

B. Tech. (Agricultural Engineering)
First Year
I Semester
2022-23

S. No	Course No.	Subject	L (Hr.)	T (Hr.)*	P (Hr.)	Credit
1	22MS121	Engineering Mathematics-I	3	1*	–	3
2	22PH122	Engineering Physics	2	1*	2	3
3	22CH123	Engineering Chemistry	2	0	2	3
4	22ME124	Thermodynamics Refrigeration & Air condition	2	1*	2	3
5	22CE125	Surveying and Leveling	2	0	2	3
6	22SC126	Principle of Soil Science	2	0	2	3
7	22ME127	Engineering Mechanics	2	1*	2	3
Practical Subject						
1	22ME175	Engineering Drawing	–	–	4	2
			15	4	16	23

* All Tutorial Hours are

(B. Tech. (Ag. Engg.))

II Semester

S. No.	Subject Code	Subject (Theory)	Group	Periods (Per Hour)			Credits
				L	T	P	
1	22MS221	Engineering Mathematics-II	Maths	3	1*		3
2	22EV222	Environmental Science and Disaster Management	Environment	2		2	3
3	22MT223	Entrepreneurship Development and Business Management	Management	3			3
4	22CE224	Fluid Mechanics & Open Channel Hydraulics	Mechanical	2	1*	2	3
5	22ME225	Theory of Machine	Mechanical	2	1*		2
6	22ME226	Workshop Technology and Practices	Mechanical	1	1*	4	3
7	22ME227	Strength of Materials	Mechanical	1	1*	2	2
8	22CA228	Web Designing and Internet Applications	Computer Sc	1	1*	2	2
Total				15	6*	12	21

* All Tutorial Hours are non credit.

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III Semester

S. No	Course No.	Subject	L (Hr.)	T (Hr.)*	P (Hr.)	Credit
1	22MS321	Engineering Mathematics-III	3	1*	–	3
2	22HO322	Principles of Horticultural Crops & Plant Protection	1	1*	2	2
3	22AN323	Principles of Agronomy	2	0	2	3
4	22SD324	Communication Skills and Personality Development	1	1*	2	2
5	22CE325	Soil Mechanics	1	1*	2	2
6	22CE326	Theory of Structures	1	1*	2	2
7	22ME327	Machine Design	2	1*	–	2
8	22ME328	Heat & Mass Transfer	2	1*	–	2
9	22EE329	Electrical Machines and Power Utilization	2	0	2	3
			15	7	12	21

* All Tutorial Hours are non credit.

Semester-IV

S. No.	Subject Code (Theory)	Subject (Theory)	Group	Periods (Per Hour)			Credits
				L	T	P	
1	22CE421	Building Construction & Cost Estimation	Civil	2	1*		2+0=2
2	22EE422	Applied Electronics & Instrumentation	Electronics	2		2	2+1=3
3	22AE423	Tractor and Automotive Engines	Ag Engg.	2		2	2+1=3
4	22AE424	Engineering Properties of Agricultural Produce	Ag Engg.	1	1*	2	1+1=2
5	22AE425	Watershed Hydrology	Ag Engg.	1	1*	2	1+1=2
6	22AE426	Irrigation Engineering	Ag Engg.	2		2	2+1=3
7	22AE427	Sprinkler & Micro Irrigation Systems	Ag Engg.	1	1*	2	1+1=2
8	22EE428	Fundamentals of Renewable Energy Sources	Ag Engg.	2		2	2+1=3
9	22ME471	Auto CAD Applications (Lab)	Mechanical		1*	4	0+2=2
Total				13	4*	18	22

***Tutorials hours will be considered as non credit**

**B. Tech. (Agricultural Engineering)
V Semester**

S. No	Course No.	Subject	Credit Scheme			
			Theory	Tutorial	Practical	Total
Vth Semester						
1	22AE521	Tractor Systems and Controls	2	0	2	3
2	22AE522	Farm Machinery and Equipment-I	2	0	2	3
3	22AE523	Agricultural Structures and Environmental Control	2	0	2	3
4	22HO524	Post Harvest Engineering of Cereals, Pulses and Oil Seeds	2	0	2	3
5	22AE525	Soil and Water Conservation Engineering	2	0	2	3
6	22AE526	Watershed Planning and Management	1	1	2	2
7	22AE527	Drainage Engineering	1	1	2	2
8	22AE528	Renewable Power Sources	2	0	2	3
9	22AE570	In-plant training-I				5
			14	2	18	27

Semester-VI
Teaching & Examination Scheme

S. No	Subject Code	Subject	Group	Credit Scheme			
				L	T	P	Credit
VIth Semester							
1	22CA621	Computer Programming and Data Structures	Computer Sc	1	1*	4	1+2=3
2	22AE622	Farm Machinery and Equipment-II	Ag Engg.	2	0	2	2+1=3
3	22AE623	Post Harvest Engineering of Horticultural Crops	Ag Engg.	1	0	2	1+1=2
4	22AE624	Water Harvesting & Soil Conservation Structures	Ag Engg.	2	0	2	2+1=3
5	22AE625	Groundwater, Wells and Pumps	Civil	2	0	2	2+1=3
6	22AE626	Dairy and Food Engineering	Ag Engg.	2	0	2	2+1=3
7	22AE627	Bio-energy Systems: Design and Applications	Ag Engg.	2	0	2	2+1=3
8	22AE678	Tractor and Farm Machinery Operation and Maintenance (Lab)	Ag Engg.		1*	4	0+2=2
				12	2*	20	22
*In-plant training-II Summer break June-July after VIth Semester (Student READY)							

***Tutorials hours will be considered as non credit**

B. Tech. (Agricultural Engineering)**VII Semester****(No Change)**

S. No	Course No.	Title of the Course	practical	Credit
Student READY (Rural and Entrepreneurship Awareness Development Yojana)				
1.	22AE771	Industrial Attachment/ Internship	10 Weeks	10
2.	22AE772	Experiential Learning On campus	10 Weeks	10
3.	22AE773	Skill Development training-II	5 Weeks	5
4.	22AE774	Educational Tour		2
Total				27

B.Tech (Ag. Engg.)**Semester-VIII****Teaching & Examination Scheme**

Sr. No.	Sub. Code	SUBJECT	L (Hr)	T (Hr)	P (Hr)	Credit
1.	Elective-I-					
	29AE821-A	Landscape Irrigation Design and Management	2	0	2	3
	29AE821-B	Remote Sensing & GIS Application	2	0	2	3
2	29AE822-B	Elective-II- Tractor Design and Testing	2	0	2	3
3	29AE823-A	Elective-III- Food Plant Design and Management	2	0	2	3
1	22AE871	Project Planning and Report Writing (Student READY)	0	0	20	10
Total			6	0	26	19

ENGINEERING MATHEMATICS-I [3 (3+0)]

UNIT-I:

Matrices I - Elementary transformations, rank of a matrix, reduction to normal form, Gauss-Jordan method to find inverse of a matrix, Eigen values and Eigenvectors, Cayley – Hamilton theorem,

UNIT-II

Matrices-II - Linear transformation, orthogonal transformations, diagonalisation of matrices, quadratic forms. PAQ form, Echelon form, Solution of linear equations, nature of rank, using Cayley -Hamilton theorem to find inverse of A.

UNIT-III :

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.

UNIT-IV

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.

UNIT-V

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).

Text Book:

- D. K. Jain., Engineering Mathematics-I
- Gorakh Prasad, Differential calculus, Pothisala Pvt. Ltd. Allahabad
- Gorakh Prasad, Integral calculus, Pothisala Pvt. Ltd. Allahabad,
- H.K. Das Engineering Mathematics-I, S.Chand & company Ltd.
- D.C. Agrawal, Engineering Mathematics-I, Sai prakasan

Reference:

- B.S.Grewal, Engineering Mathematics, Khanna Publishers, 2004.
- B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, 2005.
- Chandrika Prasad, Mathematic for Engineers, Prasad Mudranalaya, 1996.
- H.K.Das, Basic Engineering Mathematics, S.Chand & company Ltd.
- B.V.Ramana, Higher Engineering mathematics, Tata Mcgraw-Hills Publishing Company Limited.

ENGINEERING PHYSICS [3 (2+1)]

Unit-I (Magnetism)

Dia, Para and ferromagnetism-classification, Langevin theory of dia and paramagnetism, Adiabatic demagnetization, Weiss molecular field theory and ferromagnetism, Curie-Weiss law.

Unit- II (Quantum Physics)

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.

Unit- III Solid State Physics & Superconductivity)

Statement of Bloch's function, Bands in 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.

