BLUE BOOK
2016

Faculty of Agricultural Engineering & Technology

Professor Jayashankar Telangana State Agricultural University

Rajendranagar, Hyderabad - 500030

Detailed Lecture Out Lines - 2016

B.Tech. (Agricultural Engineering) Degree

1. Department wise list of courses, course numbers and credit hours

Sl. No.	Course Number	Title of the Course	Credit hours	Remarks
I. Farm Machinery and Power Engineering (FMPE)				
1	FMPE 111	Engineering Drawing	2(0+2)	Basic Engg.
2	FMPE 112	Theory of Machines	2(2+0)	Basic Engg.
3	FMPE 113	Workshop Technology and Practices	3(1+2)	Basic Engg.
4	FMPE 211	Machine Design	2(2+0)	Basic Engg.
5	FMPE 212	Auto CAD Applications	2(0+2)	Basic Engg.
6	FMPE 213	Tractor and Automotive Engines	3(2+1)	
7	FMPE 311	Farm Machinery and Equipment-I	3(2+1)	
8	FMPE 312	Tractor Systems and Controls	3(2+1)	
9	FMPE 313	Farm Machinery and Equipment-II	3(2+1)	
10	FMPE 314	Tractor and Farm Machinery Operation and Maintenance	2(0+2)	
		Total	**25(13+12)**	
II. Irrigation and Drainage Engineering (IRDE)				
1	IRDE 221	Fluid Mechanics and Open Channel Hydraulics	3(2+1)	Basic Engg.
2	IRDE 222	Irrigation Engineering	3(2+1)	
3	IRDE 223	Sprinkler and Micro Irrigation Systems	2(1+1)	
4	IRDE 321	Drainage Engineering	2(1+1)	
5	IRDE 322	Groundwater, Wells and Pumps	3(2+1)	
		Total	**13(8+5)**	

III. Processing and Food Engineering (PRFE)				
1	PRFE 231	Engineering Properties of Agricultural Produce	2(1+1)	
2	PRFE 232	Heat and Mass Transfer	2(2+0)	Basic Engg.
3	PRFE 233	Thermodynamics, Refrigeration and Air Conditioning	3(2+1)	Basic Engg.
4	PRFE 234	Post Harvest Engineering of Cereals, Pulses and Oil Seeds	3(2+1)	
5	PRFE 331	Agricultural Structures and Environmental Control	3(2+1)	
6	PRFE 332	Dairy and Food Engineering	3(2+1)	
7	PRFE 333	Post Harvest Engineering of Horticultural Crops	2(1+1)	
		Total	**18(12+6)**	

IV. Renewable Energy Engineering (RNEE)				
1	RNEE 241	Electrical Machines and Power Utilization	3(2+1)	Basic Engg.
2	RNEE 242	Fundamentals of Renewable Energy Sources	3(2+1)	
3	RNEE 341	Renewable Power Sources	3(2+1)	
4	RNEE 342	Bio-energy Systems: Design and Applications	3(2+1)	
		Total	**12(8+4)**	
V. Soil and Water Conservation Engineering (SWCE)				
1	SWCE 151	Engineering Mechanics	3(2+1)	Basic Engg.
2	SWCE 152	Surveying and Levelling	3(1+2)	Basic Engg.
3	SWCE 153	Soil Mechanics	2(1+1)	Basic Engg.
4	SWCE 154	Strength of Materials	2(1+1)	Basic Engg.
5	SWCE 251	Design of Structures	2(1+1)	Basic Engg.
6	SWCE 252	Building Construction and Cost Estimation	2(2+0)	Basic Engg.
7	SWCE 253	Watershed Hydrology	2(1+1)	
8	SWCE 351	Soil and Water Conservation Engineering	3(2+1)	
9	SWCE 352	Watershed Planning and Management	2(1+1)	
10	SWCE 353	Water Harvesting and Soil Conservation Structures	3(2+1)	
		Total	**24(14+10)**	

VI. Student Ready Programmes				
1	READY 261	Skill Development Training-I (Student READY) Registration only	5(0+5)	
2	READY 361	Skill Development Training-II (Student READY) Registration only	5(0+5)	
3	READY 461	10 weeks Industrial Attachment /Internship (Student READY)	10(0+10)	
4	READY 462	10 weeks Experiential Learning / Hands on Training (Student READY)	10(0+10)	
5	READY 463	Educational Tour (Registration only)	2 (0+2)	
6	READY 464	Project Work, Planning and Report Writing (Student READY)	10(0+10)	
		Total	**42(0+42)**	
VII. Applied Agriculture and Basic Sciences (AABS)				
1	AABS 101	Engineering Mathematics-I	3(2+1)	
2	AABS 102	Engineering Physics	3(2+1)	
3	AABS 103	Engineering Chemistry	3(2+1)	
4	AABS 104	Communication Skills and Personality Development	2(1+1)	
5	AABS 105	Principles of Soil Science	3(2+1)	
6	AABS 106	Engineering Mathematics-II	3(2+1)	
7	AABS 107	Environmental Science and Disaster Management	3(2+1)	
8	AABS 108	Principles of Agronomy	3(2+1)	
9	AABS 109	Web Designing and Internet Applications	2(1+1)	Basic Engg.
10	AABS 201	Computer Programming and Data Structures	3(1+2)	Basic Engg.
11	AABS 202	Engineering Mathematics-III	3(2+1)	
12	AABS 203	Principles of Horticultural Crops and Plant Protection	2(1+1)	
13	AABS 301	Applied Electronics and Instrumentation	3(2+1)	Basic Engg.
14	AABS 302	Entrepreneurship Development and Business Management	3(2+1)	
		Total	**39(24+15)**	

2. Semester wise course numbers, courses, and credit hours

Sl. No.	Course number	Course title	Credit hours	Remarks
I Semester				
1	AABS 101	Engineering Mathematics-I	3(2+1)	
2	AABS 102	Engineering Physics	3(2+1)	
3	AABS 103	Engineering Chemistry	3(2+1)	
4	AABS 104	Communication Skills and Personality Development	2(1+1)	
5	AABS 105	Principles of Soil Science	3(2+1)	

6	FMPE 111	Engineering Drawing	2(0+2)	
7	SWCE 151	Engineering Mechanics	3(2+1)	
8	SWCE 152	Surveying and Levelling	3(1+2)	
	COCA 100	NSS/NCC (Non-credit)	1(0+1) NC	
		Total	**22(12+10)**	
II Semester				
1	AABS 106	Engineering Mathematics-II	3(2+1)	
2	AABS 107	Environmental Science and Disaster Management	3(2+1)	
3	AABS 108	Principles of Agronomy	3(2+1)	
4	AABS 109	Web Designing and Internet Applications	2(1+1)	
5	FMPE 112	Theory of Machines	2(2+0)	
6	FMPE 113	Workshop Technology and Practices	3(1+2)	
7	SWCE 153	Soil Mechanics	2(1+1)	
8	SWCE 154	Strength of Materials	2(1+1)	
	COCA 200	Physical Education (Non-credit)	1(0+1) NC	
		Total	**20(12+8)**	
III Semester				
1	AABS 201	Computer Programming and Data Structures	3(1+2)	
2	FMPE 211	Machine Design	2(2+0)	
3	IRDE 221	Fluid Mechanics and Open Channel Hydraulics	3(2+1)	
4	IRDE 222	Irrigation Engineering	3(2+1)	
5	PRFE 231	Engineering Properties of Agricultural Produce	2(1+1)	
6	PRFE 232	Heat and Mass Transfer	2(2+0)	
7	PRFE 233	Thermodynamics, Refrigeration and Air Conditioning	3(2+1)	
8	RNEE 241	Electrical Machines and Power Utilization	3(2+1)	
9	SWCE 251	Design of Structures	2(1+1)	
	COCA 300	Yoga, Ethics and Moral Education (Non-credit)	1(0+1) NC	
		Total	**23(15+8)**	
IV Semester				
1	AABS 202	Engineering Mathematics-III	3(2+1)	
2	AABS 203	Principles of Horticultural Crops and Plant Protection	2(1+1)	
3	FMPE 212	Auto CAD Applications	2(0+2)	
4	FMPE 213	Tractor and Automotive Engines	3(2+1)	
5	IRDE 223	Sprinkler and Micro Irrigation Systems	2(1+1)	
6	PRFE 234	Post Harvest Engineering of Cereals, Pulses and Oil Seeds	3(2+1)	
7	RNEE 242	Fundamentals of Renewable Energy Sources	3(2+1)	
8	SWCE 252	Building Construction and Cost Estimation	2(2+0)	
9	SWCE 253	Watershed Hydrology	2(1+1)	
10	READY 261	Skill Development Training-I (Student READY) Registration only (one month)	5(0+5)	
		Total	**27(13+14)**	

