometrical solids; Isometric projection of geometrical solids. Preparation of working drawing from models and isometric views. Drawing of missing views. Different methods of dimensioning. Concept of sectioning. Revolved and oblique sections. Sectional drawing of simple machine parts. Types of rivet heads and riveted joints. Processes for producing leak proof joints. Symbols for different types of welded joints. Nomenclature, thread profiles, multi start threads, left and right hand threads. Square headed and hexagonal nuts and bolts. Conventional representation of threads. Different types of lock nuts, studs, machine screws, cap screws and wood screws. Foundation bolts. Forms of screw threads, representation of threads, Bolts- headed centre, stud screws, set screws, butt, hexagonal and square; keys-types, taper, rank taper, hollow saddle etc.

Suggested Readings:

Bhat N D. 2010. Elementary Engineering Drawing. Charotar Publishing House Pvt. Ltd., Anand.

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

AGRN-313 **Horticultural and field crops** **2(1-0-2)**

Agronomy: Farm crops, Cultivation of wheat, Paddy, Jowar, Cotton, Maize, Groundnut, Potato, and Sugarcane with reference to its varieties. Area of growing, sowing time, Seed rate, Method of sowing, manuring irrigation a water requirement. Harvesting, Threshing and yields. Crop rotation, Soil, Soil formation, Classification (sand, loam, silt, clay), Soil Characteristics, Manuring and its importance, Study of Gobar, Compost and Green manure.

Agronomy Practical: Identification of crops being grown at the crop Research Farm. Identification of rabi season weeds. Calculation of seed rate, fertilizer management, yield estimated in crops and practical assessment of plant growth in field crops.

Horticulture: Importance of fruit and vegetable in diet, scope and importance of fruit and vegetable industry. A general survey of fruits grown in India.
Planting plants: Their merits and demerits, preliminary operation before planting.
Temperature relation: Temperature as part of climate, influence of temperature on plants, freeze and frost and their control. Water relation: Water absorption and movement in plant, methods of irrigation systems for fruits and vegetables, their merits and demerits. Light relation: Role of light in seed germination, photoperiodism, and light source of radiant energy. Soil: Essential elements and their role, methods for correcting deficiency and excess. Nutrition: Essential elements and their role, methods for correcting deficiency and excess. Propagation: Sexual propagation, cuttage, layarage and graftage. Raising and sectioning of root stock. Pruning and growth control: System and methods of training fruit trees pruning principles and method pruning tools and their material. Marketing storage of horticulture produce, preparation for marketing. Cultivation of Cauliflower, Cabbage, Onion, Bottle gourd, Carrot, Pea, Tomato, Banana, Oranges, Mango and Guava with reference to its varieties, sowing time, seed rate, method of sowing, manuring, irrigation and water requirements, harvesting threshing and yield.

Horticulture Practical: Different techniques of propagation; Use of plating board; pruning and training tools and implements; spraying of nutrients to overcoming deficiencies in the fruit plants.

SEMESTER - II				
No.	**Course No**		**Course Name**	**Credit Hours**
1.	MAS	411	Engineering Mathematics-I	2 (2-1-0)
2..	LNG	307	Communication Skills, technical writing and Personality Development	3(2-0-2)
3.	ME	304	Workshop Technology and Practices	3(1-0-4)
4.	CE	401	Engineering Mechanics	3(2-0-2)

5.	ENVS	502	Environmental Science and Disaster Management	3(2-0-2)
6.	ME	503	Heat and Mass Transfer	3(2-0-2)
7.	CE	406	Fluid Mechanics and Open Channel Hydraulics	3(2-0-2)
8.	CSIT	428	Computer Programming and Data Structure	3(2-0-2)
			Total	**24(15-1-16)**

MAS-411 Engineering Mathematics – I 3 (2-1-0)

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

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

Suggested Readings:

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

LNG-307 Communication Skill, Technical Writing and Personality Development 3 (2-0-2)

Theory: Reading Comprehension: - Factual, formulating, translating global comprehension; language in terms of synonyms; collection in context, introduction to different types of writing

descriptive, narrative and exposition, letter writing-formal and informal – speech acts-norms of preparing introductory address, presidential address, vote of thanks.

Practical: Integrated grammar by means of class exercise, common errors in English writing, use of cohesive devices, dialogue practice, orientation to different types of letters, performing different speech acts according to contexts, exercise based on examination like TOEFL, GRE, GATE, MAT, IELTS.

ME-304 Workshop Technology and Practices 3(1-0-4)

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

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

Suggested Readings:

Hazra, Choudari S K and Bose S K. 1982. Elements of Workshop technology (Vol. I and II). Media Promoters and Publishers Pvt.Ltd., Mumbai.

Chapman W A J. 1989. Workshop Technology (Part I and II). Arnold Publishers (India) Pvt. Ltd., AB/9 Safdarjung Enclave, New Delhi.

Raghuwamsi B S. 1996. A Course in Workshop Technology (Vol. I and II). Dhanpat Rai and Sons, 1682 NaiDarak, New Delhi.

CE-401 Engineering Mechanics 3 (2-0-2)

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

Practical: Problems on composition and resolution of forces, moments of a force, couples, transmission of a couple, resolution of a force into a force & a couple; Problems relating to resultant of; Co-planer force system, collinear force system, concurrent force system, co-planer concurrent force system, co-planer non-concurrent force system, Non-coplaner concurrent force system, Non-coplaner non-concurrent force system, system of couples in space; Problems relating to centroids of composite areas; Problems on moment of inertia, polar moment of inertia, radius of gyration, polar radius of gyration of composite areas; Equilibrium of concurrent – co-planer and non-concurrent – co-planer force systems; Problems involving frictional forces; Analysis of simple trusses by method of joints and method of sections; Analysis of simple trusses by graphical method; Problems relating to simple stresses and strains; Problems on shear force and bending moment diagrams; Problems relating to stresses in beams; Problems on torsion of shafts; Analysis of plane and complex stresses.

References:

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.

ENVS-502 Environmental Science and Disaster Management 3(2-0-2)

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

in conservation of natural resources. Equitable use of resources for sustainable lifestyles. Ecosystems: Concept, Structure, function, Producers, consumers, decomposers, Energy flow, ecological succession, food chains, food webs, ecological pyramids. Introduction, types, characteristic features, structure and function of the forest, grassland, desert and aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity and its conservation: - Introduction, definition, genetic, species & ecosystem diversity and bio-geographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Environmental Pollution: definition, cause, effects and control measures of a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Social Issues and the Environment from Unsustainable to Sustainable development, Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. dies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.

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

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

Quantitative Techniques for Disaster Management Environmental Impact Assessment (EIA) and Disaster Management Disaster Management Policy Environmental Modelling.

Suggested Readings:

BharuchaErach. 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, AshuthoshGautam. 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.

ME-503 Heat and Mass Transfer 3(2-0-2)

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, Kirchhoff's law, grey bodies and emissive power, solid angle, intensity of radiation. Radiation exchange between black surfaces, geometric configuration factor. Heat transfer analysis involving conduction, convection and radiation by networks. Types of heat exchangers, fouling factor, log mean temperature difference, heat exchanger performance, transfer units. Heat exchanger analysis restricted to parallel and counter flow heat exchangers. Steady state molecular diffusion in fluids at rest and in laminar flow, Flick's law, mass transfer coefficients. Reynold's analogy.

Suggested Readings:

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

CE-406 Fluid Mechanics and Open Channel Hydraulics 3(2-0-2)

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 Readings:

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

CSIT-428 Computer Programming and Data Structure 3(2-0-2)

Theory: Introduction to high level languages, Primary data types and user defined data types, Variables, typecasting, Operators, Building and evaluating expressions, Standard library

functions, Managing input and output, Decision making, Branching, Looping, Arrays, User defined functions, passing arguments and returning values, recursion, scope and visibility of a variable, String functions, Structures and union, Pointers, Stacks, Push/Pop operations, Queues, Insertion and deletion operations, Linked lists.