Unit- IV (Laser)

Spontaneous and stimulated emission, Einstein A and B coefficients, Population inversion, He-Ne and Ruby lasers, Ammonia and Ruby masers, Holography-Note.

Unit-V (Optical fiber & Illumination)

Optical fiber, Physical structure, basic theory, Mode type, input output characteristics of optical fiber and applications, Illumination: laws of illumination, luminous flux, luminous intensity, candlepower, brightness.

Practical :-

1. To determine the slit width from Fraunhofer diffraction pattern using laser beam;
2. To plot and verify the characteristic curve of PN junction diode.
3. To plot and verify the characteristic curve of zener junction diode.
4. To find out the wave length of light by using spectrometer.
5. To study the characteristic curve of PNP transistor.
6. To study the characteristic curve of NPN transistor.
7. To determine the hall coefficient (R_H) of a semiconductor material.
8. To study the variations of thermo emf of a copper-constantan thermo-couple with temperature;
9. To determine the energy band gap in a semiconductor using a p-n Junction diode;
10. To find the numerical aperture of optical fiber: To set up the fiber optic analog and digital link;

Text Books:

- Text book of Optics by Brijlal & Subramanian (S. Chand). 2010
- Text book of Engineering Physics by Navneet Gupta & S.K. Tiwary (Dhanpat Rai & Co.)
- Text book of Engineering Physics by M.N. Avadhanulu and. P.G. Kshirsagar (S. Chand & Co.) 2010

ENGINEERING CHEMISTRY [3 (2+1)]

UNIT-I

Water and its industrial applications: Hardness of water and its units, Temporary and permanent hardness. Disadvantages of hard water, scale and sludge formation in boilers, Corrosion: causes. Types and method of prevention. Boiler corrosion. Numerical problems based on hardness of water.

UNIT-II

Fuel and Lubricant: Introduction and classification of fuels, characteristics of good fuel, calorific value and its units, Determination of calorific value by bomb calorimeter, properties and mechanism of lubricants.

UNIT-III

High Polymers: Introduction and classification of polymers, types of polymerization, Mechanism of polymerization, determination of molecular weight of polymers. Preparation, properties and uses of Nylon6, nylon 66, Teflon, and PVC.

UNIT-IV

Enzymes and Bio Molecules: Enzymes and their use in the manufacturing of ethanol and acetic acid by fermentation methods. Introduction properties and application of lipids, proteins, carbohydrates and vitamins,

UNIT-V

Analytical methods and spectroscopy: Introduction and importance of spectroscopy, electromagnetic radiation, Introduction principle and application of IR and UV-VIS spectroscopy, Analytical methods in brief like TGA, DTA and DSC, analytical applications of radioactive materials.

Practical:

- Determination of water hardness by EDTA method:
- Determination of water alkalinity:
- Determination of X Max and verification of Beer Lambert Law by KMnO_4 solution:
- Determination of X Max and verification of Beer Lambert Law by $\text{K}_2\text{Cr}_2\text{O}_7$ solution:
- Identification of element and functional group (alcohol):
- Identification of element and functional group (carboxylic acid):
- Identification of element and functional group (amide):
- Identification of element and functional group (aldehyde):
- Identification of element and functional group (thioamide):
- Estimation of chloride in water:
- Estimation of dissolved oxygen in water:
- Determination of BOD and COD in water sample:
- Determination of viscosity of oil:
- Determination of specific rotation of an optically active compound:
- Determination of calorific value of fuel:
- Determination of saponification value of given oil:

Text Book:

- Jain, P.C. and Jain, M. 1998. Engineering Chemistry, Dhanpatrai Publication, Delhi.
- Bahl B S, Arun Bahl and Tuli B D. 2007. Essentials of Physical Chemistry. S.Chand and Co.

Engineering Mechanics 3 (2+1)

Unit – I

Basic concepts of Engineering Mechanics. Introduction to condition of equilibrium: Force and system of force. Moment and couples: Moment and parallel forces, couples, General conditions of equilibrium.

Unit –II

Centre of Gravity: Centre of parallel forces, C.G in some simple cases, C.G. of solids. Moment of Inertia: Moment of Inertia, Radius of Gyration and perpendicular axis. Determination of moment of inertia of simple sections. Free body diagram and equilibrium of forces

Unit – III

Friction: Introduction, critical angle of friction, friction on horizontal planes, friction on inclined planes, Rolling friction.

Unit – IV

Analysis of simple framed structures using methods of joints, methods of sections and graphical method.

Unit-V

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.

Textbook:

- Khurmi, R.S. , Engineering Mechanics, S.Chand Publication.
- S. S. Bhavikatti, K. G. Rajashekarappa,, Engineering Mechanics, New Age International.

Thermodynamics, Refrigeration and Air Conditioning [3 (2+1)]

UNIT-I

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.

UNIT-II

Carnot cycle, Carnot theorem. Entropy, physical concept of entropy, change of entropy of gases in thermodynamics process. Otto, diesel and dual cycles.

UNIT-III

Principles of refrigeration, - units, terminology, production of low temperatures, air refrigerators working on reverse Carnot cycle and Bell Coleman cycle. Vapour refrigeration-mechanism, P-V,P-S,P-H diagrams, vapor compression cycles, dry and wet compression, super cooling and sub cooling. Vapour absorption refrigeration system.

UNIT- IV

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.]

UNIT-V

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 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.

Suggested Text Books & References

- Thermal engineering (R.K. Rajput) Laxmi Publication.
- Engineering Thermodynamics by T. P. Roy & Choudhary
- Thermal engineering (Domkundwar, Kothandaraman and Khajuria) Dhanatrai Publication

SURVEYING AND LEVELLING [3 (1+2)]

UNIT-I

Surveying – Introduction, classification and basic principles. Linear measurements, Chain surveying – definition, selection of survey station and lines, types of ranging & chaining. Types of chains, recording the measurement, Errors in measurements, their elimination and correction. Offset measurement, cross staff optical square, prism square, obstacles in chaining and ranging.

UNIT-II

Methods of traversing prismatic and surveyors compass angle and bearing, quadrantal system, local attraction magnetic declination dip traversing plotting bow, ditch rule, transit rule, errors in compass survey, their elimination and correction

UNIT-III

Plane table surveying – instruments, accessories, methods, principle two points, three points problems, errors in plane tabling, minor instruments, clinometer, sextant, planimeter.

UNIT-IV

Levelling : Basic definitions, principles and methods of leveling, Leveling difficulties and error in leveling.

Contouring : Introduction and importance of contouring, Computation of area and volume.

UNIT-V

Advance surveying technology: Theodolite traversing. Theodolite surveying, Ranging by theodolite, temporary and permanent adjustment of theodolite. Introduction to setting of curves. Introduction to GPS survey, Introduction to GIS & Remote sensing and its applications.

Practical:

- Introduction to different survey chains.
- Chain survey of an area and preparation of map.
- Compass survey of an area and plotting of compass survey.
- Plane table survey by using radiation method and intersection method
- Leveling. 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.
- Minor instruments and their uses.
- Uses of GPS and total station.

Text Book:

- B.C.Punamia,; Surveying & Levelling Vol.-I;Lakshmi Publication, New Delhi.
- Kanetkar, T.P. and Kulkarni, S.P. 1965. Surveying and Levelling. A.V. Griha Prakashan, Pune-4.
- Agor, R. 1998. Surveying and Levelling, Khanna Publishers, New Delhi.

Principles of Soil Science [3 (2+1)]

UNIT-1 Soils

Nature and origin of soil; soil forming rocks and minerals, their classification and composition, soil forming processes, classification of soils – soil taxonomy orders;

UNIT-2

Important soil physical properties; and their importance; soil particle distribution; soil inorganic colloids – their composition, properties and origin of charge; ion exchange in soil and nutrient availability;

UNIT-3

Soil organic matter – its composition and decomposition, effect on soil fertility; soil reaction – acidic, saline and sodic soils; Quality or irrigation water;

UNIT-4

Essential plants nutrients – their functions and deficiency symptoms in plants; important inorganic fertilizers and their reactions in soils;

UNIT-5

Use of saline and sodic water for crop production, Gypsum requirement for reclamation of sodic soils and neutralising RSC; Liquid fertilisers and their solubility and compatibility.

Practical:

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

Text Book:

- D. K. Das, Introductory Soil Science; Kalyanin Publication.
- V. N. Sahai, Fundamentals of Soil Science; Kalyanin Publication
- Rai, M.M. 1998. Principles of Soil Science. Macmillon India Ltd., New Delhi

Reference:

- Brady Nyle C and Ray R Well. 2002. Nature and properties of soils. Pearson Education Inc., New Delhi.
- Indian Society of Soil Science. 1998. Fundamentals of Soil Science. IARI, New Delhi.
- ICAR, 1997. Hand Book of Agriculture, ICAR Pub. New Delhi.