V Semester				
1	AABS 301	Applied Electronics and Instrumentation	3(2+1)	
2	FMPE 311	Farm Machinery and Equipment-I	3(2+1)	
3	FMPE 312	Tractor Systems and Controls	3(2+1)	
4	IRDE 321	Drainage Engineering	2(1+1)	
5	PRFE 331	Agricultural Structures and Environmental Control	3(2+1)	
6	RNEE 341	Renewable Power Sources	3(2+1)	
7	SWCE 351	Soil and Water Conservation Engineering	3(2+1)	
8	SWCE 352	Watershed Planning and Management	2(1+1)	
		Total	**22(14+8)**	
VI Semester				
1	AABS 302	Entrepreneurship Development and Business Management	3(2+1)	
2	FMPE 313	Farm Machinery and Equipment-II	3(2+1)	
3	FMPE 314	Tractor and Farm Machinery Operation and Maintenance	2(0+2)	
4	IRDE 322	Groundwater, Wells and Pumps	3(2+1)	
5	PRFE 332	Dairy and Food Engineering	3(2+1)	
6	PRFE 333	Post Harvest Engineering of Horticultural Crops	2(1+1)	
7	RNEE 342	Bio-energy Systems: Design and Applications	3(2+1)	
8	SWCE 353	Water Harvesting and Soil Conservation Structures	3(2+1)	
9	READY 361	Skill Development Training-II (Student READY) Registration only (one month)	5(0+5)	
		Total	**27(13+14)**	
VII Semester				
1	READY 461	12 weeks Industrial Attachment /Internship (Student READY)	10(0+10)	
2	READY 462	12 weeks Experiential Learning / Hands on Training (Student READY)	10(0+10)	
3	READY 463	Educational Tour (Registration only)	2 (0+2)	
		Total	**22(0+22)**	
VIII Semester				
1	DEPT	Elective course	3(2+1)	
2	DEPT	Elective course	3(2+1)	
3	DEPT	Elective course	3(2+1)	
4	READY 464	Project Work, Planning and Report Writing (Student READY)	10(0+10)	
		Total	**19(6+13)**	
		Grand Total	**182(85+97)**	

Elective courses

Sl. No.	Course number	Course title	Credit hours
1	FMPE 411	Mechanics of Tillage and Traction	3 (2+1)
2	FMPE 412	Farm Machinery Design and Production	3 (2+1)
3	FMPE 413	Human Engineering and Safety	3 (2+1)
4	FMPE 414	Tractor Design and Testing	3 (2+1)
5	FMPE 415	Hydraulic Drives and Controls	3 (2+1)
6	FMPE 416	Precision Agriculture and System Management	3 (2+1)
7	FMPE 417	Artificial Intelligence	3 (3+0)
8	FMPE 418	Mechatronics	3 (2+1)
9	IRDE 421	Management of Canal Irrigation System	3 (2+1)
10	IRDE 422	Minor Irrigation and Command Area Development	3 (2+1)
11	IRDE 423	Precision Farming Techniques for Protected Cultivation	3 (2+1)
12	IRDE 424	Water Quality and Management Measures	3 (2+1)
13	IRDE 425	Landscape Irrigation Design and Management	3 (2+1)
14	IRDE 426	Plastic Applications in Agriculture	3 (2+1)
15	PRFE 431	Food Quality and Control	3 (2+1)
16	PRFE 432	Food Plant Design and Management	3 (2+1)
17	PRFE 433	Food Packaging Technology	3 (2+1)
18	PRFE 434	Development of Processed Products	3 (2+1)
19	PRFE 435	Process Equipment Design	3 (2+1)
20	RNEE 441	Photovoltaic Technology and Systems	3 (2+1)
21	RNEE 442	Waste and By-products Utilization	3 (2+1)
22	SWCE 451	Floods and Control Measures	3 (2+1)
23	SWCE 452	Wasteland Development	3 (2+1)
24	SWCE 453	Information Technology for Land and Water Management	3 (2+1)
25	SWCE 454	Remote Sensing and GIS Applications	3 (2+1)

AABS 101 **3 (2+1)**

ENGINEERING MATHEMATICS - I

Objective: To impart the knowledge on advanced aspects of engineering calculus and different Mathematical methods to enable the students for solving the engineering problems in the courses of agricultural, civil and mechanical engineering.

Lecture	Topic

Theory

1	Matrices - Elementary transformations - Introduction of Matrices, Types of Matrices, Singular and Non-Singular Matrices, Inverse of 2x2 Matrices, Row and Column Operations, Similar basic problems.
2	Rank of a matrix - Definition, properties, problems – Rank of matrices for square and rectangular matrices.
3	Reduction to Echelon form - Working rule to find rank of matrices by Echelon form, related lower and higher order matrices to find rank by reducing to Echelon form.
4	Reduction to Normal form - Working rule to find rank of matrices by Normal form, related lower and higher order matrices to find rank by reducing to Normal form.
5	Reduction to PAQ form - Working rule of a square matrix reduction into PAQ form - related problems.
6	Gauss-Jordon method to find inverse of a matrix - Working rule - related problems.
7	Solution of linear equations - Consistency and Inconsistency of system of linear equations. Related problems on finding the number of solutions for system of equations.
8	Eigen values and Eigen vectors – Introduction, properties on Eigen values and Eigen vectors – Related problems.
9	Cayley-Hamilton theorem to find positive and negative powers of A - Definition – Finding the inverse, positive and negative powers of matrices by Cayley - Hamilton Theorem.
10	Diagonalization of matrices by Linear transformation - Working rule of forming diagonal matrix. Examples on diagonal matrices of order 3x3.
11	Diagonalization of matrices by Orthogonal Transformation - Definition of Quadratic form - Properties and Examples.

12 Nature of rank, Quadratic forms - Working rule of conversion from Quadratic form to Canonical form with few examples. Define Nature of Rank of Quadratic form.

13 Differential calculus - Taylor's and Maclaurin's expansions - Explanation of Taylor's and Maclaurin's Theorem - Algebraic, Trigonometric and Lagorithmatic function's expansions.

14 Indeterminate forms - Various types of indeterminate forms, explanation of L-Hospital's Rule - Problems on indeterminate forms.

15 Problems on Curvature and Radius of Curvature of function - Length of Arc in Cartesian and polar coordinates. Examples on finding the Radius of curvature.

16 Function of two or more independent variables - Partial differentiation - Explanation on functions of several variables, definition of Partial Differentiation - examples.

17 Composite functions, total derivatives - Explanation of chain rule - Definition of total derivative - problems.

18 Homogeneous functions and Euler's theorem - Homogeneous functions - applications of Euler's theorem.

19 Problems on Maxima and Minima - Critical point, Saddle point – applications - Problems on finding of Maxima and Minima.

20 Integral calculus - Volumes and surfaces of revolution of curves - Problems on finding the area and volume of a surface revolution of Cartesian and Polar functions.

21 Double Integrals - Definition - Problems on double integration for Cartesian and Polar functions.

22 Triple Integrals - Definition - Problems on triple integration for Cartesian and Polar functions.

23 Change of order of Integration - Problems on changing the order of integration for two and three independent variables functions.

24 Application of double and triple integrals to find area and volume - Finding area and volume by using double and triple integrals for various agricultural applications.

25 Vector calculus - Differentiation of vectors, scalar and vector point functions - Introduction to vectors with some basic applications, Definition of differentiation of Vector functions.

26 Vector differential operators - Gradient of a scalar point function - Introducing various vector differential operators - problems on gradient of functions.

27 Divergence and Curl of a vector point function and their physical interpretations – Introducing Divergence and Curl of a vector point functions - problems on divergence and curl of functions.

28 Identities involving Del, grad, Curl, and Second order differential operators - Various types of Identities, derivations on second order differential operators.

29 Line integrals and their physical interpretations - Define the line integral - Problems on Line integrals and its applications.

30 Surface integrals and their physical interpretations – Definition of surface integral - Problems on surface integrals and its applications.

31 Volume integrals and their physical interpretations – Definition of volume integral - Various problems on volume integrals and its applications

32 Gauss divergence, Green's and Stoke's theorems (without proofs) - Explanation of Stoke's and Green's theorem.

Practical

1 Problems on Rank of a matrix, reduction to Normal form,

2 Problems on Consistency and solution of linear equations

3 Problems on Eigen values and Eigen vectors

4 Problems on Cayley-Hamilton theorem

5 Problems on Diagonalization of matrices

6 Problems on Quadratic forms

7 Problems on Taylor's and Maclaurin's expansion

8 Problems on Indeterminate form, curvature

9 Problems on Tracing of curves

10 Problems on Partial differentiation, maxima and minima

11 Problems on Volume and surface of revolution

12 Problems on Multiple integrals

13 Problems on Beta and Gama functions,

14 Problems on Differentiation of vectors, gradient, divergence and curl of a vector point

function

15 Problems on Line, surface and volume integrals

16 Problems on Stoke's divergence and Green's Theorems.

References

1 Advanced Engineering Mathematics (Updated version)-R.K .Jain & S.R.K Iyenger.

2 Differential Calculus by Shanti Narayan, 2015. S. Chand and Co. Ltd. New Delhi.

3 Integral Calculus by Shanti Narayan, 2015. S. Chand and Co. Ltd., New Delhi.

4 Vector Calculus by Shanti Narayan. 2015. S. Chand and Co. Ltd.
New Delhi.

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

AABS 102 **3 (2+1)**

ENGINEERING PHYSICS

Objective: To give insight to students about magnetism, semiconductors, optics and fundamentals of Nano Technology required for Agricultural Engineering studies related to equipment in its operation, maintenance, testing and controlling.

Lecture	Topic

Theory

1	Dia, Para and ferromagnetism – Classification of dia, para and ferromagnetic materials, their characteristics, orbital angular momentum.
2	Langevin theory of dia and paramagnetism - Derivation of Langevin's theory of diamagnetism.
3	Langevin theory of dia and paramagnetism - Derivation of Langevin's theory of paramagnetism.
4	Weiss molecular field theory and ferromagnetism - Theory and derivation of equation of Weiss molecular theory.
5	Adiabatic demagnetization - Description - Domain theory of ferromagnetism, Hysterisis loop, classification of ferromagnetic substances.
6	Curie-Weiss law - Theory and derivation of equation of Curie-Weiss law.
7	Wave particle duality, de-Broglie concept, uncertainty principle - Wave nature of matter, wave-particle duality, de-Broglie hypothesis, de-Broglie wavelength and its derivation, properties of matter waves.
8	Wave particle duality, de-Broglie concept, uncertainty principle - Expression of Wave velocity and group velocity and their relation, Heisenberg uncertainty principle.
9	Wave function, Time dependent and time independent Schrodinger wave equation - Derivation of equation of motion of matter waves (Schrodinger time dependent and independent equations), wave function, significance of wave function, normalization condition.
10	Wave function, Time dependent and time independent Schrodinger wave equation - Solution of particle in box problem, one dimensional potential box.