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

Suggested Readings:

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

SEMESTER - III				
No.	**Course No**		**Course Name**	**Credit Hours**
1.	MAS	490	Engineering Mathematics – II	3 (2-1-0)
	ABM	502	Entrepreneurship Development and Agri-Business Management	3(2-0-2)
2.	CSIT	429	Web Designing and Internet Applications	2(1-0-2)
3.	MAS	511	Statistical Methods	3(2-0-2)
4.	CE	410	Soil Mechanics	3(2-1-0)
5.	ECE	301	Basic Electronics	2(1-0-2)

6.	ME	414	Theory of Machines	3(2-0-2)
7.	FMP	502	Renewable Energy	3(2-0-2)
8.	EE	407	Electrical Machines and Power Utilization	3(2-0-2)
9.	CE	408	Strength of Materials	2(1-1-0)
			Total	**24(15-2-14)**

MAS-490 Engineering Mathematics – II 3 (2-1-0)

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.

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

Suggested Readings:

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

ABM 502 Entrepreneurship Development and Agri-Business Management 3(2-0-2)

Theory: Entrepreneurship, management – Management functions – planning- Organizing - Directing – motivation – ordering – leading – supervision-Communication and control – Capital – Financial management – importance of financial statements – balance sheet – profit and loss

statement, Analysis of financial statements – liquidity ratios – leverage ratios, Coverage ratios – turnover ratios – profitability ratios, Agro-based industries – Project – project cycle – Project appraisal and evaluation techniques – undiscounted measures – payback period – proceeds per rupee of outlay, Discounted measures – Net Present Value (NPV) – Benefit-Cost Ratio (BCR) – Internal Rate of Return (IRR) – Net benefit investment ratio (N / K ratio) – sensitivity analysis- Importance of agribusiness in Indian economy International trade-WTO agreements – Provisions related to agreements in agricultural and food commodities. Agreements on agriculture (AOA) – Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS). Development (ED): Concept of entrepreneur and entrepreneurship Assessing overall business environment in Indian economy– Entrepreneurial and managerial characteristics- Entrepreneurship development Programmes (EDP)- Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development- Globalization and the emerging business entrepreneurial environment- Managing an enterprise: Importance of planning, budgeting, monitoring evaluation and follow-up managing competition. Role of ED in economic development of a country- Overview of Indian social, political systems and their implications for decision making by individual entrepreneurs- Economic system and its implications for decision making by individual entrepreneurs- Social responsibility of business. Morals and ethics in enterprise management- SWOT analysis- Government schemes and incentives for promotion of entrepreneurship. Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors- Venture capital (VC), contract farming (CF) and joint ventures (JV), public-private partnerships (PPP)- Overview of agricultural engineering industry, characteristics of Indian farm machinery industry.

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

Suggested Readings:

Harsh, S.B., Conner, U.J. and Schwab, G.D. 1981. Management of the Farm Business. Prentice Hall Inc., New Jersey.

Joseph, L. Massie. 1995. Essentials of Management. Prentice Hall of India Pvt. Ltd., New Delhi.

Omri Rawlins, N. 1980. Introduction to Agribusiness. Prentice Hall Inc., New Jersey

Gittenger Price, J. 1989. Economic Analysis of Agricultural Projects. John Hopkins University, Press, London.

Thomas W Zimmer and Norman M Scarborough. 1996. Entrepreneurship. Prentice-Hall, New Jersey.
Mark J Dollinger. 1999. Entrepreneurship Strategies and Resources. Prentice-Hall, Upper Saddal Rover, New Jersey.
Khanka S S. 1999. Entrepreneurial Development. S. Chand and Co. New Delhi.
Mohanty S K. 2007. Fundamentals of Entrepreneurship. Prentice Hall India Ltd., New Delhi.

CSIT-429 Web Designing and Internet Applications 2(1-0-2)

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 Readings:

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

MAS-511 Statistical Methods 3(2-0-2)

Theory: Numerical analysis and Laplace transformation: finite difference, various difference operators and their relationships. factorial notation, interpolation with equal integrals. Newton's forward and backward interpolation formula. Bessel's and Stirling's difference interpolation formulae. Interpolation with unequal intervals. Newton's divided difference formula. Lagrange's interpolation formula. numerical differentiations, numerical integrations, difference equations and their solutions, numerical solutions of ordinary differential equations by Picard's Taylor's series. Fuller's and modified Fuller's methods. Runga-Kutta method; Laplace transformation and its applications to the solutions of ordinary and simultaneous differential equations. Testing of Hypothesis-Level of Significance-Degrees of Freedom-Statistical errors, Large sample test (Z-

test), Small sample test t-test (One tailed, two tailed and Paired tests), Testing of Significance through variance (F-test), Chi -Square test, contingency table, Correlation, Regression.

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

Suggested Readings:

Chandel SRS. A Hand book of Agricultural Statistics. AchalPraskasamMasndir, 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.

CE-410 Soil Mechanics 3(2-1-0)

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

Practical: Determination of water content of soil; Determination of specific gravity of soil; Determination of field density of soil by core cutter method; Determination of field density by sand replacement method; Grain size analysis by sieving (Dry sieve analysis); Grain size analysis by hydrometer method; Determination of liquid limit by Casagrande's method;

Determination of liquid limit by cone penetrometer and plastic limit; Determination of shrinkage limit; Determination of permeability by constant head method; Determination of permeability by variable head method; Determination of compaction properties by standard proctor test; Determination of shear parameters by Direct shear test; Determination of unconfined compressive strength of soil; Determination of shear parameters by Tri-axial test; Determination of consolidation properties of soils.

Suggested Readings:

Punmia B C, Jain A K and Jain A K. 2005. Soil Mechanics and Foundations. Laxmi Publications (P) Ltd. New Delhi.

Ranjan Gopal and Rao A S R. 1993. Basic and Applied Soil Mechanics. Welley Easters Ltd., New Delhi.

Singh Alam. 1994. Soil Engineering Vol. I. CBS Publishers and Distributions, Delhi.

ECE-301 Basic Electronics 2(1-0-2)

Theory: Introduction to signals, spectra, transducers, electronics and systems, p-n junction diodes, rectifiers – half-wave, full wave, capacitive filters, Zener diodes, power supply and voltage regulation; p-n-p and n-p-n transistors, transistor characteristics, transistor as an amplifier – CE, CB, CC; biasing and bias-stability, small-signal, equivalent Circuits, H-Parameter Model, Signal Handling Capacity, Frequency Response Of Amplifiers; Concepts Of Feedback Amplifiers, negative feedback, gain-bandwidth product, regenerative feedback and conditions for oscillation, oscillators; OP-AMPs and application of OP-AMPs; Field effect devices – JEFT, MOSFET and their characteristics; SCRs, power amplifiers; Logic Gates; Flip – Flops amd ICS.

Practical : Familiarity with electronic components and use of multimeters, Use of millivoltmeters, signal generators and oscilloscopes; Pulse and frequency response of R-C and C-R circuits; Half wave and full wave rectifiers, Rectification with capacitor filters and Zener diodes; Transistors, CE amplifier, biasing condition, gain and signal handling capacity; Measurement of frequency response and bandwidth of a CF amplifier; Characteristics of unity gain amplifier and summing circuits; Characteristics of OP-Amp integrators and differentiator; Characteristics of digital logic gates; Studies Flip-Flops, shift registers and counters. Characteristics of OP-Amps, inverting & non-inverting amplifiers.

ME-414 Theory of Machines 3(2-0-2)

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, isochronism, power and effort of a governor. Static and dynamic balancing. Balancing of rotating masses in one and different planes.

Suggested Readings:

Bevan Thomas. 1984. Theory of Machines. CBS Publishers and Distributors, Delhi.
Ballaney P L. 1985. Theory of Machines. Khanna Publishers, 2-B Nath Market, NaiSarak, 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.

FMP-502 Renewable Energy 3(2-0-2)

Solar Energy option, solar radiation. Liquid flat plate collectors and their performance, concentrating collectors. Solar energy operated systems for heating, cooling, drying and water pumping, solar pond. Thermal energy storage, photovoltaic conversion.
Available wind power. Analysis of wind regimes. Types of wind mills and their characteristics. Wind pumps, coupling of pump and wind rotor. Anaerobic fermentation of biomass. Design of biogas system for heating, lighting and running IC engines. Alcohol fuels, use of alcohol fuels in IC engines. Producer gas system. Use of CNG in IC engines. Geothermal energy. Types of Non-Conventional Energy & its utilization.

Practical: Study of flat plate and concentrating type of collectors. Study of solar cooker, solar water heaters, solar dryer. Study of photo voltaic cell, solar pump. Study of different solar radiation measuring instruments. Study of windmill and wind pump.

Suggested Readings:

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

EE-407 Electrical Machines and Power Utilization 3(2-0-2)

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

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

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

Suggested Readings:

Thareja B L &Theraja AK. 2005. A text book of Electrical Technology. Vol. I S. Chand & Company LTD., New Delhi.