Engineering Drawing [2 (0+2)]

- 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.

Text Book:

- ✓ 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.

Engineering Mathematics - II 3(3+0)

UNIT – I

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, Tutorials on solution of ordinary differential equations of first and higher orders.

UNIT – II

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 solutions of differential equations. Bessel's and Legendre's differential equations, Convergence of infinite series.

UNIT – III

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, harmonic analysis, analytical functions,

UNIT – IV

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. Cauchy-Riemann equations, harmonic functions.

UNIT – V

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. Solution of partial differential equations, Application of partial differential equations.

Suggested Reading

Narayan Shanti. 2004. A Text Book of Matrices. S. Chand and Co. Ltd. New Delhi.

Grewal B S. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi.

Ramana B V. 2008. Engineering Mathematics. Tata McGraw-Hill. New Delhi.

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

UNIT – I

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;

UNIT – II

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;

UNIT – III

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;

UNIT – IV

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;

UNIT – V

Dimensional analysis and similitude: Rayleigh's method and Buckingham's 'Pi' theorem, types of similarities, dimensional analysis, dimensionless numbers. Introduction to fluid machinery.

Practical

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

Suggested Reading

Khurmi, R .S. 1970. A Text Book of Hydraulics, Fluid Mechanics and Hydraulic Machines S. Chand & Company Limited, New Delhi.

Strength of Materials 2 (1+1)

UNIT-I

Concept of simple stress, strain, direct stress, shear strain, free body diagram, concept of uniform and non-uniform sections, strain in uniform tapering section, Lateral strain Poisson's ratio and change in dimensions of different shapes.

UNIT-II

Elastic constants, their relationship and volume changes. Thermal stresses, composite section and their equation formulations.

UNIT-III

Use of energy principle in solving problems stress and strain due to gradual, sudden application of forces, impact and shock loading, resilience, modulus of resilience complex stress, derivation of formulas for different cases. Mohr circle and its application in solving complex stress problem. Comparison of analytical and graphical solution of complex stress problem.

UNIT-IV

Slope and deflection of beams using integration techniques, moment area theorems and conjugate beam method.

UNIT-V

Columns and Struts. Riveted and welded connections. Stability of masonry dams. Introduction to intermediate beams, Propped beams. Fixed and continuous beams.

Practical:

- To study 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 its fracture.
- 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 load deflection and other physical properties of closely coiled helical spring in tension and compression.
- To study the Brinell's Hardness tests on the given specimens.
- 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.

Text Book:

- Khurmi, R.S. 1998 Strength of Materials and Mechanics of Structures,. Vol. I & II Khanna Publishers, New Delhi.
- Bansal R.K.;A Textbook of Strength of Materials; Laxmi Publications,New Delhi.

References:

- Singh Gurubaksh. 1998 Strength of Materials and Structures,. Vol. I & II Khanna Publishers, New Delhi.
- Timoshenko, S.P. and Young, D.H. 1968.Strength of Materials. Affiliated East-West Press Pvt. Ltd., New Delhi.

Theory of Machines 2 (2+0)

UNIT – I

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.

UNIT – II

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.

UNIT – III

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,

UNIT – IV

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.

UNIT – V

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

Suggested Reading

- Bevan Thomas. 1984. Theory of Machines. CBS Publishers and Distributors, Delhi.
- Ballaney P L. 1985. Theory of Machines. Khanna Publishers, 2-B Nath Market, Nai Sarak, New Delhi.
- Rao J S and Dukupatti 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.

Environmental Science and Disaster Management 3 (2+1)

Unit I

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.

Unit II

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-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Unit III

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.

Unit IV

Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. 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.

Unit V

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

Practical:

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

Suggested Reading

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

Entrepreneurship Development and Business Management 3 (3+0)

UNIT – I 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,

UNIT – II 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.

UNIT – III 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).

UNIT – IV Entrepreneurship 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.

UNIT – V 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

Suggested Reading

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

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

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.

Workshop Technology and Practice 3 (1+2)

UNIT – I Introduction to various carpentry tools, materials, types of wood and their characteristics and Processes or operations in wood working;

UNIT – I 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.

UNIT – III 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.

UNIT – IV 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.

UNIT – V 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 tenon 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.

Suggested Reading

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

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

Web Designing and Internet Applications 2 (1+1)

UNIT – I

Basic principles in developing a web designing, Planning process, Five Golden rules of web designing,

UNIT – II

Designing navigation bar, Page design, Home Page Layout , Design Concept.

UNIT – III

Basics in Web Design, Brief History of Internet, World Wide Web , creation of a web site, Web Standards , Audience requirement.

UNIT – IV

Introduction to JavaScript, variables & functions, Working with alert, confirm and prompt, Connectivity of Web pages with databases; Project

Practical

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

Suggested Reading

Jennifer Niederst Robbins. Developing web design latest edition.

Frain and Ben. Responsive Web Design with HTML5..

Nicholas c.Zakas. Java Script for Web Developers.

Engineering Mathematics - III 3(2+1)

UNIT-I

Numerical analysis and Laplace transformation: finite difference, various difference operators and their relationships. Factorial notation, interpolation with equal intervals.

UNIT-II

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.

UNIT-III

Numerical differentiations, numerical integrations, difference equations and their solutions, numerical solutions of ordinary differential equations by Picard's method, Taylor's series. Fuller's and modified Fuller's methods. Runge-Kutta method;

UNIT-IV

Laplace transformation and its applications to the solutions of ordinary and simultaneous differential equations.

UNIT-V

Testing of Hypothesis-Level of Significance-Degrees of freedom-Statistical errors, Large sample test (Z-test), Small sample test t-test (One tailed, two tailed and Paired tests), Testing of Significance through variance (F-test), Chi -Square test, contingency table, Correlation, Regression.

Suggested Reading

- Grewal, B.S. 1983. Higher Engineering Mathematics, Khanna Publishing House, New Delhi.
- D. K. Jain. Engg. Mathematics III
- H.K.Das, Engg. Mathematics III
- Agrawal B L. Basic Statistics. Wiley Eastern Ltd. New Age International Ltd.
- Rangaswamy R. A Text Book of Agricultural Statistics. New Age Int. publications Ltd.
- Gupta S.C. Fundamental Applied Statistics.

Machine Design 2 (2+0)

UNIT-I

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.

UNIT-II

Elementary fatigue and creep aspects. Cotter joints, knuckle joint and pinned joints, turnbuckle. Design of welded subjected to static loads.

UNIT-III

Design of threaded fasteners subjected to direct static loads, bolted joints loaded in shear and bolted joints subjected to eccentric loading.

UNIT-IV

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.

UNIT-V

Design of flat belt and V-belt drives and pulleys. Design of gears. Design of screw motion mechanisms like screw jack, lead screw, etc. Selection of anti-friction bearings.

Suggested Reading

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

Heat and Mass Transfer 2 (2+0)

UNIT-I

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,

UNIT-II

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.

UNIT-III

Introduction to Absorptivity, reflectivity and transmissivity of radiation. Black body and monochromatic radiation, Planck's law, Stefan-Boltzman law, Kirchoff's law, grey bodies and emissive power, solid angle, intensity of radiation. Radiation exchange between black surfaces, geometric configuration factor. Heat transfer analysis involving conduction, convection and radiation by networks.

UNIT-IV

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.

UNIT-V

Steady state molecular diffusion in fluids at rest and in laminar flow, Flick's law, mass transfer coefficients. Reynold's analogy.

Suggested Reading

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

Soil Mechanics 2 (1+1)

UNIT-I

Introduction of soil mechanics, field of soil mechanics, phase diagram physical and index properties of soil classification of soils, general classification based on particles size, textural classification and I.S. soil classification system stress condition in soils, effective and neutral stress, Elementary concept of Boussinesque and Westergaard's analysis, newmark influence chart.

UNIT-II

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 to be circle, theoretical test. Numerical exercise based on various types of tests.

UNIT-III

Compaction composition of soils standard and modified proctor test, abbot compaction and Jodhpur mini compaction text field compaction method and control.

UNIT-IV

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.

UNIT-V

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 exercise. Stability of slopes: Introduction to stability analysis of infinite and finite slopes friction circles 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.
- Grain size analysis by sieving (Dry sieve analysis).
- Grain size analysis by hydrometer method.
- Determination of liquid limit by Casagrande's method.
- 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 consolidation properties of soils.

Text Book:

- Punamia B.C.; Fundamentals Soil Mechanics; Laxmi Publication, New Delhi.
- Arora, K.R. 2000. Soil Mechanics and Foundation Engineering. Standard Publishers and Distributors, New Delhi.