11 Spectroscopy - Qualitative explanation of Zeeman effect - Larmour's precession, qualitative explanation of Zeeman effect, classical theory of Zeeman effect and its related problems, Normal Zeeman effect and anomalous Zeeman effect

12 Qualitative explanation of Stark effect and Paschan Back effect - Stark effect, Paschan Back effect and related problems

13 Raman spectroscopy - Theory of Raleigh scattering, Raman effect, Quantum theory of Raman effect

14 Bands theory of solids - Free electron theory (Drude's model and Quantum free electron theory, Fermi-Derac distribution, Fermi level)

15 Bands theory of solids - Nearly free electron theory, density of states, origin of energy gap, Energy versus inter atomic distance

16 Statement of Bloch's function - Statement of Bloch's function, particle in periodic potential, K-P model, Brillouin Zone.

17 Distinction between metals, insulators and semiconductors - Band theory, classification of solids into metals, semiconductors and insulators. Introduction to semiconductors.

18 Velocity of Bloch's electron and effective mass - Velocity of Bloch's electron and effective mass of electron and hole, variation of E,v,m^* and f_k with k.

19 Intrinsic and extrinsic semiconductors - Direct and Indirect band gap semiconductors, Intrinsic and Extrinsic semiconductors.

20 Law of mass action, Donors and acceptor levels and determination of energy gap in semiconductors - Donor and accepter levels, law of mass action, determination of energy gap in semiconductors.

21 Superconductivity, critical magnetic field, Meissner effect, Isotope effect - Superconductivity, origin of superconductivity, BCS theory (qualitative explanation), critical magnetic field, Meissner effect, isotope effect, magnetic levitation

22 Type-I and II superconductors - Characteristics of Type-I and Type-II superconductors, Giant Magneto Resistance (GMR)

23 Josephson's effect DC and AC - Description - AC and DC Josephson's effects.

24 Introduction to high Tc superconductors, SQUIDS - High temperature super conductors, applications of superconductors and SQUIDS

25 Spontaneous and stimulated emission, Population inversion, Einstein A and B coefficients - Introduction to lasers and its characteristics, spontaneous and stimulated emission, meta-stable state, population inversion, Einstein A & B coefficients and their

relations

26 He-Ne and Ruby lasers - Optical cavity, Construction and working of He-Ne laser

27 He-Ne and Ruby lasers, Ammonia and Ruby masers, Holography-Note -Construction and working of Ruby, Introduction of MASERS, Ammonia and Ruby MASERS, Holography note

28 Optical fiber, Physical structure, basic theory - Optical fibers - principle, physical structure, acceptance angle, acceptance cone, numerical aperture and related problems

29 Mode type, input output characteristics of optical fiber and applications - Types of optical fibers, input and output characteristics of optical fiber and applications

30 Illumination - laws of illumination, luminous flux, luminous intensity, candle power, brightness - Study of Illumination, laws of illuminations, luminous flux, Luminous intensity, candle power, brightness

31 Nano Science &Technology - Introduction - types of nanomaterials and their properties

32 Nano Science &Technology - Synthesis of nanomaterials (top down and bottom up approach) and their characterization

Practical

1 To find the frequency of A.C. supply using an electrical vibrator

2 To find the low resistance using Carey Foster bridge without calibrating the bridge wire

3 To determine dielectric constant of material using De Sauty's bridge

4 To determine the value of specific charge (e/m) for electrons by helical method

5 To study the induced e.m.f. as a function of velocity of the magnet

6 To obtain hysteresis curve (B-H curve) on a C.R.O. and to determine related magnetic quantities

7 To study the variation of magnetic field with distance along the axis of a current carrying circular coil and to detuning the radius of the coil

8 To determine the energy band gap in a semiconductor using a p-n Junction diode

9 To determine the slit width from Fraunhofer diffraction pattern using laser beam

10 To find the numerical aperture of optical fiber

11	To set up the fiber optic analogue and digital link
12	To study the phase relationships in L.R. circuit
13	To study LCR circuit
14	To study the variations of thermo emf of a copper-constantan thermo-couple with temperature
15	To find the wave length of light by prism
16	Practical Exam

References

1. Brijlal and Subrahmanyam. Text Book of Optics. S. Chand and Co., New Delhi.
2. Sarkar Subir Kumar. Optical State Physics and Fiber Optics. S. Chand and Co., New Delhi.
3. Gupta S. L., Kumar V., Sharma R C., Elements of Spectroscopy. Pragati Prakasam, Meerut.
4. Saxena B. S., and Gupta R. C., Solid State Physics. Pragati Prakasam, Meerut.
5. Srivastava B. N. Essentials of Quantum Mechanics. Pragati Prakasam, Meerut
6. Vasudeva D. N., Fundamentals of Magnetism and Electricity. S. Chand and Co., New Delhi.
7. Rishabh Anand, 2014. Essentials of Nanotechnology. Medtec, 1st Edition.

AABS 103 **3(2+1)**

ENGINEERING CHEMISTRY

Objective: To study the chemical aspects of engineering materials and processes such as phase rule, ionization, corrosion, lubricants etc., this will give good insight to the students to go for engineering applications in agricultural engineering industries.

Lecture	**Topic**

Theory

1	Phase rule - Definition – Equation - explanation of the terms involved - degrees of freedom – ice to water to vapour system F=0. Water ←→water vapour F=1, pure gas F=2, mixture of gases F=3.
2	Phase rule – one component system- water and Sulphur system.
3	Phase rule - Two component system-mixture of gases-sodium chloride solution-decomposition of calcium carbonate, the silver lead system.
4	Fuels - Fuel and its classifications. Solid, Liquid and gaseous fuel. Characteristics and their uses.
5	Fuels - Calorific value, description of calorimetric value (HCV & LCV)
6	Colloids - Classification of colloidal Systems - solid foam, aerosol, emulsion, solid emulsion, smoke, sol.
7	Colloids – Properties of collides – Tindal effect, Brownian movement, Deflocculation, electro osmosis, electro phoresis, adsorption.
8	Colloids - Applications-blue colour of the sky, adsorption indicators, artificial kidney machine, foods, medicines, thixotropic paints, purification of municipal water, formation of delta. Comparison of Lyophilic and Lyophobic sols.
9	Corrosion - Causes for corrosion-nature of metal, nature of corroding environment.
10	Corrosion - Types of Corrosion- dry or chemical corrosion, wet or electro chemical corrosion.
11	Corrosion - Method of preventing Corrosion- Proper designing using pure metal, metal alloys - cathodic protection, anodic protection, modifying the environment, protective coatings.
12	Water - Temporary and permanent hardness, units of hard water, equivalents of calcium carbonate.

13 Water – disadvantages of hard water - washing, bathing, drinking, textile industry, sugar industry, dyeing industry, paper industry, laundry boiler corrosion.

14 Water - scale and sludge formation in boilers, disadvantages of sludge formation, prevention of sludge formation, disadvantages of scale formation, prevention of scale formation.

15 Thermo gravimetric - Analytical methods, trace analysis, ceramic yield, thermal stability, oxidation process, combustion.

16 Polarographic analysis - qualitative analysis, quantitative analysis

17 Nuclear Radiation - Definition, detectors - electrical detectors –ionization chamber, proportional counter, semiconductor detector, neutron detector, Geiger Muller conductor.

18 Nuclear Radiation - Optical detectors – photographic emulsion, expansion cloud chamber, diffusion cloud chamber, bubble chamber, spark chamber. Analytical applications of radioactive materials.

19 Enzymes - Definition, structure and manufacturing of enzymes,

20 Enzymes - Enzymes and their use in the manufacturing of ethanol by fermentation method.

21 Enzymes - Enzymes and their use in the manufacturing of acetic acid by fermentation method.

22 Principles of food chemistry – Lipids - component fatty acids, component glycerides, autoxidation, flavour revision, heated fats, phospholipids.

23 Principles of food chemistry - Proteins – protein structure, plant protein, animal protein, functional protein, chemical chain, denaturalisation.

24 Principles of food chemistry - carbohydrates – related compound, dietary fibres, polysaccharides, oligosaccharides.

25 Principles of food chemistry - vitamins – water soluble vitamins (B, C), fat soluble vitamins (A, D, E, K).

26 Lubricants - Functions of lubricants, mechanism of lubricants – fluid film lubrication, boundary lubrication, extreme pressure lubrication.

27 Lubricants - classification – liquid lubricants, semi-solid lubricants, solid lubricants.

28 Lubricants - selection of lubricant – lubricants of cutting tools, internal combustion, gears, delicate instruments, transformers, spindles in textile industry.

29 Lubricants - Properties of lubricating oils - viscosity, viscosity index, flash and fire points, cloud point and pour point, oiliness, emulsification, volatility, carbon residue, specific gravity, aniline point.

30 Polymers - polymers definition, types of polymerization, chain polymerization, step polymerization.

31 Polymers - plastics and resins, uses of plastics, classification of plastics – thermoplastic resins, thermosetting resins, properties, polyvinyl chloride.

32 Introduction to IR Spectroscopy – Introduction to IR and its applications, Effects of IR and Prevention of effects of IR spectroscopy.