Theraja B L &Theraja AK 2005. A text book of Electrical Technology. Vol. II S. Chand & Company LTD., New Delhi.

Vincent Del Toro. 2000. Electrical Engineering Fundamentals. Prentice-Hall of India Private LTD., New Delhi.

Anwani M L. 1997. Basic Electrical Engineering. Dhanpat Rai & Co.(P) LTD. New Delhi.

CE-408 Strength of Materials 2(1-0-2)

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

Practical: To perform the tension test on metal specimen (M.S., C.I.), to observe the behavior 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.

References:

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, NaiSarak, New Delhi

SEMESTER - IV				
No.	**Course No**		**Course Name**	**Credit Hours**
1.	CE	409	Building Materials and Structural Design.	3(2-1-0)
2.	ME	413	CAD/CAM Machine Drawing and Computer Graphics	2(1-0-2)
3.	ME	310	Thermodynamics, Refrigeration and Air Conditioning	3(2-0-2)
4.	FMP	404	Tractor and Automotive Engines	3(2-0-2)
5.	IDE	403	Engineering Hydrology	3(2-1-0)
6.	IDE	502	Irrigation Engineering	3(2-0-2)
7.	SES	503	Soil Physics	2(1-0-2)
8.	ME	415	Machine Design	2(2-0-0)
9.	FPE	430	Engineering Properties of Biological Materials	2(1-0-2)
			Total	**23(15-2-12)**

CE-409 Building Materials and Structural Design. 3(2-1-0)

Steel and its structural properties, Riveted and welded connections, Design of sections for tensions, Compression and bending including built-up sections, Grillage foundations, Roof trusses, Plate and lattice girders, Industrial buildings, Indian standard code. Introduction to I.S. code for practice for R.C. design, Design of two- way slabs, retaining walls, Continues beams, Water tanks etc. IRC bridge loadings – load distribution on bridge girders. Design of Masonry and Timber Structures. Working Stress Design Method: Assumption, distribution of stresses on the cross section in bending transformed area, analysis and design of rectangular singly and doubly reinforces section, T and L sections. Limit State Design Method: Assumptions, distribution of stresses on the cross section in bending Analysis and design of a rectangular singly & doubly reinforced Sec., T and L Sections.

ME-413 CAD/CAM Machine Drawing and Computer Graphics 2(1-0-2)

Theory: First and third angle methods of projection. Preparation of working drawing from models and isometric views. Drawing of missing views. Different methods of dimensioning. Concept of sectioning. Revolved and oblique section. 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 thread. 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. Design process, application of computers for design, definition of CAD, benefits of CAD, CAD system components. Computer hardware for CAD. Display, input and output devices. Graphic primitives, display file, frame buffer, display control, display processors, Line generation, graphics software. Points and lines, Polygons, filling of polygons. Text primitive. Other primitives. Windowing and clipping, view port.

Homogeneous coordinates. Transformations. Planar and space curves design. Analytical and synthetic approaches. Parametric and implicit equations. B-spline and Beizer curves. Geometric modeling techniques. Wire frames. Introduction to solid modeling. Introduction to numerical control, basic components of NC system, NC coordinates and motion control systems. Computer numerical control, direct numerical control, combined CNC/DNC. NC machine tools and control units. Tooling for NC machines, part programming, punched tape, tape coding and format, manual and computer assisted part programming.

Practical: Preparation of manual drawings with dimensions from Models and Isometric drawings of objects and machine components; Preparation of sectional drawings of simple machine parts; Drawing of riveted joints and thread fasteners; Demonstration on computer graphics and computer aided drafting use of standard software; Practice in the use of basic and drawing commands on auto cad; Generating simple 2-D drawings with dimensioning using autocad; Practice in the use of modify and rebelling commands; Practice in graphics, mathematics, curve fitting and transformations; Demonstration on CNC machine.

ME-310 Thermodynamics, Refrigeration and Air Conditioning 3(2-0-2)

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. Vapor refrigeration-mechanism, P-V, P-S,P-H diagrams, vapor compression cycles, dry and wet compression, super cooling and sub cooling. Vapour absorption refrigeration system. Common refrigerants and their properties. Design calculations for refrigeration system. Cold storage plants. Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychometric chart and its use, elementary psychometric process. Air conditioning – principles – Type and functions of air conditioning, physiological principles in air conditioning, air distribution and duct design methods, fundamentals of design of complete air conditioning

systems – humidifiers and dehumidifiers – cooling load calculations, types of air conditioners – applications.

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

Suggested Readings:

Kothandaraman C P Khajuria P R and Arora S C. 1992. A Course in Thermodynamics and Heat Engines. Dhanpet Rai and Sons, 1682 NaiSarak, 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 NaiSarak, 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.

FMP-404 Tractor and Automotive Engines 3(2-0-2)

Theory: Study of sources of farm power –conventional & non-conventional energy sources. Classification of tractors and IC engines. Review of thermodynamic principles of IC (CI & SI) engines and deviation from ideal cycle. General energy equation and heat balance sheet. Study of mechanical, thermal and volumetric efficiencies. Study of engine components their construction, operating principles and functions. Study of engine strokes and comparison of 2-stroke and 4-stroke engine cycles and CI and SI engines. Study of Engine Valve systems, valve mechanism, Valve timing diagram, and valve clearance adjustment Study of Cam profile, valve lift and valve opening area. Study of importance of air cleaning system. Study of types of air cleaners and performance characteristics of various air cleaners. Study of fuel supply system. Study of fuels, properties of fuels, calculation of air-fuel ratio. Study of tests on fuel for SI and CI engines. Study of detonation and knocking in IC engines. Study of carburetion system, carburetors and their main functional components. Study of fuel injection system – Injection pump, their types, working principles. Fuel injector nozzles – their types and working principle. Engine governing – need of governors, governor types and governor characteristics. Study of lubrication system – need, types, functional components. Study of lubricants – physical properties, additives and their

application. Engine cooling system – need, cooling methods and main functional components. Study of need and type of thermostat valves. Additives in the coolant. Study of radiator efficiency. Study of ignition system of SI engines. Study of electrical system including battery, starting motor, battery charging, cut-out, etc. Comparison of dynamo and alternator. Familiarization with the basics of engine testing

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

Suggested Readings:

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

IDE -403 Engineering Hydrology 3(2-1-0)

Theory: Weather and hydrology, Forms of precipitations; Measurements and estimations, Evaporation & transpiration: Factor affecting, Measurements and estimation, Stream flow measurement: Measurement of stage & velocity, Stage discharge relationship, Runoff: Introduction to hydrograph, runoff characteristics of streams, yield (annual runoff volume), flow duration curve, flow mass curve. Hydrograph: Factors affecting flood hydrograph, Components of hydrograph, Base flow separation, Effective rainfall, Unit hydrograph, Synthetic & Instantaneous unit hydrograph, Flood routing: Basic equations and Method of flood routing, Hydrologic channel routing, Clark method for instantaneous unit hydrograph, Nash conceptual model.

Suggested Readings:

Chow, V.T., D.R. Maidment and L.W. Mays. 2010. Applied Hydrology, McGraw Hill Publishing Co., New York.
Jaya Rami Reddy, P. 2011. A Text Book of Hydrology. University Science Press, New Delhi.
Linsley, R.K., M.A. Kohler, and J.L.H. Paulhus. 1984. Hydrology for Engineers. McGraw-Hill Publishing Co., Japan.
Mutreja, K.N. 1990. Applied Hydrology. Tata McGraw-Hill Publishing Co., New Delhi.
Raghunath, H.M. 2006. Hydrology: Principles Analysis and Design. Revised 2nd Edition, New Age International (P) Limited Publishers, New Delhi.

Subramanya, K. 2008. Engineering Hydrology. 3rd Edition, Tata McGraw-Hill Publishing Co., New Delhi.
Suresh, R. 2005. Watershed Hydrology. Standard Publishers Distributors, Delhi.
Varshney, R.S. 1986. Engineering Hydrology. Nem Chand and Brothers, Roorkee, U.P.