Theory of Structures 2 (1+1)

UNIT I

Loads and use of BIS Codes. Design of connections.

UNIT II

Design of structural steel members in tension, compression and bending.

UNIT III

Design of steel roof truss.

UNIT IV

Analysis and design of singly and doubly reinforced sections, Shear, Bond and Torsion.

UNIT V

Design of Flanged Beams, Slabs, Columns, Foundations, Retaining walls and Silos.

Practical:

- Design and drawing of steel roof truss;
- Design and drawing of RCC building;
- Design and drawing of Retaining wall.

Reference Books

- Design of steel structures Vol. I, By: Ram Chandra
- Steel structures, By: Vazirani and Ratwani
- Junarkar, S.B. 2001. Mechanics of Structures Vol. I Charotar Publishing Home, Anand.
- Khurmi R. S. 2001. Strength of materials. S. Chand & Company Ltd., 7361, Ram Nagar, New Delhi – 110055.
- Kumar Sushil 2003. Treasure of R.C.C. Design. R.K. Jain. 1705-A, Nai Sarak , Delhi- 110006, P.B.1074.
- IS: 800-1984 Code of Practice for General Construction in steel
- Indian Standard Code of Practice for use of structural steel in General Building Construction

Electrical Machines and Power Utilization 3 (2+1)

Unit I- Basic Principles of Machines: Flux, flux density, magnetic field intensity, reluctance Electro motive force, reluctance, laws of magnetic circuits, determination of ampere-turns for series and parallel magnetic circuits, hysteresis and eddy current losses,

Unit II- 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,

Unit III- 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,

Unit IV- 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:

Unit V- 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 (Any Ten):

- To get familiar with AC, DC machines and measuring instruments;
- To perform open circuit and short circuit tests on a single phase transformer and hence find equivalent circuit, voltage regulation and efficiency;
- To study the constructional details of D.C. machine and to draw sketches of different components;
- To obtain load characteristics of d.c. shunt/series /compound generator;
- To study d.c. motor starters;
- To Perform load-test on 3 ph. induction motor;
- To perform no-load & blocked –rotor tests on 3 ph. Induction motor to obtain equivalent ckt. parameters & to draw circle diagram;
- 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.

Reference Books

- Nagrath I.J. and Kothari, D.P. "Electrical Machines", Tata McGraw Hill Publishing
- Thareja B L & Theraja AK. 2005. A text book of Electrical Technology. Vol. I S. Chand & Company LTD., New Delhi.

Principles of Agronomy 3(2+1)

Unit I -

Introduction and scope of agronomy. Classification of crops, Effect of different weather parameters on crop growth and development.

Unit II-

Principles of tillage, tilth and its characteristics. Crop seasons. Methods, time and depth of sowing of major field crops. Methods and time of application of manures and fertilizers.

Unit III-

Crop rotation, cropping systems, Relay cropping and mixed cropping,

Unit IV-

Soil water plant relationship, crop coefficients, water requirement of crops and critical stages for irrigation,

Unit V-

Weeds – introduction, classification and their control, Organic farming-Sustainable agriculture.

Practical

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

Suggested Reading

William L Donn. 1965. Meteorology. McGraw-Hill Book Co. New York.

Arnon L. 1972. Crop Production in Dry Regions. Leonard Hill Publishing Co. London.

Yawalkar K S and Agarwal J P. 1977. Manures and Fertilizers. Agricultural Horticultural Publishing House, Nagpur.

Gupta O P. 1984. Scientific Weed Management in the Tropics and Sub- Tropics. Today and Tomorrow's Printers and Publishers. New Delhi.

Rao V S. 1992. Principles of Weed Science. Oxford and IBH Publishing Co. Ltd. New Delhi.

Reddy Yellamanda T and Shankar Reddy G H. 1995. Principles of Agronomy. Kalyani Publishers Ludhiana.

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

Unit I- Scope of horticultural. Soil and climatic requirements for fruits, vegetables and floriculture crops, improved varieties,

Unit II- Criteria for site selection, layout and planting methods, nursery raising, commercial varieties/hybrids, sowing and planting times and methods, seed rate and seed treatment for vegetable crops;

Unit III- Macro and micro propagation methods, plant growing structures, pruning and training, crop coefficients, water requirements and critical stages,

Unit IV- Fertilizer application, fertigation, irrigation methods, harvesting, grading and packaging, post harvest practices,

Unit V- Garden tools, management of orchard, Extraction and storage of vegetables seeds. Major pests and diseases and their management in horticulture crops.

Practical

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

Suggested Reading

Bansal. P.C. 2008. Horticulture in India. CBS Publishers and Distributors, New Delhi.

Saraswathy, S., T.L.Preethi, S.Balasubramanyan, J. Suresh, N.Revathy and S.Natarajan. 2007. Postharvest management of Horticultural Crops. Agrobios Publishers, Jodhpur.

Arjunan, G., Karthikeyan, G, Dinakaran , D. and Raguchander, T. 1999. Diseases of Horticultural Crops. AE Publications, Coimbatore.

Sharma Neeta and Mashkooor Alam. 1997. Postharvest diseases of Horticultural crops. International Book publishing Co. UP.

Communication Skills and Personality Development 2 (1+1)

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

Practical

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

Suggested Reading

Balasubramanian T. 1989. A Text book of Phonetics for Indian Students. Orient Longman, New Delhi.

Balasubramanyam M. 1985. Business Communication. Vani Educational Books, New Delhi.

Naterop, Jean, B. and Rod Revell. 1997. Telephoning in English. Cambridge University Press, Cambridge.

Mohan Krishna and Meera Banerjee. 1990. Developing Communication Skills. Macmillan India Ltd. New Delhi.

Krishnaswamy, N and Sriraman, T. 1995. Current English for Colleges. Macmillan India Ltd. Madras.

Tractor and Automotive Engines 3(2+1)

Unit-I 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.

Unit-II 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.

Unit-III 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.

Unit-IV 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.

Unit-V 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 Reading

Liljedahl J B and Others. Tractors and Their Power Units.

Rodichev V and G Rodicheva. Tractors and Automobiles.

Engineering Properties of Agricultural Produce 2 (1+1)

Unit-I Classification and importance of engineering properties of Agricultural Produce, shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area of grains, fruits and vegetables,

Unit-II Thermal properties, Heat capacity, Specific heat, Thermal conductivity, Thermal diffusivity, Heat of respiration; Co-efficient of thermal expansion,

Unit-III Friction in agricultural materials; Static friction, Kinetic friction, rolling resistance, angle of internal friction, angle of repose, Flow of bulk granular materials, Aero dynamics of agricultural products, Drag coefficients, terminal velocity.

Unit-IV Rheological properties; force, deformation, stress, strain, elastic, plastic and viscous behaviour, Newtonian and Non-Newtonian liquid, Visco-elasticity, Newtonian and Non-Newtonian fluid, Pseudo-plastic, Dilatant, Thixotropic, Rheopectic and Bingham Plastic Foods, Flow curves.

Unit-V Electrical properties; dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant, method of determination. Application of engineering properties in handling processing machines and storage structures

Practical

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

Suggested Reading

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

Mohesin, N.N. 1980. Thermal Properties of Foods and Agricultural Materials. Gordon & Breach Science Publishers , New York.

Prentice, J.H. 1984. Measurement in Rheological Properties of Food Stuffs. Elsevier Applied science Pub. Co. Inc. New York.

Rao, M.A. and Rizvi, S.H., 1995. Engineering Properties of Foods. Marcel Dekker Inc. New York.

Singhal OP & Samuel DVK. 2003. Engineering Properties of Biological Materials. Saroj Prakashan.

Watershed Hydrology 2(1+1)

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

Unit-II Hydrologic processes-Interception, infiltration -factors influencing, measurement and indices. Evaporation - Estimation and measurement. Runoff - Factors affecting, measurement, stage - discharge rating curve, estimation of peak runoff rate and volume, Rational method, Cook's method and SCS curve number method.

Unit-III Geomorphology of watersheds – Linear, aerial and relief aspects of watersheds-stream order, drainage density and stream frequency.

Unit-IV Hydrograph - Components, base flow separation, unit hydrograph theory, S-curve, synthetic hydrograph, applications and limitations.

Unit-V Stream gauging - discharge rating curves, flood peak, design flood and computation of probable flood. Flood routing – channel and reservoir routing. Drought – classification, causes and impacts, drought management strategy.

Practical

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

Suggested Reading

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.