Practical

1 Determination of temporary and permanent hardness of water by EDTA method.

2 Estimation of Chloride in water

3 Estimation of dissolved oxygen in water

4 Determination of BOD in water sample

5 Determination of COD in water sample

6 Estimation of available chlorine in bleaching powder

7 Determination of viscosity of oil.

8 Estimation of activity of water sample

9 Estimation of alkalinity of water sample

10 Determination of coagulation of water and chloride ion content

11 Determination of specific rotation of an optically active compound.

12 Determination of Xnax and verification of beer Lambert law

13 Determination of calorific value of fuel

14 Identification of functional groups (alcohol, aldehyde, ketones, carboxylic acid and amide) by IR

15 Chromatographic analysis: Determination of molar refraction of organic compounds.

16 Practical Exam

References

1 Jain P. L., and Jain M., 1994. Engineering Chemistry. Danpat Rai publishing company Pvt. Ltd., Delhi.

2 Bahl B. S., Arun Bahl and Tuli B. D., 2007. Essentials of Physical Chemistry, S.Chand and Co. Ltd., Delhi.

3 John M deMan, Principles of Food Chemistry. S.Chand and Co. Ltd., Delh.

AABS 104 **2(1+1)**

COMMUNICATION SKILLS AND PERSONALITY DEVELOPMENT

Objective: To develop comprehension and communication of students in English. By the end of the course the students will be able to

- Have a clear concept communication skills in English by using A.V. aids in spoken English
- Improve their reading skills
- Present the reports orally and participating debates and group discussions.

Lecture	Topic
Theory	
1	Process of communication – Communication skills – Importance of communication skills – Ways and means to acquire communication skills.
2	Structural and functional grammar – Tenses, voice, conversion of sentences – Agreement of subject with verb.
3	Reading comprehension - General and Technical articles – War minus shooting – comprehension and vocabulary.
4	The sporting spirit – Reading comprehensive and vocabulary.
5	A dilemma – Reading comprehensive and vocabulary.
6	Phonetics and Transcripts.
7	Stress and accent.
8	Structural and functional grammar – Tenses, voice and Agreement of subject with verb (Definition & Rules).
9	Process of communication, Verbal and Non-verbal communication.
10	Listening skills – Listening and note taking
11	Presentation skills individual and group presentation skills – Oral presentation skills, field diary, Lab record, Indexing, Foot note and Bibliographical procedures.
12	Précis writing and abstracting.

13 Letter writing and correspondence (explanation).

14 Report writing – Types of reports

15 Group Discussion – Importance of Presentations and Public Speaking.

16 Organizing Seminars, conferences and meetings.

Practical

1 Structural and functional grammar – Tenses, voice, Conversion of sentence – Agreement of subject with verb.

2 Process of communication – Communication skills – Importance of communication skills – Ways and means to acquire communication skills.

3 Listening skills – Listening of short stories – Talks listening comprehension.

4 Writing skills – Importance of grammar – Paragraph writing – Technical writing – Professional writings.

5 Presentation skills – Group presentation – Individual presentation – Exercises.

6 Writing field diary – Lab record – Indexing – Footnotes – Bibliographical references – Exercises.

7 Précis writing and abstracting – Summarizing – Exercises.

8 Letter writing – Business correspondence personal letters - Official letters etc.

9 Report writing – Lab reports – Investigation reports – Enquiry reports.

10 Group discussions – Exercises with various topics in the class room.

11 Seminar and meeting (Exercises)

12 Vocabulary - Biology, Synonyms – Antonyms – Homonyms.

13 Words after confused.

14 Interviews and kinds of interviews.

15 Style, diction.

16 Semester Final Practical Examinations.

References

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

6 Narayanaswamy V. R., 1979. Strengthen your writing. Orient Longman, New Delhi.

7 Sharma R. C. and Krishna Mohan. 1978. Business Correspondence. Tata Mc Graw Hill publishing Company, New Delhi.

AABS 105 **3(2+1)**

PRINCIPLES OF SOIL SCIENCE

Objective: To impart knowledge on soil genesis, soil forming processes, structure, soil organic matter, soil chemical properties, etc which give a comprehensive idea to students how to design implements in relation to soils and also how to treat the soils for soil health and structure improvements, soil conservation, irrigation and drainage applications.

Lecture	Topic

Theory

1	Nature and origin of soil and soil forming - Definition - Soil as a three phase four component system- branches of Soil science-Difference between surface and sub-surface soil
2	Rocks - Definition-classification-primary-secondary, essential-igneous sedimentary and metamorphic rocks
3	Rocks - Definition-classification-primary-secondary, essential-igneous sedimentary and metamorphic rocks
4	Minerals and their classification and composition - Definition-classification-primary-secondary, essential accessory, silicate minerals; quartz-feldspars-micas-pyroxenes-amphiboles secondary silicate; secondary minerals; P, Ca, Mg, S and micronutrient containing minerals-chemical formulae.
5	Minerals and their classification and composition - Definition-classification-primary-secondary, essential accessory, silicate minerals; quartz-feldspars-micas-pyroxenes-amphiboles secondary silicate; secondary minerals; P,Ca,Mg,S and micronutrient containing minerals-chemical formulae.
6	Weathering - Definition-types of weathering-physical weathering of rocks; agents of physical weathering-temperature, water, wind and glaciers
7	Chemical weathering - Solution-hydration-hydroysis-caronation-oxidation-reduction-biological weathering; role of plants and animals in weathering.
8	Soil formation - Soil forming factors-active and passive soil factors and their role in soil formation
9	Soil forming processes - Elluviation-illuviation-humification-calcification-laterization-podzolization-salinization-alkalization and gleization.
10	Soil forming processes - Elluviation-illuviation-humification-calcification-laterization-podzolization-salinization-alkalization and gleization.

11 Soil profile - Detailed description of theoretical soil profile

12 Soil taxonomy orders - New comprehensive system of soil classification (7^{th} approximation)-soil orders and their characteristics.

13 Important soil physical properties - Soil separates and their properties. Specific surface-soil texture-definition-textural classes-methods of determination of soil texture-importance of soil structure.

14 Soil particle distribution - Definition-classification based on type, class and grade-factors influencing formation of aggregates- importance and management of soil structure.

15 Soil inorganic colloids - Definition-general properties-inorganic and organic colloids-origin of change on colloids(positive & negative)

16 Ion exchange in soil and nutrient availability - Cation and anion exchange-factors influencing ion exchange capacity or soils-importance of ion exchange-calculation of base saturation and exchangeable acidity.

17 Soil organic matter - importance of organic matter-C:N ratio of organic matter and its importance

18 Soil fertility - Concepts of soil fertility and soil productivity-definitions and differences-Arnon's criteria of essentiality-essential and beneficial elements-factors influencing availability of nutrients.

19 Problem soils - Definition- Physical problems-soil depth-slope-soil crust-soil compaction-drainage submergence (formation-adverse effects-effect on soil properties and plant growth- management). Chemical problems-classification-acid, saline, saline sodic-sodic and calcareous soils- characteristics-nutrients availability in problem soils and their reclamation.

20 Problem soils - Definition- Physical problems-soil depth-slope-soil crust-soil compaction-drainage submergence (formation-adverse effects-effect on soil properties and plant growth- management). Chemical problems-classification-acid, saline, saline sodic-sodic and calcareous soils- characteristics-nutrients availability in problem soils and their reclamation.

21 Essential plants nutrients – their functions and deficiency symptoms in plants

22 Important inorganic fertilizers and their reactions in soils

23 Liquid fertilizers and their solubility and compatibility

24 Irrigation water - Quality of irrigation water- classification based on EC, SAR, RSC and Boron content-use of saline waters in agriculture.

25 Soil water movement - Saturated, unsaturated and vapour flows, laws governing water flow- Darcy's and Poiseuille's law. Infiltration; Factors- importance. Evaporation; Factors influencing evaporation-Ways to minimize it-soil much – organic mulch etc.

26 Soil air - Composition of soil air- processes of gaseous exchange-soil aeration indices- and their importance (oxygen content- PDR- aeration porosity-redox potential) – management

27 Soil temperature - influence of soil temperature on plant growth-factors influencing soil temperature- management of soil temperature. Soil colour; determination-importance.

28 Soil temperature - influence of soil temperature on plant growth-factors influencing soil temperature- management of soil temperature. Soil colour; determination-importance.

29 Soil biology - Soil flora and fauna- their characteristics-role of beneficial organisms-mineralization-immobilization-nitrogenfixation-nitrification-denitrification – solubilisation of phosphorus and sulphur.

30 Soil biology - Soil flora and fauna- their characteristics-role of beneficial organisms-mineralization-immobilization-nitrogenfixation-nitrification-denitrification – solubilisation of phosphorus and sulphur.