IDE -502 Irrigation Engineering 3(2-0-2)

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

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

Suggested Readings:

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

SES -503 Soil Physics 2 (1-0-2)

Theory: General physical characteristics of soil, soil as a dispersed three phase system, volume and mass relationships of soil constituents, soil profile, texture, particle size distribution, specific surface and soil classes, nature and behavior of clay, soil structure of aggravation, soil water content and potential, measurements of soil water, flow water in saturated and unsaturated soils, soil air and aeration, soil temperature and heat flow, soil compaction and consolidation.
Measurement of soil physical characteristics, soil water content, soil water potential, soil moisture characteristic curve, infiltration, hydraulic conductivity and soil composition.
Practical: Volume and mass relationship of soil constituents (problems and determination of dry Bulk density, particle density), Effect of concentration of ions and types of cations on physical properties of soils, Determination of soil compatibility, Determination of consistency, Determination of soil compaction – root growth, Determination of Soil-Water characteristic curve, Determination of pore size distribution. Measurement of soil water content, Determination of saturated hydraulic conductivity using first law of moisture flow – Darcy's Law, Determination of water flow in unsaturated soil using second law of moisture flow, Infiltration rate determination, Determination of upper and lower plastic limits, Determination of Attenberg's constant.

ME-415 Machine Design 2(2-0-0)

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

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

FPE-401 Engineering Properties of Biological Materials 2(1-0-2)

Theory: Engineering properties of agricultural and food materials. Concept of rheology, Rheological characteristics of biological materials, Newtonian and non-Newtonian, products.

Thermal, electrical and optical properties of food materials. Application of engineering properties in designing of food process equipment. Determination of roundness, spherecity of fruits and vegetables, Effect of moisture on frictional properties and specific gravity of grains, Study of elastic –plastic behavior, relaxation behavior and textural properties of selected food materials, Viscosity measurement of fluid foods and thermal properties of fluid foods.

Practical: Identification of different shapes of Biological materials based on standard chart, Principle & working of small dimension measuring instruments, Determination of Roundness & Roundness ration of materials, Determination of volume & sp. Gravity, Determination of sphericity of Grains, Fruits & Use, Determination of Bulk density & True density of small & large objects, Determination of angle of repose, Determination of leaf surface area a) Tracing & cutting method b) Tracing & Counting method, Determination of Egg Surface Area, Determination of Terminal velocity of grain.

SEMESTER - V				
No.	**Course No**		**Course Name**	**Credit Hours**
1.	FPE	541	Post-Harvest Engineering of Cereals, Pulses and Oil Seeds	3(2-0-2)
2.	ECE	512	Instrumentation and Control Engineering	3(2-0-2)
3.	FMP	403	Farm Machinery and Equipment-I	3(2-0-2)
4.	FPE	431	Agricultural Structures and Environmental Control	3(2-0-2)
5.	SWCE	501	Soil and Water Conservation Engineering	3(2-0-2)
6.	SWCE	518	Watershed Planning and Management	3(2-0-2)
7.	IDE	505	Drainage Engineering	3(2-1-0)
8.	FMP	505	Renewable Power Sources	3(2-0-2)
			Total	**24(16-1-14)**
(AET 400) * Skill Development Training-I (Student READY) Registration only (Non gradial)				5(0-0-10)

FPE-541 **Post-Harvest Engineering of Cereals, Pulses and Oil Seeds** **3(2-0-2)**

Theory: Cleaning and grading, aspiration, scalping; size separators, screens, sieve analysis, capacity and effectiveness of screens. Various types of separators: specific gravity, magnetic, disc, spiral, pneumatic, inclined draper, velvet roll, colour sorters, cyclone, shape graders. Size reduction: principle, Bond's law, Kick's law, Rittinger's law, procedure (crushing, impact, cutting and shearing), Size reduction machinery: Jaw crusher, Hammer mill, Plate mill, Ball mill. Material handling equipment. Types of conveyors: Belt, roller, chain and screw. Elevators: bucket, Cranes & hoists. Trucks (refrigerated/ unrefrigerated), Pneumatic conveying. Drying: moisture content and water activity; Free, bound and equilibrium moisture content, isotherm, hysteresis effect, EMC determination, Psychrometric chart and its use in drying, Drying principles and theory, Thin layer and deep bed drying analysis, Falling rate and constant rate drying periods, maximum and decreasing drying rate period, drying equations, Mass and energy balance, Shedd's equation, Dryer performance, Different methods of drying, batch-continuous; mixing-non-mixing, Sun-mechanical, conduction, convection, radiation, superheated steam,

tempering during drying, Different types of grain dryers: bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray. Mixing: Theory of mixing of solids and pastes, Mixing index, types of mixers for solids, liquid foods and pastes. Milling of rice: Conditioning and parboiling, advantages and disadvantages, traditional methods, CFTRI and Jadavpur methods, Pressure parboiling method, Types of rice mills, Modern rice milling, different unit operations and equipment. Milling of wheat, unit operations and equipment. Milling of pulses: traditional milling methods, commercial methods, pre-conditioning, dry milling and wet milling methods: CFTRI and Pantnagar methods. Pulse milling machines, Milling of corn and its products. Dry and wet milling. Milling of oilseeds: mechanical expression, screw press, hydraulic press, solvent extraction methods, preconditioning of oilseeds, refining of oil, stabilization of rice bran., Extrusion cooking: principle, factors affecting, single and twin screw extruders. By-products utilization.

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

Suggested Readings:

Chakraverty, A. Post-Harvest Technology of cereals, pulses and oilseeds. Oxford & IBH publishing Co. Ltd., New Delhi.

Dash, S.K., Bebartta, J.P. and Kar, A. Rice Processing and Allied Operations. Kalyani Publishers, New Delhi.

Sahay, K.M. and Singh, K.K. 1994. Unit operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd. New Delhi.

Geankoplis C. J. Transport processes and unit operations, Prentice Hall of India Pvt Ltd, New Delhi

Earle, R.L. 2003. Unit Operations in Food Processing. Pergamon Press. Oxford. U.K.

Henderson, S.M., and Perry, R. L. Agricultural Process Engineering, Chapman and hall, London

McCabe, W.L., Smith J.C. and Harriott, P. Unit operations of Chemical Engineering. McGraw Hill.

Singh, R. Paul. and Heldman, R.Dennis. 2004. Introduction to Food Engineering. 3rd Edition. Academic Press, London.

ECE-512 Instrumentation and Control Engineering 3(2-0-2)

Theory: Measurement system and error analysis, measurement of level, flow, temperature, strain pressure, vacuum, force, torque, power, displacement, vibration, acceleration, pH, colour viscosity, surface tension and composition. Indicating recording instruments, digital displays, transmitting and telemetering devices. Introduction to control system- Feedback and feed forward control strategies, block diagrams, Laplace and inverse Laplace transforms mathematics models of physical systems, transfer functions steady state analysis, dynamics of first and second order systems. Mode of control and generation of control action; P. PI and PID control elements and value positioners, frequency response and root locus analysis. Stability and quality of overall control.
Electronic, pneumatic and hydraulic control systems and their application in farm machinery, food processing industry, aquaculture and their applications milk processing plants.

Practical: Calibration of Bourdon pressure gauge; Dynamic calibration of different types of thermometers, Determination of time constants of thermometers and thermocouples. Calibration of differential pressure transmitters; Calibration of velometer and hot wire anemometer; Speed measurement using non-contact type sensors; Determination of discharge coefficient using morifcemeter and venturimeter; use and calibration of rotameter, pH meter, conductivity meter and viscometer; Static calibration of flapper nozzle assembly; Calibration of pneumatic P, PI and PID controllers; Study and calibration of control valves; Cascade control of level and flow/temperature and flow.

FMP-403 Farm Machinery and Equipment-I 3(2-0-2)

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

steels and alloys for agricultural application. Identification of heat treatment processes specially for the agricultural machinery components.

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

Suggested Readings:

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

FPE-431 Agricultural Structures and Environmental Control 3(2-0-2)

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

Practical: Measurements for environmental parameters and cooling load of a farm building, Design and layout of a dairy farm, Design and layout of a poultry house, Design and layout of a goat house/sheep house, Design of a farm fencing system, Design of a feed/fodder storage

structures, Design of grain storage structures, Design and layout of commercial bag and bulk storage facilities, Study and performance evaluation of different domestic storage structure, Estimation of a Farm building.