Irrigation Engineering 3(2+1)

Unit-I 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;

Unit-II 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;

Unit-III Underground pipe conveyance system: components and design; land grading: criteria for land levelling, land levelling design methods, estimation of earth work;

Unit-IV 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;

Unit-V Water requirement of crops: concept of evapotranspiration (ET), measurement and estimation of ET, water and irrigation requirement of crops, depth of irrigation, frequency of irrigation, irrigation efficiencies;

Surface methods of water application: border, check basin and furrow irrigation- adaptability, specification and design considerations.

Practical

- Measurement of soil moisture by different soil moisture measuring instruments;
- Measurement of irrigation water;
- Measurement of infiltration characteristics;
- Determination of bulk density, field capacity and wilting point;
- Estimation of evapotranspiration;
- Land grading methods;
- Design of underground pipeline system;
- Estimation of irrigation efficiency;
- Study of advance, recession and computation of infiltration opportunity time;
- Infiltration by inflow-outflow method;
- Evaluation of border irrigation method;
- Evaluation of furrow irrigation method;
- Evaluation of check basin irrigation method.

Suggested Reading

Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing House New Delhi.

Majumdar D. K. 2013. Irrigation Water Management Principles. PHI learning Private Limited New Delhi 2nd Edition.

Allen R. G., L. S. Pereira, D. Raes, M. Smith. 1998. Crop Evapotranspiration guidelines for computing crop water requirement. Irrigation and drainage Paper 56, FAO of United Nations, Rome.

Sprinkler and Micro irrigation Systems 2(1+1)

Unit-I 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;

Unit-II Micro Irrigation Systems: types-drip, spray, & bubbler systems, merits and demerits, different components; Design of drip irrigation system: general considerations, wetting patterns, irrigation requirement, emitter selection,

Unit-IV 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;

Unit-V Fertigation: advantages and limitations of fertigation, fertilizers solubility and their compatibility, precautions for successful fertigation system, fertigation frequency, duration and injection rate, methods of fertigation.

Practical

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

Suggested Reading

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.

Fundamentals of Renewable Energy Sources 3 (2+1)

Unit-I Concept and limitation of Renewable Energy Sources (RES), Criteria for assessing the potential of RES, Classification of RES, Solar, Wind, Geothermal, Biomass, Ocean energy sources, Comparison of renewable energy sources with non renewable sources.

Unit-II Solar Energy: Energy available from Sun, Solar radiation data, solar energy conversion into heat through, Flat plate and Concentrating collectors, different solar thermal devices, Principle of natural and forced convection drying system, Solar Photo voltaics: p-n junctions. Solar cells, PV systems, Stand alone, Grid connected solar power station, Calculation of energy through photovoltaic power generation and cost economics.

Unit-III Wind Energy: Energy available from wind, General formula, Lift and drag. Basis of Wind energy conversion, Effect of density, Frequency variances, Angle of attack, Wind speed, Types of Windmill rotors, Determination of torque coefficient, Induction type generators, Working principle of wind power plant.

Unit-IV Bio-energy: Pyrolysis of Biomass to produce solid, liquid and gaseous fuels. Biomass gasification, Types of gasifier, various types of biomass cook stoves for rural energy needs. Biogas: types of biogas plants, biogas generation, factors affecting biogas generation and usages, design consideration, advantages and disadvantages of biogas spent slurry.

Practical

- Study of different types of solar cookers, solar water heating system,
- Natural convection solar dryer, forced convection solar dryer,
- Solar desalination unit,
- Solar greenhouse for agriculture production,
- Study of different types Biogas plants,
- Study of different types Biomass gasifiers,
- Study of Biomass improved cook-stoves,
- Study of Solar photovoltaic system.

Suggested Reading

Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.

Rai, G.D., Solar Energy Utilization, Khanna Publishers, Delhi.

Khandelwal, K.C. & S. S. Mahdi. 1990. Biogas Technology- A Practical Handbook.

Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Non Conventional Energy Sources, Himanshu Publications.

Applied Electronics and Instrumentation 3(2+1)

UNIT-I

Digital Fundamentals: Number System- Decimal, Binary, octal, hexadecimal, their complements, operation and conversion, floating point and signed numbers. Basic theorem of Boolean algebra

UNIT-II

Combinational Logic Circuits (basic gates (AND, OR, NOR), SOP rule and Kmap), binary ladder D/A converter, successive approximation A/D converter, half and full adder circuits, R-S flip flop, J-K flip flop.

UNIT-III

Passive Components: Resistors- Inductors and Capacitors and their types. Introduction to semiconductors, Diodes, V-I characteristics, Diode as rectifier, various type of rectifier (half wave, full wave and bridge) Bipolar junction Transistor and their working, introduction to CC, CB & CE transistor configurations, different configuration and modes of operation of BJT, DC biasing of BJT (fixed, self, potential divider, direct coupling).

UNIT-IV

Voltage regulator using zener diode, Series and shunt regulator using transistor (Transistor series regulator, controlled transistor series regulator, shunt Transistor voltage regulator, Transistor current regulator.) Phase shift oscillator, analysis of differential amplifier using transistor, ideal OP-AMP characteristics, linear and non-linear application of OP-AMP (adder, subtractor, integrator, active filter, comparator, differentiator, differential instrumentation amplifier and oscillator) OP- Amp as voltage regulator.

UNIT - V

Generalized instrumentation, measurement of displacement, temperature, velocity, force and pressure using potentiometer, resistance thermometer, thermocouples, bourden tube, LVDT, strain gauge and tacho-generator.

Practical

- To study V-I characteristics of p-n junction diode;
- To study half wave, full wave and bridge rectifier;
- To study transistor characteristics in CE configurations;
- To study about AND, NOT, and OR gates.
- To study a OP-AMP IC 741 as inverting and noninverting amplifier;
- To study a OP-AMP IC 741 as differentiator amplifier;
- To study a differential amplifier using two transistor;
- To study a OP-AMP IC 741 as differential amplifier;
- To study a OP-AMP IC 741 as a comparator;
- To familiarize with various types of transducers.

Textbook:

- Principles of Electronics – V.K. Mehta - S.Chand.
- Applied Electronics – R. S. Sendha, S.Chand.
- Basic Electronics – B. L. Thareja, S.Chand.

Building Construction and Cost Estimation 2(2+0)

UNIT-I Building Materials: Rocks, Stones, Bricks Properties and varieties of Tiles, Lime, Cement, Concrete, Sand. Glass, Rubber, Plastics, iron, Steel, Aluminum, Copper, Nickle. Timber.

UNIT-II Building components: Lintels, Arches, stair cases, Different types of floors, Finishing: Damp Proofing and water proofing, Plastering, pointing, white washing and distempering – Painting,

UNIT-III Building design, Design procedures, Technology, building construction, Types of agricultural buildings and related needs, application of design theory and practice to the conservation, sloped and flat roof buildings,

UNIT-IV Construction economics: Preliminary estimates, Detailed Estimates of Buildings source of cost information, use of cost analyses for controlling design, Factors affecting building costs; cost evaluation of design and planning alternatives for building and estate development,

UNIT-V Measurement and pricing, Economic methods for evaluating investments in buildings and building systems: cost-in-use, benefit-to-costs and savings-to-investment ratios, rate of return, net benefits, payback

Suggested Reading

Punmia B.C. Ashok Kumar Jain and Arun Kumar Jain. Building Construction. Laxmi Publications (P) ltd., New Delhi.

Duggal S K. Building material. New Age International Publishers.

Sane Y.S. Planning and Designing of Buildings.

Rangwala S C. 1994. Engineering Materials. Charotar Publishing House, Anand.

Dutta B.N. 2000. Estimating and Costing. UBS publishers.

Auto CAD Applications 2 (0+2)

Practical

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

Suggested Reading

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

Tractor Systems and Controls 3(2+1)

Unit-I - 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.

Unit-II - 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.

Unit-III - 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.

Unit-IV - 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.

Unit-V- 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,
- Determination of Moment of Inertia of a tractor.
- Determination of Traction performance of a traction wheel.

Suggested Reading

Rodichev V and G Rodicheva. Tractors and Automobiles.

Singh Kirpal. Automobile Engineering – Vol I.

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

Unit-I - 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.

Unit-II - 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.

Unit-III - 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.

Unit-IV - 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.

Unit-V - Introduction to materials used in construction of farm machines. Heat treatment processes and their requirement in farm machines. Properties of materials used for critical and functional components of agricultural machines. Introduction to steels and alloys for agricultural application. Identification of heat treatment processes specially for the agricultural machinery components.

Practical

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

Suggested Reading

Kepner RA, Roy Barger & EL Barger. Principles of Farm Machinery.

Smith HP and LH Wilkey. Farm Machinery and Equipment.

Culpin Claude. Farm Machinery.

Srivastava AC. Elements of Farm Machinery.