31 Important soil groups of India - Alluvial soils-black soils-red soils-laterite soils and coastal soils.

32 Bulk density and particle density - factors influencing and their importance - porosity types-calculation-importance.

Practical

1 Identification of rocks and minerals.

2 Examination of soil profile in the field.

3 Collection of Soil Sample.

4 Determination of bulk density.

5 Particle density and porosity of soil.

6 Determination of organic carbon of soil.

7 Determination of Nitrogen.

8	Determination of Phosphorus.
9	Determination of Potassium.
10	Identification of nutrient deficiency symptoms of crops in the field
11	Determination of gypsum requirement of sodic soils
12	Determination of water quality parameters.
13	Determination of pH and EC of soils.
14	Determination of infiltration rate of soil.
15	Determination of soil strength and soil colour.
16	Determination of Soil texture by Hydro meter method
17	Practical Exam

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2. Indian Society of Soil Science. 1998. Fundamentals of Soil Science. IARI, New Delhi.
3. Tisdale S l, Nelson W L, Beaton J D and Halvlin J L. 1995. Prentice-hall of India, New Delhi.
4. Hillell D. 1982. Introduction to Soil Physics. Academic Press, London
5. Sehgal J., A Textbook of Pedology Concepts and Applications. Kalyani Publishers, New Delhi

FMPE 111 **2(0+2)**

ENGINEERING DRAWING

Objective: To equip the students with knowledge and skills on visualization of buildings, objects, equipment, machines through drawings, plans, sectional views, isometric views and orthographic projections. To impart knowledge and skills to the students in computer aided designs involving graphics and machine drawing

Lecture	**Topic**
Practical	
1	Introduction of drawing - Introduction of drawing instruments & their uses, lettering.
2	Dimensioning – Different methods of dimensioning.
3	Introduction to Drawing scales - Plain scales & Diagonal scales.
4	First and third angle methods of projection - principles of orthographic projection - reference planes.
5	Points and lines in space and traces of lines and planes - Projection of points and lines - Parallel to both the planes, Perpendicular to one plane, Inclined to one plane.
6	Projection of lines - Lines inclined to both the planes, Projection of lines in space and traces of lines and planes,
7	Auxiliary planes and true shapes of oblique planes - Finding out true length and inclination of lines.
8	Projection of planes- Plane perpendicular to both the reference planes, Perpendicular to one plane & parallel to other planes.
9	Projection of planes - Inclined to both the planes.
10	Projections of solids- Change of position method, alteration of ground lines - Axis perpendicular to one plane and parallel to the other.
11	Projections of solids - Axis inclined to one plane and parallel to other.
12	Projection of solids - Axis inclined to both H.P & V.P.

13	Section of solids - Section plane parallel to one plane and perpendicular to the other, Section plane perpendicular to one plane and inclined to other
14	Section of solids - Section plane inclined to both the planes.
15	Interpenetration of solid surfaces – Interpenetration of Prism Vs Prism.
16	Interpenetration of Cylinders – – Interpenetration of Cylinders Vs Cylinder.
17	Development of Surfaces of geometrical solids - Methods of development, Development of lateral surfaces of right solids- Prisms and Cylinder
18	Development of Solids - Developments of lateral surfaces of Pyramids and Cone.
19	Orthographic projection – Conversion of Isometric Views to Orthographic Views of simple solids
20	Orthographic projection - Conversion of Isometric Views to Orthographic Views of simple solids
21	Orthographic projection - Conversion of Isometric Views to Orthographic Views of simple solids
22	Drawing of missing views- Orthographic Views of simple solids
23	Isometric projection of geometrical solids - Conversion of orthographic views to isometric views of simple solids
24	Isometric projection of geometrical solids - Conversion of orthographic views to isometric views of simple solids
25	Isometric projection of geometrical solids - Conversion of orthographic views to isometric views of simple solids
26	Preparation of working drawing from models and isometric views
27	Concept of sectioning - Revolved and oblique sections - sectional drawing of simple machine parts - Piston
28	Sectional drawings of machine components - Foot Step bearing & Knuckle joint
29	Types of rivet heads and riveted joints - Lap joint and Butt joint - Processes for producing leak proof joint.
30	Symbols for different types of welded joints - Weld Joints - Representation of weld symbols on drawing - Screw Threads & Its types - Nomenclature - thread profiles - multi start threads - left and right hand threads.
31	Square headed and hexagonal nuts and bolts - Drawing of different types of nuts

and bolts - Lock nuts, studs, foundation bolts, machine screws, Cap screws, wood screws.

32 Forms of screw threads - representation of threads - Conventional Representation of Threads - bolts – headed center - set screws, stud screws, butt, square and hexagonal - keys-types, taper, rank taper, hollow saddle etc

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2	Elementary Engineering Drawing	Bhatt N D 1995. Charotar Publishing House, Anand
3	Engineering Drawing	Narayana K L Kannaiah P and Venkata Reddy K 1996. New Age International Ltd., New Delhi.
4	Machine Drawing	Narayana K L and Kannaiah P. 2010. Scitech Publications (India) Pvt. Ltd., Chennai.

SWCE 151 **3 (2+1)**

ENGINEERING MECHANICS

Objective: To impart knowledge and training to students on the basic principles of physical and engineering mechanics of solid systems involving forces, moments, stresses and shear forces for application in designs of engineering structures.

Lecture	Topic
Theory	
1	Introduction, Divisions of Engineering Mechanics and Basic Units
2	System of Forces, Resultant for Composition of forces
3	Analytical method for resultant force, Parallelogram law of forces
4	Method of resolution for the resultant force
5	Moment of a force, Types of moments and law of moments
6	Levers, types of levers, simple and compound levers
7	Classification of parallel forces, analytical method for the resultant of parallel forces
8	Couple, moment of a couple, classification of couples
9	Couple, moment of a couple, classification of couples
10	Equilibrium of forces, analytical method for the equilibrium of coplanar forces, Conditions and types of equilibrium
11	Equilibrium of forces, analytical method for the equilibrium of coplanar forces, Conditions and types of equilibrium
12	Centre of gravity, centroid, methods for centre of gravity
13	Moment of inertia, moment of inertia of an area of plane figure w.r.t an axis in its plane
14	Moment of inertia, moment of inertia of an area of plane figure w.r.t an axis in its plane
15	Determination of moment of inertia of simple geometrical sections
16	Determination of moment of inertia of simple geometrical sections

17 Frictional forces, types, limits and laws of friction

18 Frictional forces, types, limits and laws of friction

19 Angle of friction, coefficient of friction

20 Types of loading, methods for the reactions of a beam, analytical and graphical methods

21 Types of loading, methods for the reactions of a beam, analytical and graphical methods

22 Types of loading, methods for the reactions of a beam, analytical and graphical methods

23 Simple stresses, drawing of shear force and bending moment diagrams for different types of beams under different loading conditions

24 Simple stresses, drawing of shear force and bending moment diagrams for different types of beams under different loading conditions

25 Simple stresses, drawing of shear force and bending moment diagrams for different types of beams under different loading conditions

26 Types of frames, simple stresses,

27 Analysis of simple framed structures using method of joints

28 Analysis of simple framed structures using method of sections

29 Analysis of simple framed structures using graphical method

30 Analysis of plane and complex stresses

31 Types of shafts and torque and strength relations in stationary and motion

32 Types of shafts and torque and strength relations in stationary and motion

Practical

1 Problems on Composition and resolution of forces, moments of a force, couples

2 Problems on transmission of a couple, resolution of a force into a force & a couple

3 Problems relating to resultant of a concurrent - coplanar force system

4 Problems relating to nonconcurrent - coplanar force system, nonconcurrent - noncoplaner force system,

5 Problems relating to parallel - noncoplaner force system, system of couples in space

6	Problems relating to centroids of composite areas
7	Problems on moment of inertia, polar moment of inertia, radius of gyration, polar radius of gyration of composite areas
8	Problems involving frictional forces
9	Analysis of simple trusses by method of joints and method of sections
10	Analysis of simple trusses by graphical method
11	Problems relating to simple stresses and strains
12	Problems on shear force and bending moment diagrams
13	Problems relating to stresses in beams
14	Problems on torsion of shafts
15	Analysis of plane and complex stresses.
16	Practical Examination

References

1	Engineering Mechanics and Dynamics	Sundarajan V 2002. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
2	Engineering Mechanics	Timoshenko S and Young D H 2003. McGraw Hill Book Co., New Delhi
3	Applied Mechanics	Prasad I B 2004. Khanna Publishers, New Delhi
4	Applied Mechanics and Strength of materials	Prasad I B 2004. Khanna Publishers, New Delhi
5	A Text Book of Engineering Mechanics	Bansal R K 2005. Laxmi Publishers, New Delhi.
6	A Text Book of Engineering Mechanics	Khurmi, R . S. 2007. S. Chand & Company Limited, New Delhi.
7	Engineering Mechanics	Kumar, K. L 1998. Tata McGraw-Hill Publishing Company Limited, New Delhi

SWCE 152 **3 (1+2)**

SURVEYING AND LEVELING

Objective: To enable the students to acquire skills in the measurement of land, preparation of plans and maps and find out their areas (regular or irregular) either for civil engineering or Agricultural Engineering related works, in general, and land and water management works in particular by various methods and instruments (chains, tapes, compasses, plane table etc.) available commercially. Further to enable the students to take and calculate the reduced levels with the help of various leveling instruments and prepare contour maps and further estimate the cuts and fill quantities while land leveling or grading work is taken up in any agricultural field namely plane, profile, contour adjustment, plan inspection by evaluating the natural downfield and cross slopes and designing a formation slope based on the land use capability, ultimately estimating the cuts and fills earthwork required to take up the work. Further to enable the students learn theodolite traversing, electronic theodolite traversing and handling total station.