Suggested Readings:

Pandey, P.H. Principles and practices of Agricultural Structures and Environmental Control, Kalyani Publishers, Ludhiana.
Ojha, T.P and Michael, A.M. Principles of Agricultural Engineering, Vol. I, Jain Brothers, Karol Bag, New Delhi.
Nathonson, J.A. Basic Environmental Technology, Prentice Hall of India, New Delhi.
Venugopal Rao, P. Text Book of Environmental Engineering, Prentice Hall of India, New Delhi.
Garg, S.K. Water Supply Engineering, Khanna Publishers, New Delhi-6.
Dutta, B.N. Estimating and Costing in Civil Engineering, Duttta& CO, Lucknow.
Khanna, P.N. Indian Practical Civil Engineer's Hand Book, Engineer's Publishers, New Delhi.
Sahay, K.M. and Singh, K.K. Unit Operations of Agricultural Processing, Vikas publishing pvt. Ltd, Noida.
Banerjee, G.C. A Text Book of Animal Husbandry, Oxford IBH Publishing Co, New Delhi.

SWCE-501 Soil and Water Conservation Engineering 3(2-0-2)

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

Practical: Study of different types and forms of water erosion. Exercises on computation of rainfall erosivity index. Computation of soil erodibility index in soil loss estimation. Determination of length of slope (LS) and cropping practice (CP) factors for soil loss estimation by USLE and MUSLE. Exercises on soil loss estimation/measuring techniques. Study of rainfall simulator for erosion assessment. Estimation of sediment rate using Coshocton wheel sampler

and multi-slot devisor. Determination of sediment concentration through oven dry method. Design and layout of contour bunds. Design and layout of graded bunds. Design and layout of broad base terraces. Design and layout of bench terraces. Design of vegetative waterways. Exercises on rate of sedimentation and storage loss in tanks. Computation of soil loss by wind erosion. Design of shelterbelts and wind breaks for wind erosion control. Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures.

Suggested Readings:

Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service, New Delhi.

Mal, B.C. 2014. Introduction to Soil and Water Conservation Engineering. 2014. Kalyani Publishers.

Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.

Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.

Norman Hudson. 1985. Soil Conservation. Cornell University Press, Ithaka, New York, USA.

Frevert, R.K., G.O. Schwab, T.W. Edminster and K.K. Barnes. 2009. Soil and Water Conservation Engineering, 4th Edition, John Wiley and Sons, New York.

Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

SWCE-518 Watershed Planning and Management 3(2-0-2)

Theory: Watershed - introduction and characteristics. Watershed development - problems and prospects, investigation, topographical survey, soil characteristics, vegetative cover, present land use practices and socio-economic factors. Watershed management - concept, objectives, factors affecting, watershed planning based on land capability classes, hydrologic data for watershed planning, watershed codification, delineation and prioritization of watersheds – sediment yield index. Water budgeting in a watershed. Management measures - rainwater conservation technologies - *in-situ* and *ex-situ* storage, water harvesting and recycling. Dry farming techniques - inter-terrace and inter-bund land management. Integrated watershed management - concept, components, arable lands - agriculture and horticulture, non-arable lands - forestry, fishery and animal husbandry. Effect of cropping systems, land management and cultural practices on watershed hydrology. Watershed programme - execution, follow-up practices, maintenance, monitoring and evaluation. Participatory watershed management - role of watershed associations, user groups and self-help groups. Planning and formulation of project proposal for watershed management programme including cost-benefit analysis.

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

Suggested Readings:

Ghanshyam Das. 2008. Hydrology and Soil Conservation Engineering: Including Watershed Management. 2nd Edition, Prentice-Hall of India Learning Pvt. Ltd., New Delhi.

Katyal, J.C., R.P. Singh, Shriniwas Sharma, S.K. Das, M.V. Padmanabhan and P.K. Mishra. 1995. Field Manual on Watershed Management. CRIDA, Hyderabad.

Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service. New Delhi.

Sharda, V.N., A.K. Sikka and G.P. Juyal. 2006. Participatory Integrated Watershed Management: A Field Manual. Central Soil and Water Conservation Research and Training Institute, Dehradun.

Singh, G.D. and T.C. Poonia. 2003. Fundamentals of Watershed Management Technology. Yash Publishing House, Bikaner.

Singh, P.K. 2000. Watershed Management: Design and Practices. E-media Publications, Udaipur.

Singh, R.V. 2000. Watershed Planning and Management. Yash Publishing House, Bikaner.

Tideman, E.M. 1999. Watershed Management: Guidelines for Indian Conditions. Omega Scientific Publishers, New Delhi.

IDE -505 Drainage Engineering 3(2-1-0)

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

Practical: *In-situ* measurement of hydraulic conductivity by single auger hole and inverse auger hole method; Estimation of drainage coefficients; installation of piezometer and

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

Suggested Readings:

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

FMP- 505 Renewable Power Sources 3(2-0-2)

Theory: Energy consumption pattern & energy resources in India. Renewable energy options, potential and utilization. Biogas technology and mechanisms, generation of power from biogas, Power generation from urban, municipal and industrial waste. Design & use of different commercial sized biogas plant. Solar thermal and photovoltaic Systems for power generation. Central receiver (Chimney) and distributed type solar power plant, OTEC, MHD, hydrogen and fuel cell technology. Wind farms. Aero-generators. Wind power generation system. Power generation from biomass (gasification &Dendro thermal), Mini and micro small hydel plants. Fuel cells and its associated parameters.

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

Suggested Readings:

Garg H.P. 1990. Advances in Solar Energy Technology; D. Publishing Company, Tokyo.
Alan L: Farredbruch& R.H. Buse. 1983. Fundamentals of Solar Academic Press, London.
Bansal N.K., Kleemann M. &Meliss Michael. 1990. Renewable Energy Sources & Conversion Technology; Tata Mecgrow Publishing Company, New Delhi.
Rathore N. S., Kurchania A. K. & N.L. Panwar. 2007. Non-Conventional Energy Sources, Himanshu Publications.

Mathur, A.N. & N.S. Rathore. 1992. Biogas Production Management & Utilization. Himanshu Publications, Udaipur.
Khandelwal, K.C. & S.S. Mahdi. 1990. Biogas Technology.
Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.
Mathur A.N. & N.S. Rathore. Renewable Energy Sources Bohra Ganesh Publications, Udaipur

SEMESTER – VI				
No.	**Course No**		**Course Name**	**Credit Hours**
1.	FMP	504	Tractor Systems and Controls	3(2-0-2)
2.	FMP	506	Farm Machinery and Equipment-II	3(2-0-2)
3.	FPE	542	Post-Harvest Engineering of Horticultural Crops	2(1-0-2)
4.	SWCE	519	Water Harvesting and Soil Conservation Structures	3(2-0-2)
5.	IDE	520	Groundwater, Wells and Pumps	3(2-0-2)
6.	FMP	507	Field Operation and maintenance of Tractors and Farm Machinery	3(1-0-4)
7.	FPE	543	Dairy and Food Engineering	3(2-0-2)
8.	FMP	610	Bio-energy Systems: Design and Applications	3(2-0-2)
9.	IDE	521	Sprinkler and Micro Irrigation Systems	2(1-1-0)
			Total	**25(15-1-18)**

FMP-504 Tractor Systems and Controls 3(2-0-2)

Theory: Study of need for transmission system in a tractor. Transmission system – types, major functional systems. Study of clutch – need, types, functional requirements, construction and principle of operation. Familiarization with single plate, multi-plate, centrifugal and dual clutch systems. Study of Gear Box – Gearing theory, principle of operation, gear box types, functional requirements, and calculation for speed ratio. Study of differential system – need, functional components, construction, calculation for speed reduction. Study of need for a final drive. Study of Brake system – types, principle of operation, construction, calculation for braking torque. Study of steering system – requirements, steering geometry characteristics, functional components, calculation for turning radius. Familiarization with Ackerman steering. Steering systems in track type tractors. Study of Hydraulic system in a tractor – Principle of operation, types, main functional components, functional requirements. Familiarization with the Hydraulic system adjustments and ADDC. Study of tractor power outlets – PTO. PTO standards, types and functional requirements. Introduction to traction. Traction terminology. Theoretical calculation of shear force and rolling resistance on traction device. Study of wheels and tyres – Solid tyres and pneumatic tyres, tyre construction and tyre specifications. Study of traction aids. Study of tractor mechanics – forces acting on the tractor. Determination of CG of a tractor. Determination and importance of moment of inertia of a tractor. Study of tractor static equilibrium, tractor stability especially at turns. Determination of maximum drawbar pull. Familiarization with tractor as a spring-mass system. Ergonomic considerations and operational safety. Introduction to tractor testing. Deciphering the engine test codes.