Lal Radhey and AC Datta. Agricultural Engineering.

AGRICULTURAL STRUCTURES AND ENVIRONMENTAL CONTROL 3 (2+1)

Unit-I - Planning and layout of farm stead. Physiological reactions of livestock to solar radiation and other environmental factors, livestock production facilities, BIS. Standards for dairy, piggery, poultry and other farm structures.

Unit II

Design, construction and cost estimation of farm structures; animal shelters, compost pit, fodder silo, fencing and implement sheds, barn for cows, buffalo, poultry, etc.

UNIT III

Design and construction of rural grain storage system; Engineering for rural living and development, rural roads, their construction cost and repair and maintenance.

UNIT IV

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 its design, cost and maintenance, design of septic tank for small family. Estimation of power requirement for domestic and irrigation, source of power supply, use of alternate source of energy, electrification of rural housing.

UNIT V

Scope, importance and need for environmental control, renewable and non-renewable resources and their equitable use, concept of eco system, biodiversity of its conservation, environmental pollution and their control, solid waste management system, BOD and COD of food plant waste, primary and secondary treatment of food plant waste.

Practical:

- Instruments for measurements of environmental parameters.
- Environmental indices for your city.
- Harmonic analysis for sole-air temperature.
- Reflective and no reflective air space in buildings.
- Design and layout of a dairy farm.
- Design and layout of a poultry house.
- Design and layout of a sheep/goat house.
- Design of a biogas plant.
- Design of a farm fencing system.
- Design of ventilation system for dairy and poultry house.
- Design of a feed/fodder storage structures.
- Familiarization with local grain storage structures.
- Design of grain storage structures.
- Cost estimation of a farm building.

Suggested Reading

Pandey, P.H. Principles and practices of Agricultural Structures and Environmental Control, Kalyani Publishers, Ludhiana.

Ojha, T.P and Michael, A.M. Principles of Agricultural Engineering, Vol. I, Jain Brothers, Karol Bag, New Delhi.

Sahay, K.M. and Singh, K.K. Unit Operations of Agricultural Processing, Vikas publishing pvt. Ltd, Noida.

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

Unit-I - 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.

Unit-II - 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.

Unit-III - 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.

Unit-IV - Pulse Milling- 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.,

Mixing: Theory of mixing of solids and pastes, Mixing index, types of mixers for solids, liquid foods and pastes.

Unit-V - Material handling equipment. Types of conveyors: Belt, roller, chain and screw. Elevators: bucket, Cranes & hoists. Trucks (refrigerated/ unrefrigerated), Pneumatic conveying.

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,
- 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,
- Study of different types of conveying and elevating equipments,
- Study of different types of mixers.
- Study of different types of food extruders.
- Visit to grain processing industries.

Suggested Reading

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

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

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

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

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

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

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

Soil and Water Conservation Engineering 3(2+1)

Theory

Unit-I - 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.

Unit-II - 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.

Unit-III - 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.

Unit-IV - Gully and ravine reclamation - principles of gully control - vegetative measures, temporary structures and diversion drains. Grassed waterways and design.

Unit-V - 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 device.
- Determination of sediment concentration through oven dry method.
- Design and layout of contour bunds.
- Design and layout of graded bunds.
- Design and layout of broad base terraces.
- Design and layout of bench terraces.
- Design of vegetative waterways.
- Exercises on rate of sedimentation and storage loss in tanks.
- Computation of soil loss by wind erosion.
- Design of shelterbelts and wind breaks for wind erosion control.

- Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures.

Suggested Reading

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

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

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

Watershed Planning and Management 2(1+1)

Unit-I - Watershed - introduction and characteristics. Watershed development - problems and prospects, investigation, topographical survey, soil characteristics, vegetative cover, present land use practices and socio-economic factors.

Unit-II - 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.

Unit-III - 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.

Unit-IV - 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.

Unit-V - Watershed programme - execution, follow-up practices, maintenance, monitoring and evaluation. Participatory watershed management - role of watershed associations, user groups and self-help groups. Planning and formulation of project proposal for watershed management programme including cost-benefit analysis.

Practical

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

Suggested Reading

- Ghanshyam Das. 2008. Hydrology and Soil Conservation Engineering: Including Watershed Management. 2nd Edition, Prentice-Hall of India Learning Pvt. Ltd., New Delhi.
- Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service. New Delhi.
- 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.

Drainage Engineering 2(1+1)

Unit-I - 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;

Unit-II - 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;

Unit-III - Design of subsurface drainage system; drainage materials, drainage pipes, drain envelope; layout, construction and installation of drains;

Unit-IV - Drainage structures; vertical drainage; Bio-drainage; mole drains;

Salt balance, reclamation of saline and alkaline soils, leaching requirements,

Conjunctive use of fresh and saline water.

Practical

- *In-situ* measurement of hydraulic conductivity by single auger hole and inverse auger hole method;
- Estimation of drainage coefficients;
- Installation of piezometer and observation wells;
- Preparation of iso-bath and isobar maps;
- Determination of drainable porosity;
- Design of surface drainage systems;
- Design of gravel envelop;
- Design of subsurface drainage systems;
- Determination of chemical properties of soil and water;
- Study of drainage tiles and pipes;
- Installation of sub-surface drainage system;
- Cost analysis of surface and sub-surface drainage system.

Suggested Reading

Bhattacharya AK and Michael AM. 2013. Land Drainage, Principles , Methods and Applications. Vikas Publication House, Noida (UP)

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

Renewable Power Sources 3 (2+1)

Unit-I - Energy consumption pattern & energy resources in India. Renewable energy options, potential and utilization.

Unit-II - Biogas technology and mechanisms, generation of power from biogas, Power generation from urban, municipal and industrial waste.

Unit-III - Design & use of different commercial sized biogas plant. Solar thermal and photovoltaic Systems for power generation.

Unit-IV - Central receiver (Chimney) and distributed type solar power plant, OTEC, MHD, hydrogen and fuel cell technology.

Unit-V - 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 Reading

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.

Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.

Mathur A.N. & N.S. Rathore. Renewable Energy Sources Bohra Ganesh Publications, Udaipur.

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

Unit-I 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.

Unit-II Introduction to interculture equipment. Use of weeders – manual and powered. Study of functional requirements of weeders and main components. Familiarization of fertilizer application equipment.

Unit-III 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.

Unit-IV 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.

Unit-V Study of root crop diggers – principle of operation, blade adjustment and approach angle, and calculation of material handled. Study of potato and groundnut diggers. Study of Cotton harvesting – Cotton harvesting mechanisms, study of cotton pickers and strippers, functional components. Study of maize harvesting combines. Introduction to vegetables and fruit harvesting equipment and tools.

Practical

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

Suggested Reading

Kepner RA, Roy Barger & EL Barger. Principles of Farm Machinery.
Smith HP and LH Wilkey. Farm Machinery and Equipment.

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

Practical

- Familiarization with different makes and models of agricultural tractors.
- Identification of functional systems including fuels system, cooling system, transmission system, steering and hydraulic systems.
- Study of maintenance points to be checked before starting a tractor.
- Familiarization with controls on a tractor.
- Safety rules and precautions to be observed while driving a tractor.
- Driving practice of tractor.
- Practice of operating a tillage tool (mould-board plough/ disc plough) and their adjustment in the field. Study of field patterns while operating a tillage implement.
- Hitching & De-hitching of mounted and trail type implement to the tractor.
- Driving practice with a trail type trolley – forward and in reverse direction.
- Introduction to tractor maintenance – precautionary and break-down maintenance.
- 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 Reading

Ghosh RK and S Swan. Practical Agricultural Engineering.

Southorn N. Tractor operation and maintenance.

Jain SC and CR Rai. Farm Tractor Maintenance and Repair.

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

Unit-I 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),

Unit-II 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,

Unit-III Packaging of horticultural commodities, Packaging requirements (in terms of light transmittance, heat, moisture and gas proof, micro organisms, mechanical strength), Different types of packaging materials commonly used for raw and processed fruits and vegetables products, bulk and retail packages and packaging machines, handling and transportation of fruits and vegetables, Pack house technology, Minimal processing, Common methods of storage, Low temperature storage, evaporative cooled storage, Controlled atmospheric storage, Modified atmospheric packaging,

Unit-IV 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,

Unit-V Important parameters and equipment used for different unit operations, Post harvest management and equipment for spices and flowers, Quality control in Fruit and vegetable processing industry. Food supply chain.

Practical

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

Suggested Reading

Arthey, D. and Ashurst, P. R. 1966. Fruit Processing. Chapman and Hall, New York.

Pantastico, E.C.B. 1975. Postharvest physiology, handling and utilization of tropical and subtropical fruits and vegetables AVI Pub. Co., New Delhi.