Lecture	Topic

Theory

1 Introduction of Surveying, definition, Units of measurement-Basic units of length, area and volume, objectives of Surveying, classification of Surveying,

2 Uses of surveys and Principles of surveying- difference between a plan and map, precision in surveying- work of the surveyor. Measurement of distance-Linear Measurements-Direct Measurement-Chains and their constructional details-Chain types

3 Measuring tapes-Instruments for chain survey. Instruments for marking stations-Instruments used for ranging. Direct Ranging-Indirect Ranging-Reciprocal ranging, Folding and unfolding of chain

4 Chain surveying-Triangulation-basic definitions-Base line, check line and tie line-field work in chain surveying-Method of booking field notes-offsets-layout of offsets

5 Method of chaining- Errors in measurements -Chain and tape corrections- -problems on correction of distance and areas

6 Cross Staff survey-types of cross staffs-French cross staff, Optical square etc.-computation of areas by planimeter

7 Compass Survey-Introduction-types of traversing –Meridians-True meridian,

Magnetic Meridian, Arbitrary Meridan. Description of prismatic and Surveyor's compass-method of declination – concept of local attraction

8 Bearings-types- designation of bearings –fore and back bearings, Examples on bearings-Included angles-Examples on computation of Included angles. Determination of true bearings from magnetic bearings

9 Plane table survey-basic definitions-setting of plane table-orientation-methods of plane tabling

10 Levelling-introduction-basic definitions-Methods of leveling. Classification of leveling-profile leveling-cross sectioning-curvature and refraction leveling-Instruments used in leveling - Levelling difficulties and errors in leveling

11 Temporary adjustments of dumpy level, Bench Marks-Booking the staff readings-Methods of calculating reduced level-Height of collimation and Rise and Fall methods

12 Contouring – characteristics and uses

of contour lines-contour drawing - Computation of area and volume

13 Theodolite traversing – components of the theodolite – types - temporary adjustments in theodolite

14 Introduction to setting of curves- horizontal curves- vertical curves- need for providing curves- classification of curves- degree of circular curve – stationing - layout of a curve by the incremental chord method- layout of a curve by the total chord method

15 Total station- Operations of Total Station – use of total station – advantages**,** Electronic Theodolite difference between total station and theodolite

16 Introduction to GPS survey- The Fundamental Components of GPS – errors in GPS

Practical

1 Measurement of distances by pacing method

2 Acquaintance with the survey instruments

3 Folding, unfolding of the chain and ranging a chain line

4 Chain triangulation survey

5 Plotting of chain triangulation

6	Cross staff survey
7	Plotting of cross staff survey
8	Study of prismatic compass and surveyor compass and accessories
9	Compass survey by intersection method and plotting
10	Plotting of compass survey by intersection method
11	Compass survey by traverse method and plotting
12	A tutorial class on problems on bearings
13	Plane table survey by radiation and plotting
14	Acquaintance with leveling equipment
15	Temporary adjustments for a leveling instrument
16	Tutorial class on reduction of levels
17	Simple leveling
18	Profile leveling
19	Differential levelling
20	Contour survey by grid method
21	Plotting of contour map
22	Computation of areas of irregular figure – Trapezoidal rule - Simpson's rule and volumes of irregular solids- Trapezoidal rule - Prismoidal rule
23	Introduction of software in drawing contour
24	Study of Theodolite and temporary adjustments
25	Measurement of horizontal angles by repetition method
26	Measurement of horizontal angles by reiteration method
27	Measurement of vertical angles/ Height of object and deflection angles
28	Traversing by included angles
29	Setting out curves by Theodolite
30	Detailed study of components total station
31	Total station survey of an area

32	Practical examination	

References

1	Surveying (Vol.I & Vol.II)	Punmia,B C 1987. Laxmi Publications, New Delhi
2	Surveyiong(Vol.I)	Arora K R 1990. Standard Book House, Delhi
3	Surveying and Levelling - I & II	Kanetkar T P 1993. Pune Vidyarthi Griha, Prakashan, Pune
4	Text book of Surveying	Venugopala Rao P. 2015, PHI Learning pvt (Ltd), Delhi
5	Advanced Surveying (Total station, GIS and Remote sensing)	Satheesh Gopi 2008, Dorling Kindersely (India) Pvt. Ltd, 482 FIE, Patparganj, Delhi- 110092. India.

AABS 106 **3(2+1)**

ENGINEERING MATHEMATICS - II

Objective: To impart knowledge of different types of differential equations and its applications in solving the engineering problems in the field of fluid mechanics, hydrology, drainage, heat and mass transforms and unit operations.

Lecture	Topic

Theory

1	Ordinary differential equations : Introduction to Formation of Differential Equations - Introduction - Formation of differential equation by eliminating arbitrary constants and arbitrary functions.
2	Exact differential equations and reducible to exact form - Introduction - Problems on solving the Exact Differential Equations.
3	Problems on reducible to exact form by various integrating factors - various Integrating factors. Problems on Non Exact differential equations.
4	Linear and Bernoulli's differential equations - Introduction- problems on solving the Linear & Bernoulli's Differential Equations.
5	Differential Equations of first order and higher degree- Introduction- Problems on solving various types of first order first degree.
6	Clairaut's form of differential equation of first order and first degree- Introduction- Problems on Clairaut's form of differential equations.
7	Methods of finding Complementary functions of higher order differential equations - Introduction- Solving various types of higher order problems.
8	Methods of finding Particular Integrals of higher order differential equations- Introduction- Methods of higher order problems.
9	Problems on various types for finding Particular Integrals of differential equations - Solving higher order problems.
10	Cauchy's and Legendre's linear equations - Introduction on Cauchy's and Legendre's linear equations-related problems.
11	Method of variation of parameters - Solving higher order problems by using variation of parameters.
12	Simultaneous linear differential equations with constant coefficients- Introduction - Solving simultaneous differential equation problems.

13 Series solution techniques -Legendre's differential equations- Introduction- Solving differential problems.

14 Series solution techniques - Bessel's differential equations - Problems on Bessel's differential equation.

15 Complex Analysis - Functions of a Complex variable- Introduction - Problems on basic Complex functions.

16 Limits and Continuity of Complex Functions- Introduction - Problems on limit & continuity of complex functions.

17 Analytic functions and problems- Problems on derivability of complex functions and Analytic functions.

18 Cauchy-Riemann equations, Harmonic functions- Introduction- Problems on satisfying C-R equations.

19 Fourier series - Infinite series and its convergence, Periodic functions - Introduction on Infinite series - Problems on convergence of Periodic functions.

20 Euler's formulae, Dirichlet's conditions for Expansion of Fourier series-Define Euler's formulae - Dirichlet's conditions - Problems on Fourier series.

21 Functions having arbitrary period, even and odd functions- Introduction - Problems on convergence of Periodic, even and odd functions.

22 Fourier series for function having period 2L- Introduction - Examples on convergence of functions having period 2L.

23 Fourier Sine and Cosine Series- Introduction - Examples on convergence of Sine and Cosine Series of functions.

24 Half range series, Harmonic analysis- Introduction - Examples on convergence of Half range series of functions.

25 Partial differential equations- formation of P.D.E by eliminating arbitrary constants- Introduction on functions of several variables - formation of Partial differential equations.

26 Formation of partial differential equations by eliminating arbitrary functions - Introduction – Problems on formation of partial differential equations.

27 Solutions of linear partial differential equations of first order – Working rule of Lagrange's linear equation of first order. Problems on finding the solutions of Linear Partial differential equations.

28 Higher order linear partial differential equations with constant coefficients- Working rule of Higher order linear equation. Problems on solving the Higher order linear Partial differential equations.

29 Solution of non-linear partial differential equations - Working rule of non- linear Partial differential equation- Problems on finding the solutions of non- Linear Partial differential equations.

30 Solution of non-linear Partial differential equations by Charpit's method - Introduction- Problems on Linear Partial differential equations by using Charpit's method.

31 Application of Partial differential equations - Applications - Problems on finding the solution of Partial differential equations.

32 One dimensional wave and heat flow equations and Laplace Equation- Applications of partial differential equations like Wave, Heat and Laplace equations.

Practical

1 Problems on Homogeneous and Non homogeneous differential equations

2 Problems on Exact and Non exact differential equations

3 Problems on linear and Non -linear differential equations

4 Problems on solution of ordinary differential equations of first and higher orders

5 Problems on series solutions of differential equations.

6 Problems on Bessel's and Legendre's differential equations

7 Problems on convergence of infinite series

8 Problems on Fourier series of even and odd functions

9 Problems on Fourier Sine and Cosine Series

10 Problems on Cauchy-Riemann equations

11 Problems on Formation of partial differential equations

12 Problems on derivations of analytical functions

13 Problems on Lagrange's linear equations

14 Solutions of linear partial differential equations

15 Solutions of Non-linear partial differential equations

16 Application of partial differential equations

17 Practical Exam

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AABS 107 **3(2+1)**

ENVIRONMENTAL SCIENCE AND DISASTER MANAGEMENT

Objective: To impart knowledge on different environmental concerns and to create a pro-environmental attitude.

- Get knowledge on the importance of environmental studies
- Understand about the natural resources and their importance
- Acquaint with different types of pollution and their control measures and also on social issues and the environment Gain analytical skills in assessing the quality of water, air and soil

Lecture	Topic
Theory	
1	Definition – scope and importance of environmental studies – need for public awareness, people and institutions in environment
2	Natural resources – renewable and non-renewable resources -Natural resources and associated problems-forest resources –functions of forests – causes and consequences of deforestation- Timber extraction, mining, dams and their effects on forest and tribal people.
3	Water resources - Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems -Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
4	Food resources - World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity- case studies.
5	Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources- Case studies
6	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.
7	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.

8 Biodiversity – definition – types of biodiversity – bio-geographical classification in India – methods of measuring biodiversity – Biodiversity Act – functions of National Biodiversity Board.

9 Threats to biodiversity – habitat loss – poaching of wild life – man-wild life conflicts– conservation of biodiversity – *in situ* and *ex situ*.

10 Environmental pollution – causes, effects and control measures of air and water pollution – tolerable limits for toxic gases in air.

11 Causes, effects and control measures of soil pollution – bioremediation – tolerable limits for heavy metals in soil.

12 Causes, effects and control measures of thermal, marine and noise pollution.

13 Causes, effects and management of nuclear hazards, hazardous wastes, agricultural wastes and industrial wastes- Solid Waste Management: causes, effects and control measures of urban and industrial wastes- Role of an individual in prevention of pollution. Pollution case studies.

14 Social Issues and the Environment from Unsustainable to Sustainable development-Water conservation, rain water harvesting, watershed management. The Environment Protection Act – The Air (prevention and control of pollution) Act.