Practical:

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

Suggested Readings:

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

FMP-506 Farm Machinery and Equipment-II 3(2-0-2)

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

Suggested Readings:

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

FPE-542 Post-Harvest Engineering of Horticultural Crops 2(1-0-2)

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, microorganisms, mechanical strength), Different types of packaging materials commonly used for raw and processed fruits and vegetables products, bulk and retail packages and packaging machines, handling and transportation of fruits and vegetables, Pack house technology, Minimal processing, Common methods of storage, Low temperature storage, evaporative cooled storage, Controlled atmospheric storage, Modified atmospheric packaging, Preservation Technology, General methods of preservation of fruits and vegetables, Brief description and advantages and

disadvantages of different physical/ chemical and other methods of preservation, Flowcharts for preparation of different finished products, Important parameters and equipment used for different unit operations, Post-harvest management and equipment for spices and flowers, Quality control in Fruit and vegetable processing industry. Food supply chain.

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

Suggested Readings:

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

SWCE-519 Water Harvesting and Soil Conservation Structures 3(2-0-2)

Theory: Water harvesting -principles, importance and issues. Water harvesting techniques - classification based on source, storage and use. Runoff harvesting – short-term and long-term techniques. Short-term harvesting techniques - terracing and bunding, rock and ground catchments. Long-term harvesting techniques - purpose and design criteria. Structures - farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes. Farm pond - components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction. Percolation pond - site selection, design and construction details. Design considerations of *nala* bunds. Soil erosion control structures - introduction, classification and functional requirements. Permanent structures for soil conservation and gully control - check dams, drop, chute and drop inlet spillways - design requirements, planning for design, design procedures - hydrologic, hydraulic and structural design and stability analysis. Hydraulic jump and its application. Drop spillway - applicability, types - straight drop, box-type inlet spillways - description, functional use, advantages and disadvantages, straight apron and stilling basin outlet, structural components and functions. Loads on head wall, variables affecting equivalent fluid pressure, triangular load diagram for various flow conditions, creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension. Chute spillway - description, components, energy dissipaters, design criteria of Saint Antony Falls (SAF) stilling basin and its limitations. Drop inlet spillway - description, functional use and design criteria.

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

Suggested Readings:

Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.

Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.

Schwab, G.O., D.D. Fangmeier, W.J. Elliot, R.K. Frevert. 1993. Soil and Water Conservation Engineering.4th Edition, John Wiley and Sons Inc. New York.

Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

Samra, J.S., V.N. Sharda and A.K. Sikka. 2002. Water Harvesting and Recycling: Indian Experiences. CSWCR&TI, Dehradun, Allied Printers, Dehradun.

Theib Y. Oweis, Dieter Prinz and Ahmed Y. Hachum. 2012. Rainwater Harvesting for Agriculture in the Dry Areas. CRC Press, Taylor and Francis Group, London.

Studer Rima Mekdaschi and HanspeterLiniger. 2013. Water Harvesting - Guidelines to Good Practice. Centre for Development and Environment, University of Bern, Switzerland.

IDE -520 Groundwater, Wells and Pumps 3(2-0-2)

Theory: Occurrence and movement of ground water; aquifer and its types; classification of wells, fully penetrating tube wells 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 tube well 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 troubleshooting, performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics; hydraulic ram, propeller pumps, mixed flow

pumps and their performance characteristics; deep well turbine pump and submersible pump.

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

Suggested Readings:

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

Todd David Keith and Larry W. Mays. 2004. Groundwater Hydrology, 3rd Edition, John Wiley & Sons, New York (International Book Distributing Company Lucknow).

Michael AM. and Ojha TP. 2014. Principles of Agricultural Engineering Vol-II, 5th Edition. Jain Brothers Publication, New Delhi.

FMP-507 Field Operation and maintenance of Tractors and Farm Machinery 3(1-0-4)

Practical: Familiarization with different makes and models of agricultural tractors. Identification of functional systems including fuels system, cooling system, transmission system, steering and hydraulic systems. Study of maintenance points to be checked before starting a tractor. Familiarization with controls on a tractor. Safety rules and precautions to be observed while driving a tractor. Driving practice of tractor. Practice of operating a tillage tool (mould-board plough/ disc plough) and their adjustment in the field. Study of field patterns while operating a tillage implement. Hitching & De-hitching of mounted and trail type implement to the tractor. Driving practice with a trail type trolley – forward and in reverse direction. Introduction to tractor maintenance – precautionary and break-down maintenance. Tractor starting with low battery charge. Introduction to trouble shooting in tractors. Familiarization with tools for general and special maintenance. Introduction to scheduled maintenance after 10, 100, 300, 600, 900 and 1200 hours of operation. Safety hints. Top end overhauling. Fuel saving tips. Preparing the tractor for storage. Care and maintenance procedure of agricultural machinery during operation and off-season. Repair and maintenance of implements – adjustment of functional parameters in tillage implements. Replacement of broken components in tillage implements. Replacement of furrow openers and change of blades of rotavators. Maintenance of cutter bar in a reaper. Adjustments in a thresher for different crops. Replacement of V-belts on implements. Setting of agricultural machinery workshop.

Suggested Readings:

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

FPE-543 Dairy and Food Engineering 3(2-0-2)

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

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

Suggested Readings:

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

FMP-610 Bio-energy Systems: Design and Applications 3(2-0-2)

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

Suggested Readings:

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

IDE-521 Sprinkler and Micro Irrigation Systems 2(1-1-0)

Theory: Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems; design of sprinkler irrigation system: layout selection, hydraulic design of lateral, sub-main and main pipe line, design steps; selection of pump and power unit for sprinkler irrigation system; performance evaluation of sprinkler irrigation system: uniformity coefficient and pattern efficiency; Micro Irrigation Systems: types-drip, spray, & bubbler systems, merits and demerits, different components; Design of drip irrigation system: general considerations, wetting patters, irrigation requirement, emitter selection, hydraulics of drip irrigation system, design steps; necessary steps for proper operation of a drip irrigation system; maintenance of micro irrigation system: clogging problems, filter

cleaning, flushing and chemical treatment; fertigation: advantages and limitations of fertigation, fertilizers solubility and their compatibility, precautions for successful fertigation system, fertigation frequency, duration and injection rate, methods of fertigation.

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

Suggested Readings:

Keller Jack and BliesnerRon 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

No.	Course No	Course Name	Credit Hours
Semester-VII Student READY (Rural and Entrepreneurship Awareness Development Yojana)			
1.	AET 600A	10- weeks Industrial Attachment /Internship (Student READY)	15(0-0-30)
2.	AET 600B	10- weeks Experiential Learning On campus (Student READY)	15(0-0-30)
3.	AET600C1	Project Planning and Report Writing (Student READY)	5(0-0-10)
4.	AET600D	Educational Tour (Registration only)	2 (0-0-4)
		Total	**37(0-0-74)**
Educational tour during winter/January break			

SEMESTER – VIII			
No.	**Course No**	**Course Name**	**Credit Hours**
VIII Semester Student READY (Rural and Entrepreneurship Awareness Development Yojana)			
1.		Elective course	3(2-0-2)
2.		Elective course	3(2-0-2)
3.		Elective course	3(2-0-2)
4.		AET 600C2 Project Planning and Report Writing (Student READY)	10(0-0-20)
Total			**19(6-0-26)**

ELECTIVE COURSES

Each Institute will have option to offer 3 (three) need based elective courses equivalent to 9 Credit Hours as per the need of the state/industries/other stake holders under the proposed list of Elective Courses.

1. IDE -617 Floods and Control Measures 3(2+1)

Theory:

Floods - causes of occurrence, flood classification - probable maximum flood, standard project flood, design flood, flood estimation - methods of estimation; estimation of flood peak - rational method, empirical methods, unit hydrograph method. Statistics in hydrology, flood frequency methods - log normal, Gumbel's extreme value, Log-Pearson type-III distribution; depth-area-duration analysis. Flood forecasting. Flood routing - channel routing, Muskingum method, reservoir routing, modified Pul's method. Flood control - history of flood control, structural and

non-structural measures of flood control, storage and detention reservoirs, levees, channel improvement. Gully erosion and its control structures - design and implementation. Ravine control measures. River training works, planning of flood control projects and their economics. Earthen embankments - functions, classification - hydraulic fill and rolled fill dams - homogeneous, zoned and diaphragm type, foundation requirements, grouting, seepage through dams, flow net and its properties, seepage pressure, seepage line in composite earth embankments, drainage filters, piping and its causes. Design and construction of earthen dam, stability of earthen embankments against failure by tension, overturning, sliding etc., stability of slopes - analysis of failure by different methods. Subsurface dams - site selection and constructional features. Check dam - Small earthen embankments - types and design criteria. Subsurface dams - site selection and constructional features.