Dairy and Food Engineering 3 (2+1)

Unit-I 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.

Unit-II 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..

Unit-III 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;

Unit-IV 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,

Unit-V 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 Reading

Ahmed, T. 1997. Dairy Plant Engineering and Management. 4th Ed. Kitab Mahal.

McCabe, W.L. and Smith, J. C. 1999. Unit Operations of Chemical Engineering. McGraw Hill.

Rao, D.G. Fundamentals of Food Engineering. PHI learning Pvt. Ltd. New Delhi.

Singh, R.P. & Heldman, D.R. 1993. Introduction to Food Engineering. Academic Press.

Toledo, R. T. 1997. Fundamentals of Food Process Engineering. CBS Publisher.

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

Unit-I 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.

Unit-II 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.

Unit-III 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.

Unit-IV 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.

Unit-V Chute spillway - description, components, energy dissipaters, design criteria of Saint Antony Falls (SAF) stilling basin and its limitations. Drop inlet spillway - description, functional use and design criteria.

Practical

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

Suggested Reading

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

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

Groundwater, Wells and Pumps 3 (2+1)

UNIT I

Occurrence and movement of ground water, aquifer and its types, classification of wells, steady and transient flow into partially, fully and non-penetrating and open wells,

UNIT II

Familiarization of various types of bore wells common in the state, design of open well, groundwater exploration techniques, methods of drilling of wells, percussion, rotary, reverse rotary, design of assembly and gravel pack, installation of well screen, completion and development of well,

UNIT III

Groundwater hydraulics-determination of aquifer parameters by different method such as Theis, Jacob and Chow's, The is recovery method, well interference, multiple well systems, surface and subsurface exploitation and estimation of ground water potential, quality of ground water, artificial groundwater recharge planning, modeling, ground water project formulation.

UNIT IV

Pumping Systems: Water lifting devices; different types of pumping machinery, classification of pumps, component parts of centrifugal pumps; pump selection, installation and trouble-shooting; design of centrifugal pumps,

UNIT v

Pump performance curves, effect of speed on head capacity, power capacity and efficiency curves, effect of change of impeller dimensions on performance characteristics; Hydraulic ram, propeller pumps, mixed flow pumps and their performance characteristics; priming, self priming devices, roto-dynamic pumps for special purposes such as 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;
- Drilling of a tube well;
- Measurement of water level and drawdown in pumped wells;
- Study of artificial ground water recharge structures

Reference Books

- ❖ Ground water Hydrology, By: H.M. Raghunath
- ❖ Wells and Pumps Engineering, By: S.D. Khepar and A.M. Michael
- ❖ Pump: Theory & Practices, By: V.K. Jain
- ❖ Irrigation Theory and Practicals, By: A.M. Michael
- ❖ Ground Water Engineering, By: D.K. Todd
- ❖ Assessment of Ground Water Resources, By: Karanth

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

Fermentation processes and its general requirements, An overview of aerobic and anaerobic fermentation processes and their industrial application. Heat transfer processes in anaerobic digestion systems, land fill gas technology and potential.

Biomass Production: Wastelands, classification and their use through energy plantation, selection of species, methods of field preparation and transplanting. Harvesting of biomass and coppicing characteristics.

Biomass preparation techniques for harnessing (size reduction, densification and drying). Thermo-chemical degradation. History of small gas producer engine system. Chemistry of gasification.

Gas producer – type, operating principle. Gasifier fuels, properties, preparation, conditioning of producer gas. Application, shaft power generation, thermal application and economics.

Trans-esterification for biodiesel production. A range of bio-hydrogen production routes. Environmental aspect of bio-energy, assessment of greenhouse gas mitigation potential.

Practical

- Study of anaerobic fermentation system for industrial application,
- Study of gasification for industrial process heat,
- Study of biodiesel production unit,
- Study of biomass densification technique (briquetting, pelletization, and cubing),
- Integral bio energy system for industrial application,
- Study of bio energy efficiency in industry and commercial buildings,
- Study and demonstration of energy efficiency in building,
- Measuring efficiency of different insulation technique,
- Study of Brayton, Striling and Rankine cycles,
- Study of modern greenhouse technologies.

Suggested Reading

British BioGen. 1997, Anaerobic digestion of farm and food processing practices- Good practice guidelines, London, available on www.britishbiogen.co.UK.

Butler, S. 2005. Renewable Energy Academy: Training wood energy professionals.

Centre for biomass energy. 1998. Straw for energy production; Technology- Environment- Ecology. Available: www.ens.dk.

Computer Programming and Data Structure 3 (1+2)

UNIT-I Program, Programming languages. Types of programming languages. Overview of Compiler and Interpreter. Data types-Primary data types and user defined data types. Variables type casting. Operators. Managing input and output. Standard library functions.

UNIT-II Control Statements: Decision making statements-if, else if, switch. Looping statements for, while, do...while, branching statements-break, continue Functions: Built-in functions. User defined functions. Passing arguments to functions and returning values. Recursion. Scope and visibility of a variable. String functions.

UNIT-III Arrays: One and Two dimensional array. Pointers. Introduction, features, declaration, initialization. Structure and union.

UNIT-IV Data Structure: Definition of data structure, primitive operations on data structure. Types of data structure. Stack: Push and Pop operations. Infix, prefix and postfix expression. Conversion from infix to postfix. Queue: Definition, insertion and deletion operations in Queue.

UNIT-V Linked List: Static vs. dynamic data structure. Types of linked list. Insertion and deletion in linked list.

Practical

- Building an executable version of 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;

Suggested Text Books & References

- Balagurusamy, E. 1999. Programming in BASIC. BPB Publications, New Delhi.
- Balagurusamy, E. 1999. FORTRAN for Beginners. BPB Publications, New Delhi.
- Bedi, J.S. 1998. Computer and Microprocessor. Khanna Publishers, New Delhi.
- Singh, Sadhu, 1998. Computer Aided Design and Manufacturing. Khanna Publishers, New Delhi.

Elective Courses (Student will have to take minimum of 9 credits courses from the following Any 3 courses)		9 (6+3)
1	Floods and Control Measures	3(2+1)
2	Wasteland Development	3(2+1)
3	Information Technology for Land and Water Management	3(2+1)
4	Remote Sensing and GIS Applications	3(2+1)
5	Management of Canal Irrigation System	3(2+1)
6	Minor Irrigation and Command Area Development	3(2+1)
7	Precision Farming Techniques for Protected Cultivation	3(2+1)
8	Water Quality and Management Measures	3(2+1)
9	Landscape Irrigation Design and Management	3(2+1)
10	Plastic Applications in Agriculture	3(2+1)
11	Mechanics of Tillage and Traction	3(2+1)
12	Farm Machinery Design and Production	3(2+1)
13	Human Engineering and Safety	3(2+1)
14	Tractor Design and Testing	3(2+1)
15	Hydraulic Drives and Controls	3(2+1)
16	Precision Agriculture and System Management	3(2+1)
17	Food Quality and Control	3(2+1)
18	Food Plant Design and Management	3(2+1)
19	Food Packaging Technology	3(2+1)
20	Development of Processed Products	3(2+1)
21	Process Equipment Design	3(2+1)
22	Photovoltaic Technology and Systems	3(2+1)
23	Waste and By-products Utilization	3(2+1)
24	Artificial Intelligence	3(3+0)
25	Mechatronics	3(2+1)

ELECTIVE COURSES

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

Theory

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

Practical

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

Suggested Reading

- Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
- Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
- Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.
- Mutreja, K.N. 1990. Applied Hydrology. Tata McGraw-Hill Publishing Co., New York, Delhi.
- Subramanya, K. 2008. Engineering Hydrology. 3rd Edition, Tata McGraw-Hill Publishing Co., New Delhi.

2. Wasteland Development 3(2+1)

Theory

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

Practical

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

Suggested Reading

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

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

Theory

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

Practical

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

Suggested Reading

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

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

Theory

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

Practical

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

Suggested Reading

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

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

Theory

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

Practical

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

Suggested Reading

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

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

Theory

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

Practical

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

Suggested Reading

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

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

Theory

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

Practical

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

Suggested Reading

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

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

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

Theory

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

Practical

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

Suggested Reading

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

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

Theory

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

Practical

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

Suggested Reading

Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Publ. House New Delhi.

Singh Neeraj Partap. 2010. Landscape Irrigation and Floriculture Terminology, Bangalore.

Smith Stephen W. Landscape Irrigation and Management. Amazon. com.