15 The Water (prevention and control of pollution) Act – The Wildlife Protection Act and Forest Conservation Act

16 Woman and child welfare – Human Immune-deficiency Virus (HIV) / Acquired Immunodeficiency Syndrome (AIDS) – role of information technology on environment and human health

17&18 Disaster management -Natural Disasters and nature of natural disasters, their types and effects

19&20 Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves

21 Climatic change - global warming, Sea level rise, ozone depletion

22 Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters.

23 Building fire, coal fire, forest fire, oil fire, air pollution.

24&25 Water pollution, deforestation, industrial waste water pollution, road accidents,

rail accidents, air accidents, sea accidents

26 Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction.

27&28 Concept of disaster management- national disaster management framework; financial arrangements

29&30 Disaster response-Role of NGOs, community-based organizations and media. Central, state, district and local administration;

31&32 Disaster response- Armed forces -Police and other organizations in disaster response

Practical

1 Collection, processing and storage of effluent samples.

2 Determination of chemical oxygen demand in waste water sample

3 Estimation of dissolved oxygen and BOD in waste water sample

4 Determination of total dissolved solids in waste water sample

5 Analysis of temporary hardness of waste water sample by titration

6 Analysis of total hardness of waste water sample by titration

7 Determination of sound level by using sound level meter-Noise pollution case study

8 Estimation of heavy metals in soil by Atomic Absorption Spectrophotometer(AAS)

9 Visit to local area to document environmental assets

10 Visit to local polluted site observations and remedial measures

11 Estimation of species abundance of plants

12 Visit to landfill site to study solid waste management approaches

13 Visit to a pond ecosystem

14 Case study on Disaster management (Floods/Cyclones)

15 Assessment of chlorophyll content in plants

16 Visit to *in-situ* or *ex-situ* conservation center/ Social Service Organization / Environmental Education Centre

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3 Manohara chari, C. and Jaya Ram Reddy 2004. *Principles of Environmental Studies*. B SPublication, Hyderabad.

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AABS 108 **3(2+1)**

PRINCIPLES OF AGRONOMY

Objective: To enable the students to understand the farming principles to grow agricultural field crops and all farming practices whose knowledge will help the students to understand the soil, crop and machine specific parameters for design and development of farm machinery equipment and implements, seed processing equipment and soil and water engineering activities for efficient water and land productivity.

Lecture	Topic
Theory	
1	Introduction and scope of agronomy– History of agricultural development in ancient India –Agriculture in civilization era.
2	Classification of crops:-classification of field crops- according to origin, botanical, commercial, economical, seasonal, ontogeny, agronomic, leaf morphology and special purpose crops.
3	Definition of climate and weather:-definition of meteorology, climatology, agril meteorology introduction, scope and practical utility of agricultural meteorology composition and structure of atmosphere.
4	Effect of different weather parameters on crop growth and development.
5	Crops seasons- *kharif, rabi* and summer seasons in Telangana –agro climatic zones of TS and India.
6	Principles of tillage, tilth and its characteristics-objective of tillage, characteristics of good seed bed, effect of tillage on soil properties (pore space, texture, structure, bulk density, and colour of the soil).
7	Types of tillage-preparatory cultivation, inter-cultivation, after cultivation and preparatory cultivation for low land rice puddling, implement used for seed bed preparation, sowing, inter-cultivation and special operation.
8	Methods, time and depth of sowing of major field crops
9	Methods and time of application of manures and fertilizers.
10	Organic farming-sustainable agriculture definition, principles and importance.
11	Basics on Soil water plant relationship

12 Crop coefficients, water requirement of crops and critical stages for irrigation

13 Weeds-influence of weeds on crop production principles and practices of weed management and their control.

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

15 Types of soil erosion:-factors influencing soil erosion – soil conservation-erosion preventive measures. Agronomic measures for soil and water conservation.

16 Dry land agriculture-problems of crop production in dry farming-agronomic measures in reducing evapo-transpiration losses.

17 Rice – introduction – origin – distribution – area, production and productivity in India and Telangana, puddling and reasons for low yield of rice in India.

18 Classification of rice – *Indicas*, *Japonicas* and *Javanicas*– important varieties and hybrids – latest varieties for special situations – rice growth and development – Raising of rice nurseries – wet, dry, dapog and modified dapog nurseries – rice, growing seasons in Telangana and India – seed rate, seed treatment and spacing.

19 Different rice growing methods– manures and fertilizers – N, P, K, zinc, iron and bio-fertilizers – integrated nutrient management – steps for increasing fertilizer use efficiency in rice– irrigation water management – water requirement – critical stages – water use efficiency – methods of irrigation.

20 Maize – introduction – origin – distribution – area, production and productivity in India and Telangana by-products and economic importance –different types and varieties of maize – adaptation and climate.

21 Maize – soils – land preparation – seasons – seeds and sowing – zero tillage practice in rice fallows – manures and fertilizers – irrigation – weed control – harvesting –threshing and processing – yield attributes and yield – cropping systems.

22 Sorghum – introduction – origin – distribution – area, production and productivity in India and Telangana – adaptations – varieties – soils – land preparation – sorghum growing zones and seasons in Telangana.

23 Sorghum – seeds and sowing – manures and fertilizers – irrigation – weed control –yield attributes and yield – cropping systems.

24 Pearl millet – introduction – economic importance – origin – distribution – area, production and productivity in India and Telangana – adaptations – soils –varieties – land preparation – seasons – seeds and sowing – management of over aged seedlings – manures and fertilizers – irrigation and cropping systems – weed

control – harvesting – threshing and processing – yield attributes and yield.

25 Finger millet – introduction – economic importance – origin – distribution – area, production and productivity in India and Telangana – adaptations – soils –varieties – land preparation – seasons – seeds and sowing – manures and fertilizers irrigation – weed control – harvesting – threshing and processing – yield attributes and yield – cropping systems.

26 Pulses – importance of pulses in Indian agriculture – area, production and productivity of pulses in general in India. Red gram – area, production and varietal improvement – origin – distribution – soils –climate – seasons – seeds and sowing – manures, fertilizers and bio-fertilizers –irrigation – weed control – harvesting – threshing and processing – yield attributes and yield – utility value – cropping systems.

27 Black gram – area, production and productivity – soils – climate – varieties – production constraints – fertilizers and bio-fertilizers – harvesting – irrigation – threshing and processing – yield components and yield – cropping systems.– threshing and processing – yield components and yield – cropping systems. Green gram – area, production and productivity – soils – climate – varieties – production, constraints – fertilizers and bio-fertilizers – harvesting – irrigation.

28 Bengal gram – economic importance – area, production and productivity – soils – climate – varieties – manures, fertilizers and bio-fertilizers – irrigation – weed control– harvesting – threshing – threshing – processing and cropping systems.

29 Groundnut – soils – climate – influence of rainfall – temperature – light – land

preparation — seeds – seed treatment – seed rate – spacing – season – time and method of sowing-manures and fertilizers – nutrient removal – method of application – weed management – irrigation – critical stages – crop rotation and cropping systems – harvesting – harvest – yield attributes and yield

30 Soybean – origin – distribution – area, production and productivity in India and Andhra Pradesh – spread – habitat groups – varieties – crop rotation – cropping systems –soils – climate – tillage – seeds – seed treatment – seed rate – spacing – season –time and method of sowing – manures and fertilizers – NPK requirement – method of application – inter cultivation – weed management – irrigation – critical stages – crop rotation and cropping systems – harvesting – quality characters like oil quality.

31 Sugarcane – origin– planting material – setts – short crop – nursery crop – method of planting-three budded setts and bud chip method – trash mulching – wrapping and propping– manures and fertilizers – nutrient removal – method of application –weed management – irrigation – critical stages

32 Sunflower-Origin-Distribution

Practical

1 Identification of crops and their varieties.

2 Identification of seeds, manures, fertilizers and weeds.

3 Fertilizer application methods

4 Different weed control methods

5 Practice of ploughing

6 Practice of Puddling

7 Practice of sowing.

8 Seedbed preparation for nursery

9 Soil moisture estimation by direct method

10 Practice of fertilizer application

11 Practice of inter cultivation

12 Practice of weeding

13 Practice of harvesting

14 Field visit to show different methods of Irrigation to crops

Drip Irrigation, sprinkler Irrigation, Subsurface Irrigation

15 Study of meteorological instruments

16 Measurement of rainfall and evaporation and Visit to College farm.

Practical examination

References

1 William L Donn, 1965. Meteorology. McGraw –Hill Book

2 Arnon L. 1972. Crop Production in dry region. Leonard Hill Publishing Co. London.

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

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

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

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

AABS 109 **2(1+1)**

WEB DESIGNING AND INTERNET APPLICATIONS

Objective: To enable the students to understand the web based technologies and how to build applications using different ICT tools to create web sites and pages for the farming sector and Agriculture. Content can be developed to showcase farm technologies and value added farm produce to communicate with global world for making the Agriculture remunerative and attractive.

Lecture	Topic
Theory	
1	Overview - Basic principles in developing a web design.
2	Planning process - Information gathering, Planning, Design, Development, Testing, Delivery and Maintenance.
3	Five Golden rules of web designing - Define website goal - Highlight brand image - Identify target audience - Analyze competitors, websites - Evaluate and improve.
4	Designing navigation bar - Hierarchical Navigation Systems - Global Navigation Systems - Local Navigation Systems - Ad Hoc Navigation.
5	Page design- Typography, Minimalism/Flat Design, Responsive Design, Browser compatibility, Parallax Scrolling, Infinite Scrolling, CSS Animations, Ambient Video Backgrounds.
6	Home Page Layout- Introduction, Styling Page Sections, Page Sections (div), Spans of Text (span), CSS Context Selectors, The CSS Box Model, Finding Box Model Problems with Firebug, Floating Elements, Making Floating Elements Fit, Multi-column floating layouts, sizing and positioning, width and height.
7	Design Concept-Customizing, creating a basic web page, structuring content, adding formatted lists, changing text appearance, creating hypertext links, using images, using tables
8	Basics in Web Design- An introduction to domain names, web servers, and website hosting, registering your domain name
9	Brief history of Internet- Introduction, origins of the Internet, the initial Internetting concepts.