Practical: Determination of flood stage-discharge relationship in a watershed. Determination of flood peak-area relationships. Determination of frequency distribution functions for extreme flood values using Gumbel's method. Determination of confidence limits of the flood peak estimates for Gumbel's extreme value distribution. Determination of frequency distribution functions for extreme flood values using Log-Pearson Type-III distribution. Determination of probable maximum flood, standard project flood and spillway design flood. Design of levees for flood control. Design of jetties. Study of vegetative and structural measures for gully stabilization. Design of gully/ravine control structures and cost estimation. Designing, planning and cost- benefit analysis of a flood control project. Study of different types, materials and design considerations of earthen dams. Determination of the position of phreatic line in earth dams for various conditions, stability analysis of earthen dams against head water pressure, foundation shear, sudden draw down condition etc. Stability of slopes of earth dams by friction circle and other methods. Construction of flow net for isotropic and anisotropic media. Computation of seepage by different methods. Determination of settlement of earth dam. Input-output-storage relationships by reservoir routing. Visit to sites of earthen dam and water harvesting structures.

Suggested Readings:

Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.

Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.

Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

Mutreja, K.N. 1990. Applied Hydrology. Tata McGraw-Hill Publishing Co., New York, Delhi.

Subramanya, K. 2008. Engineering Hydrology. 3rd Edition, Tata McGraw-Hill Publishing Co., New Delhi.

Bureau of Reclamation. 1987. Design of Small Dams. US Department of Interior, Washington DC, USA.

Arora, K.R. 2014. Soil Mechanics and Foundation Engineering (Geotechnical Engineering). Standard Publishers Distributors, Delhi.
Garg, S.K. 2014. Soil Mechanics and Foundation Engineering. Khanna Publishers Pvt. Ltd., New Delhi.
Stephens Tim. 2010. Manual on Small Earth Dams - A Guide to Siting, Design and Construction. Food and Agriculture Organization of the United Nations, Rome.

2.SWLE-618 Wasteland Development 3(2+1)

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

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

Suggested Readings:

Abrol, I.P., and V.V. Dhruvanarayana. 1998. Technologies for Wasteland Development. ICAR, New Delhi.
Ambast, S.K., S.K. Gupta and Gurcharan Singh (Eds.) 2007. Agricultural Land Drainage - Reclamation of Waterlogged Saline Lands. Central Soil Salinity Research Institute, Karnal, Haryana.
Hridai Ram Yadav. 2013. Management of Wastelands. Concept Publishing Company. New Delhi.
Karthikeyan, C., K. Thangaraja, C. Cinthia Fernandez and K. Chandrakandon. 2009. Dryland Agriculture and Wasteland Management. Atlantic Publishers and Distributors Pvt. Ltd., New Delhi.

Rattan Lal and B.A. Stewart (Ed.). 2015. Soil Management of Smallholder Agriculture. Volume 21 of Advances in Soil Science. CRC Press, Taylor and Francis Group, Florida, USA.
Robert Malliva and Thomas Missimer. 2012. Arid Lands Water Evaluation and Management. Springer Heidelberg, New York.
Swaminathan, M.S. 2010. Science and Integrated Rural Development. Concept Publishing Company (P) Ltd., Delhi.
The Energy and Resources Institute. 2003. Looking Back to Think Ahead-Green India 2047. Growth with Resource Enhancement of Environment and Nature. New Delhi.
Virmani, S.M. (Ed.). 2010. Degraded and Wastelands of India: Status and Spatial Distribution. ICAR, New Delhi.

3. SWLE-619 Information Technology for Land and Water Management 3(2+1)

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

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

Suggested Readings:

Climate-Smart Agriculture – Source Book. 2013. Food and Agriculture Organization, Rome.
Daniel P. Loucks and Eelco van Beek. 2005. Water Resources Systems Planning and Management - An Introduction to Methods, Models and Applications. UNESCO, Paris.
Dipak De and Basavaprabhu Jirli (Eds.). 2010. Communication Support for Sustainable Development. Ganga Kaveri Publishing House, Varanasi – 221001.

FAO. 1998. Land and Water Resources Information Systems. FAO Land and Water Bulletin 7, Rome.
FulingBian and YichunXie (Eds.). 2015. Geo-Informatics in Resource Management and Sustainable Ecosystem. Springer, New York.
ICFAI Business School (IBS). 2012. Information Technology and Systems. IBS Centre for Management Research, Hyderabad.
Robert Malliva and Thomas Missimer. 2012. Arid Lands Water Evaluation and Management. Environmental Science. Springer, New York.
Sarvanan. R. 2011. Information and Communication Technology for Agriculture and Rural Development. New India Publishing Agency, New Delhi.
Soam, S.K., P.D. Sreekanth and N.H. Rao (Eds.). 2013. Geospatial Technologies for Natural Resources Management. New India Publishing Agency, Delhi.

4. SWLE-620 Remote Sensing and GIS Applications 3(2+1)

Theory: Basic component of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources; electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface; major atmospheric windows; principal applications of different wavelength regions; typical spectral reflectance curve for vegetation, soil and water; spectral signatures; different types of sensors and platforms; contrast ratio and possible causes of low contrast; aerial photography; types of aerial photographs, scale of aerial photographs, planning aerial photography- end lap and side lap; stereoscopic vision, requirements of stereoscopic photographs; air-photo interpretation-interpretation elements; photogrammetry- measurements on a single vertical aerial photograph, measurements on a stereo-pair- vertical measurements by the parallax method; ground control for aerial photography; satellite remote sensing, multispectral scanner- whiskbroom and push-broom scanner; different types of resolutions; analysis of digital data- image restoration; image enhancement; information extraction, image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices; microwave remote sensing. GI Sand basic components, different sources of spatial data, basic spatial entities, major components of spatial data, Basic classes of map projections and their properties, Methods of data input into GIS, Data editing, spatial data models and structures, Attribute data management, integrating data (map overlay) in GIS, Application of remote sensing and GIS for the management of land and water resources.

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

Suggested Readings:

Reddy Anji, M. 2006. Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad.

Elangovan, K. 2006. GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi.

George Joseph. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad.

Jensen, J.R. 2013. Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education Limited, UK.

Lillesand, T., R.W. Kiefer and J. Chipman. 2015. Remote Sensing and Image Interpretation. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.

Sabins, F.F. 2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA.

Sahu, K.C. 2008. Text Book of Remote Sensing and Geographic Information Systems. Atlantic Publishers and Distributors (P) Ltd., New Delhi.

Shultz, G.A. and E.T. Engman. 2000. Remote Sensing in Hydrology and Water Management. Springer, New York.

5. IDE -621 Management of Canal Irrigation System 3(2+1)

Theory: Purpose benefits and ill effects of irrigation; typical network of canal irrigation system and its different physical components; canal classification based on source of water, financial output, purpose, discharge and alignment; canal alignment: general considerations for alignment; performance indicators for canal irrigation system evaluation, Estimation of water requirements for canal command areas and determination of canal capacity; water duty and delta, relationship between duty, base period and delta, factors affecting duty and method of improving duty; silt theory: Kennedy's theory, design of channels by Kennedy's theory, Lacey's regime theory and basic regime equations, design of channels by Lacey's theory, maintenance of unlined irrigation canals, measurement of discharge in canals, rostering (canal running schedule) and warabandhi, necessity of canal lining: advantages and disadvantages, types of canal lining and desirable characteristics for the suitability of lining materials; design of lined canals; functions of distributary head and cross regulators; canal falls, their necessity and factors affecting canal fall; sources of surplus water in canals and types of canal escapes; requirements of a good canal outlet and types of outlet.