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

Theory

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

Practical

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

Suggested Reading

- Brahma Singh, Balraj Singh, Naved Sabir and Murtaza Hasan. 2014. Advances in Protected Cultivation. New India Publishing Agency, New Delhi.
- Brown, R.P. 2004. Polymers in Agriculture and Horticulture. RAPRA Review Reports : Vol. 15, No. 2, RAPRA Technology Limited, U.K.
- Central Pollution Control Board. 2012. Material on Plastic Waste Management. Parivesh Bhawan, East Arjun Nagar, Delhi-110032.
- Charles A. Harper. 2006. Handbook of Plastics Technologies. The Complete Guide to Properties and Performance. McGraw-Hill, New Delhi.
- Dubois. 1978. Plastics in Agriculture. Applied Science Publishers Limited, Essex, England.
- Manas Chanda, Salil K. Roy. 2008. Plastics Fundamentals, Properties, and Testing. CRC Press.
- Ojha, T.P. and Michael, A.M., 2012, Principles of Agricultural Engineering - I. Jain Brothers, Karol Bagh, New Delhi.

11. 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 Reading

Vandenberg and Gill. Tillage and Traction.

Liljedahl JB and others. Tractor and Power Units.

Daniel Hill. Fundamentals of Soil Physics.

Terzaghi K & Peck Ralph B. Soil Mechanics in Engineering Practices.

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

Theory

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

Practical

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

Suggested Reading

Richey, C.B. Agricultural Engineering Handbook.

Adinath M and AB Gupta. Manufacturing Technology.

Sharma PC and DK Aggarwal. Machine Design.

Narula V. Manufacturing process.

Singh S. Mechanical Engineer's Handbook.

Chakrabarti NR. Data book for Machine Design.

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

Theory

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

Practical

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

Suggested Reading

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

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

Theory

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

Practical

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

Suggested Reading

Liljedahl J B & Others. Tractors and Their Power Units.

Raymond N, EA Yong and S Nicolas. Vehicle Traction Mechanics.

Maleev VL. Internal Combustion Engines.

Kirpal Singh. Automobile Engineering – Vol I and Vol II.

Richey C.B. Agricultural Engineering Handbook.

Mehta ML, SR Verma, SK Mishra, VK Sharma. Testing & Evaluation of Agricultural Machinery.

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

Theory

Hydraulic Basics: Pascal's Law, Flow, Energy, Work, and Power. Hydraulic Systems, Color Coding, Reservoirs, Strainers and Filters, Filtering Material and Elements. Accumulators, Pressure Gauges and Volume Meters, Hydraulic Circuit, Fittings and Connectors. Pumps, Pump Classifications, operation, performance, Displacement, Design 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, colour codes and circuits. Building simple hydraulic circuits, hydraulics in tractors. Introduction to pneumatics, pneumatics devices, pneumatics in agriculture; Use of hydraulics and pneumatics for robotics.

Suggested Reading

Kepner RA, Roy Barger & EL Barger. Principles of Farm Machinery.

Anthony E. Fluid Power and Applications.

Majumdar. Oil Hydraulic System.

Merit. Hydraulic Control Systems.

John Deere. Fundamentals of Service Hydraulics.

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

Theory

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

Practical

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

Suggested Reading

Kuhar J E. The Precision Farming Guide for Agriculturist.

Dutta SK. Soil Conservation and land management.

Sigma and Jagmohan. Earth Moving Machinery.

Wood and Stuart. Earth Moving Machinery.

DeMess MN. Fundamentals of Geographic Information System.

Hunt Donnell. Farm Power and Machinery Management.

Sharma DN and S Mukesh. Farm Power and Machinery Management Vol I.

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

Theory

Basics of Food Science and Food Analysis, Concept, objectives and need of food quality. Measurement of colour, flavour, consistency, viscosity, texture and their relationship with food quality and composition. Sampling; purpose, sampling techniques, sampling procedures for liquid, powdered and granular materials, Quality control, Quality control tools, Statistical quality control, Sensory evaluation methods, panel selection methods, Interpretation of sensory results. Instrumental method for testing quality. Food adulteration and food safety. TQM and TQC, consumer preferences and acceptance, Food Safety Management Systems GAP, GHP, GMP, Hazards and HACCP (Hazard analysis and critical control point), Sanitation in food industry (SSOP), Food Laws and Regulations in India, FSSAI, Food grades and standards BIS, AGMARK, PFA, FPO, ISO 9000, 22000 Series. CAC (Codex Alimentarius 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, jellies, marmalades for FPO specification, Visit to quality control laboratory, Case study of statistical process control in food processing industry, Study of registration process and licensing procedure under FSSAI, Study of sampling techniques from food processing establishments, Visit to food processing laboratory and study of records and reports maintained by food processing laboratory.

Suggested Reading

Ranganna S. Hand book of Analysis and Quality Control for Fruit and Vegetable Products.

Srilakshmi B, Food Science.

Sharma Avanthi. A text book of Food Science and Technology.

Mudambi Sumati R, Rao Shalini M and Rajagopal M.V. Food Science.

Potter NN and Hotchkiss JH, Food Science.

Dev Raj, Rakesh Sharma and Joshi V.K, Quality for Value Addition in Food Processing.

The Food Safety and Standards Act along with Rules & Regulations. Commercial Law Publishers (India) Pvt. Ltd.

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

Theory

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

Practical

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

Suggested Reading

Hall, H.S. and Rosen, Y.S. Milk Plant Layout. FAO Publication, Rome.

López Antonio. Gómez. Food Plant Design.

Robberts Theunis C. Food plant engineering systems by, CRC Press, Washington.

Maroulis Z B and Saravacos G D. Food plant economics. Taylor and Francis, LLC

Mahajan M. Operations Research. Dhanpat Rai and Company Private Limited, Delhi

Maroulis Z B. Food Process Design. Marcel Dekker, Inc ,Cimarron Road, Monticello, New York 12701, USA.

19. Food Packaging Technology 3 (2+1)

Theory

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

Practical

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

Suggested Reading

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

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

Theory

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

Practical

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

Suggested Reading

Geankoplis C. J. Transport processes and unit operations, Prentice-Hall.

Rao, D. G. Fundamentals of Food Engineering PHI Learning Pvt. Ltd, New Delhi.

Norman N. Potter and Joseph H. Hotchikss. Food Science. Chapman and Hall Pub.

Acharya, K T Everyday Indian Processed foods. National Book Trust.

Mudambi Sumati R., Shalini M. Rao and M V Rajgopal. Food Science. New Age International Publishers.

Negi H.P.S., Savita Sharma, K. S. Sekhon. Hand book of Cereal technology. Kalyani Pub.

21. Process Equipment Design 3 (2+1)

Theory

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

Practical

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

Suggested Reading

Mahajani, V. V. and Umarji, S. B., Process equipment design, Macmillan.

Bhattacharyya, B. C., Introduction to Chemical Equipment design, CBS Publishers and Distributors.

Geankoplis C. J. Transport processes and unit operations, Prentice-Hall.

Rao, D. G. Fundamentals of Food Engineering PHI Learning Pvt. Ltd, New Delhi.

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

Theory

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

Practical

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

Suggested Reading

Rai GD. 1998. Non-conventional Sources of Energy. Khanna Pub.

Rathore N.S., Kurchania A.K., Panwar N.L. 2006. Renewable Energy: Theory & Practice, Himanshu Publications,.

Solanki C.S. 2011. Solar Photovoltaic: Fundamentals, Technologies and Applications, PHI Learning Private Ltd.

Meinel & Meinel. Applied Solar Energy.

Derrick, Francis and Bokalders, Solar Photo-voltaic Products.

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

Theory

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

Practical

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

Suggested Reading

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

24. Artificial Intelligence 3(3+0)

Theory

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

References

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

25. Mechatronics 3(2+1)

Theory

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

Practical

Selection of sensor for a particular application from Catalogue/Internet. Design a mechatronics product/system and incorporate application of mechatronics for enhancing product values. To study the hardware and software of mechatronics kit. To move a table in X-direction within the range of proximity sensors using Control-X software. To run a motor with PLC. To run a conveyor with computer. To study the movement of actuating cylinders and sensors.

Suggested Reading

Bolton, W. Mechatronics. Pearson Education Asia.

Wolfram, Stadler. Analytical Robotics and Mechatronics. Mc-Graw Hill.

Doebelin E.O. Measurement Systems. Mc-Graw Hill.

Mahind, A.P. Introduction to Digital Computer Electronics. TMH.

Niku, S.Y. Introduction to Robotics: Analysis, systems and applications”, Pearson Education Asia.

Craig, J.J. Introduction to Robotics. Pearson Education Asia.

List of Additional Cafeteria Courses

- Rural Transport, Water Supply and Sanitation
- Horticultural Engineering
- Aquaculture Engineering