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

Suggested Readings:

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

6. IDE -622 Minor Irrigation and Command Area Development 3(2+1)

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

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

Suggested Readings:

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

7. IDE -623 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 greenhouses – site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system,

selection of equipment, Greenhouse cooling system – necessity, methods – ventilation with roof and side ventilators, evaporative cooling, different shading material fogging, combined fogging and fan-pad cooling system, design of cooling system, maintenance of cooling and ventilation systems, pad care etc. Greenhouse heating – necessity, components, methods, design of heating system. Root media – types – soil and soil less media, composition, estimation, preparation and disinfection, bed preparation. Planting techniques in green house cultivation. Irrigation in greenhouse and net house – Water quality, types of irrigation system, components, design, installation and material requirement. Fogging system for greenhouses and net houses – introduction, benefits, design, installation and material requirement. Maintenance of irrigation and fogging systems. Fertilization – nutrient deficiency symptoms and functions of essential nutrient elements, principles of selection of proper application of fertilizers, fertilizer scheduling, rate of application of fertilizers, methods, automated fertilizer application. Greenhouse climate measurement, control and management. Insect and disease management in greenhouse and net houses Selection of crops for greenhouse cultivation, major crops in greenhouse – irrigation requirement, fertilizer management, cultivation, harvesting and post-harvest techniques; Economic analysis.

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

Suggested Readings:

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

8. IDE -624 Water Quality and Management Measures 3(2+1)

Theory:Natural factors affecting quality of surface water and groundwater, water quality objectives in relation to domestic, industrial and agricultural activities, drinking water quality standards, irrigation water quality classification as per USSL and All Indian Coordinated Research Project (AICRP) criteria, point and non-point water pollution sources, water contamination due to inorganic and organic compounds, water contamination related to agricultural chemicals, food industry, hydrocarbon and synthetic organic compounds. Arsenic and fluoride contamination in groundwater and remedial measures, water decontamination technologies, cultural and management practices for using poor quality water for irrigation.

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

Suggested Readings:

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

9. IDE 610 Landscape Irrigation Design and Management 3 (2+1)

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

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

Suggested Readings:

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

10. IDE-616 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 color 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 aqua-cultural engineering and animal husbandry - animal shelters, vermi-beds and inland fisheries. Silage film technique for fodder preservation. Agencies involved in the promotion of plasticulture in agriculture at national and state level. Human resource development in plasticutlure applications.

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

Suggested Readings:

Brahma Singh, Balraj Singh, Naved Sabir and Murtaza Hasan. 2014. Advances in Protected Cultivation. New India Publishing Agency, New Delhi.

Brown, R.P. 2004. Polymers in Agriculture and Horticulture. RAPRA Review Reports : Vol. 15, No. 2, RAPRA Technology Limited, U.K.
Central Pollution Control Board. 2012. Material on Plastic Waste Management. PariveshBhawan, East Arjun Nagar, Delhi-110032.
Charles A. Harper. 2006. Handbook of Plastics Technologies. The Complete Guide to Properties and Performance. McGraw-Hill, New Delhi.
Dubois. 1978. Plastics in Agriculture. Applied Science Publishers Limited, Essex, England.
Manas Chanda, Salil K. Roy. 2008. Plastics Fundamentals, Properties, and Testing. CRC Press.
Ojha, T.P. and Michael, A.M., 2012, Principles of Agricultural Engineering - I. Jain Brothers, Karol Bagh, New Delhi.
Pandey, P.H. 2014. Principles and Practices of Agricultural Structures and Environmental Control. Kalyani Publishers, Ludhiana, India.
Shankar, A.N. 2014. Integrated Horticulture Development in Eastern Himalayas, Plasticulture in Agri-Horticulture Systems, 241-247.
Srivastava, R.K., R.C. Maheswari, T.P. Ojha, and A. Alam. 1988. Plastics in Agriculture. Jain Brothers, Karol Bagh, New Delhi.

11. FMP-610 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, application of dimensional analysis in soil dynamics and traction prediction equation. Introduction to traction and mechanics, off road traction and mobility, traction model, traction improvement, tyre size, tyre lug geometry and their effects, tyre testing, soil compaction and plant growth, variability and application of GIS in soil dynamics.

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

Suggested Readings:

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

12. FMP-611 Farm Machinery Design and Production 3(2+1)

Theory: Introduction to design parameters of agricultural machines & design procedure. Characteristics of farm machinery design. Research and development aspects of farm machinery. Design of standard power transmission components used in agricultural machines: mechanical & hydraulic units. Introduction to safety in power transmission. Application of design principles to the systems of selected farm machines. Critical appraisal in production of Agricultural

Machinery; Advances in material used for agricultural machinery. Cutting tools including CNC tools and finishing tools. Advanced manufacturing techniques including powder metallurgy, EDM (Electro-Discharge Machining), Heat Treatment of steels including pack carburizing, shot pining process, etc. Limits, Fits & Tolerances, Jigs & Fixtures. Industrial lay-out planning, Quality production management. Reliability. Economics of process selection. Familiarization with Project Report.

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

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

13. FMP-612 Human Engineering and Safety 3(2+1)

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

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

Suggested Readings:

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

14. FMP-613 Tractor Design and Testing 3(2+1)

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

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

Suggested Readings:

Liljedahl J B & Others. Tractors and Their Power Units.
Raymond N, EA Yong and S Nicolas. Vehicle Traction Mechanics.
Maleev VL. Internal Combustion Engines.
Kirpal Singh. Automobile Engineering – Vol I and Vol II.
Richey C.B. Agricultural Engineering Handbook.
Mehta ML, SR Verma, SK Mishra, VK Sharma. Testing & Evaluation of Agricultural Machinery.

15. FMP-614 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 of Gear 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, color codes and circuits. Building simple hydraulic circuits, hydraulics in tractors. Introduction to pneumatics, pneumatics devices, pneumatics in agriculture; Use of hydraulics and pneumatics for robotics.

Suggested Readings:

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

16. FMP-615 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 levelers, straw-chopper, straw-balers, grain combines, etc. Introduction to GIS based precision agriculture and its applications. Introduction to sensors and application of sensors for data generation. Database management. System concept. System approach in farm machinery management, problems on machinery selection, maintenance and scheduling of operations. Application to PERT and CPM for machinery system management.

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

Suggested Readings:

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

17. FPE-629 Food Quality and Control 3(2+1)

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

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

Suggested Readings:

Ranganna S. Hand book of Analysis and Quality Control for Fruit and Vegetable Products.
Srilakshmi B, Food Science.
Sharma Avanthi. A text book of Food Science and Technology.
MudambiSumati 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 LawPublishers (India) Pvt. Ltd.

18. FPE-630 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 preprocessing house, Salient features and layout of Milk and Milk product plants, Evaluation of given layout, Salient features, design and layout of modern rice mill, Salient features, design and layout of Bakery and related product plant, Study of different types of records relating to production of a food plant, Study of different types of records relating to finance of a food plant, Study of different types of records relating to marketing of a food business, Brain storming and SWOT analysis to start a food processing business.

Suggested Readings:

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

19. FPE-631 Development of Processed Products 3 (2+1)

Theory: Process design, Process flow chart with mass and energy balance, Unit operations and equipments for processing, New product development, Technology for value added products from cereal, pulses and oil seeds, Milling, puffing, flaking, Roasting, Bakery products, snack food. Extruded products, oil extraction and refining, Technology for value added products from

fruits, vegetables and spices, Canned foods, Frozen foods, dried and fried foods, Fruit juices, Sauce, Sugar based confection, Candy, Fermented food product, spice extracts, Technology for animal produce processing, meat, poultry, fish, egg products, Health food, Nutra-ceuticals and functional food, Organic food.

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

Suggested Readings:

Geankoplis C. J. Transport processes and unit operations, Prentice-Hall.
Rao, D. G. Fundamentals of Food Engineering PHI Learning Pvt. Ltd, New Delhi.
Norman N. Potter and Joseph H. Hotchikss. Food Science. Chapman and Hall Pub.
Acharya, K T Everyday Indian Processed foods. National Book Trust.
MudambiSumati 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.

20. FPE-632 Waste and By-Products Utilization 3 (2+1)

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

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

Suggested Readings:

Markel, I.A. 1981. Managing Livestock Waste, AVI Publishing Co.
Pantastico, ECB. 1975. Post-Harvest Physiology, Handling and utilization of Tropical and Sub-tropical fruits and vegetables, AVI Pub. Co.
Shewfelt, R.L. and Prussi, S.E. 1992. Post-Harvest Handling – A Systems approach, Academic Press Inc.
USDA. 1992. Agricultural Waste Management Field Hand book. USDA, Washington DC.
Weichmann J. 1987. Post-Harvest Physiology of vegetables, Marcel and Dekker Verlag.
V.K. Joshi & S.K. Sharma. Food Processing Waste Management: Treatment & Utilization. New India Publishing Agency.
VassoOreopoulou 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.