10	World Wide Web - Overview of WWW – Communication - Processes
11	Creation of a web site- subject descriptors
12	Web standards, audience requirement - Overview, introduction, web standards management, approaches to contents, design standards, technical considerations
13	Introduction to JavaScript - the script Tag, JavaScript versus ECMA Script versus Jscript. Defining functions in JavaScript – Event handlers - The document browser object
14	Variables & functions- JavaScript data types and variables, operators and statements, the JavaScript objects, functions, troubleshooting, debugging, and cross-browser issues, catching events, forms, form events, and validation, browser as Puzzle box, cookies and other client-side storage techniques, the DOM, or web page as Tree, dynamic Pages, creating custom JavaScript objects,
15	Working with alert, confirm and prompt- alert dialog box, confirmation dialog box, prompt dialog box.
16	Connectivity of web pages with databases – Project - JDBC ODBC concepts

Practical

1	FLASH - Animation concept FPS.
2	Understanding animation for web.
3	Understanding animation for web - Flash interface - working with tools.
4	DREAM WEAVER - Exploring Dreamweaver Interface - Planning & Setting Web Site Structure.
5	Working with panels - Understanding and switching views.
6	Using property inspector - Formatting text.
7	JAVA SCRIPT - Working with alert - confirm and prompt
8	Understanding - loop – arrays
9	Creating rollover image - Working with operator
10	GIF ANIMATION - Learning to use FTP - Setting FTP
11	Uploading of site - Using Control panel.

12 FTP Uploading Site - Understanding gif animation interface

13 Program to design basic web banners - Gif file format.

14 Procedure for Creating web banners with effects.

15 Creating animated web buttons.

16 Practical Exam.

References

1 Jennifer Niederst Robbins. Developing Web Design. Latest edition.

2 Frain and Ben. Responsive Web Design with HTML5.

3 Nicholas c. Zakas. Java Script for Web Developers.

4 George Q. Huang, K. L Mak. Internet Applications in Product Design and Manufacturing. ISBN:3540434658.

FAMP 112 **2 (2+0)**

THEORY OF MACHINES

Objective: To enable the students for acquiring the knowledge pertaining to mechanisms and systems like theory of machine, difference between machine and mechanism, planer mechanism, kinematics chain and pair, mechanisms, types of gears and acquiring knowledge of applications of belts, chains, gears and governors etc.

Lecture	Topic
Theory	
1	Introduction to Elements link Pair- Introduction To Theory of Machine, Introduction To Theory Of Machine, Difference Between Machine And Mechanism, Planer Mechanism, Link, Types of Links, Rigid Body
2	Kinematics Chain, and Pair-Types, Lower And Higher Pairs - Kinematic Pair or Pair, Classification of Pairs- Type of Contact Between Elements, Type of Relative Motion, Nature of Constraint or Type of Closure, Degree of Freedom, Kinematic Chain,
3	Mechanisms –Types And Inversions- Degree of Freedom in A Mechanism
4	Lower and higher pairs. - Type of Contact Between Elements- Lower Pairs, Higher Pair, Type of Relative Motion- Sliding Pair, Turning Pair, Screw Pair, Rolling Pair, Spherical Pair, Nature of Constraint or Type of Closure- Closed Pair, Open Pair
5	Four Bar Chain, Slider Crank Chain And Their Inversions- Four Bar Mechanism, Inversions Of Slider Crank Mechanism,
6	Determination of Velocity and Acceleration Using Graphical (relative velocity and acceleration) Method.- Motion of A Link, Four Bar Mechanism Analysis By Relative Velocity Method, Velocity of Rubbing at Pins, Slider Crank Mechanism Analysis By Relative Velocity Method, Acceleration Analysis
7	Instantaneous Centers-Lindring.- Instantaneous Centre of Rotation,
8	Types of gears- Law of Gearing- History of Gears, Gear Classification, Spur Gear, Helical Gear, Herringbone Gears, Rack and Pinion, Bevel Gear
9	Velocity of Sliding Between Two Teeth In Mesh - Gear Trains, Velocity Ratio, Types of Gear Trains,
10	Involute and Cycloidal Profile For Gear Teeth

11	Spur Gear, Nomenclature, Interference and Undercutting - Gear Terminology
12	Introduction To Helical, Spiral, Bevel and Worm Gear
13	Introduction To Helical, Spiral, Bevel and Worm Gear
14	Simple, Compound, Reverted, and Epicyclic Train
15	Determining Velocity Ratio By Tabular Method –Procedure
16	Determining Velocity Ratio By Tabular Method – Procedure
17	Turning Moment Diagrams, Coefficient of Fluctuation of Speed and Energy
18	Turning Moment Diagrams, Coefficient of Fluctuation of Speed and Energy
19	Weight of Flywheel, Flywheel Applications
20	Weight of Flywheel, Flywheel Applications
21	Belt Drives, Types Of Drives - Belt, Ropes And Chain Drive- Types Of Belts- Flat, V- or Circular Cross-Section, Types of Flat Belt Drives- Open Belt Drives, Crossed or Twist Belt Drives, Quarter Turn Belt Drives, Compound Belt Drives
22	Belt Materials, Length Of Belt, Power Transmitted,- Slip Of Belt Drives, Length Of Open Belt Drive, Ratio Between Belt Tensions, Power Transmitted By Belt Drive, Tension In The Belts
23	Velocity ratio, Belt Size For Flat And V Belts- V-Belt Drives
24	Effect of Centrifugal Tension, Creep and Slip on Power Transmission, Chain Drives.- Chain Drives,
25	Types of friction, Laws of Dry Friction. Friction of Pivots and Collars.
26	Single Disc, Multiple Disc, and Cone Clutches.
27	Rolling friction, anti friction bearings.
28	Types of governors. Constructional details and Analysis Of Watt, Porter, Proell Governors.
29	Effect of friction, controlling force curves. Sensitiveness, Stability, Hunting, Iso-Chronism, Power And Effort Of A Governor
30	Effect of friction, Controlling Force Curves. Sensitiveness, Stability, Hunting, Iso-chronism, Power and Effort of a Governor
31	Static and Dynamic Balancing
32	Balancing of Rotating Masses In One and Different Planes

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2 Ballaney P L. 1985. Theory of Machines. Khanna Publishers, 2-B Nath Market, Nai Sarak, New Delhi.

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4 Lal Jagdish. 1991. Theory of Mechanisms and Machines. Metropolitan Book Co. Pvt.Ltd., 1 Netaji Subash Marg, New Delhi..

5 Rattan S B. 1993. Theory of Machines. Tata McGraw Hill Publishing Co. Ltd., 12/4 Asaf Ali Road, New Delhi.

6 Khurmi R S and Gupta J K. 1994. Theory of Machines. Eurasia Publishing House Pvt. Ltd., Ram Nagar, New Delhi.

FMPE 113 **3(1+2)**

WORKSHOP TECHNOLOGY AND PRACTICES

Objective: To impart knowledge and skills to students in manufacturing processes of machines, tools and equipment and hands-on training on various aspects of machine shop for encouraging entrepreneur development for engineering enterprises in general and farm mechanization in particular

Lecture	Topic
Theory	
1	Introduction to various carpentry tools - Definition and Classification carpentry tools.
2	Marking & measuring tools - steel and wooden folding rule, tape, try square, divider etc; cutting & parting tools - hand saw, chisels, planes etc
3	Boring tools - Bradawl, Gimlet, Auger, Bits; striking tools - Hammer, Mallet; Holding tools - Bench, Bench vice, cramp etc; some miscellaneous tools - Rasp and file, scraper etc.
4	Carpentry processes - Marking, Sawing, planning, chiseling etc; joints - Halving joints, Mortise joints etc; types of wood and their characteristics
5	Introduction to smithy tools and Operation- smith's forge, Anvil & steps in smithy and forging operation
6	Introduction to welding-types of welding, Oxyacetylene gas welding –type of flames, Welding techniques and equipment
7	Principle of arc welding equipment and tools- AC or DC machine, Electrode, Electrode holder, cables etc
8	Casting processes- steps and tools used
9	Classification constructional details of lathe- parts and types of lathe
10	Main accessories, attachments, operations and tools used in centre lathes- centres, catch plates and carriers, chucks, face plates, angle plates, mandrels, and rests
11	Introduction to shaper and types of shapers: constructional details of standard shaper, working and holding devices shaper tools and main operations

12 Types of drilling machines, constructional details of pillar types and radial drilling machines radial drilling machines

13 Work holding and tools holding devices main operations - Drill vices, parallel bars, step blocks etc

14 Twist drills, drill angles and sizes types and classification: nomenclature of twist drill, series of drill size

15 Construction details and principle of operation of column and knee type universal milling machine

16 Plain milling cutter main operations on milling machine

Practical

1 Preparation of Cross half lap joint.

2 Preparation of T halving joint.

3 Preparation of Dovetail joint

4 Preparation of Mortise and Tenon joint

5 Jobs on bending shaping etc

6 Jobs on drawing punching riveting.

7 Jobs on drawing punching riveting.

8 Introduction to tools and measuring instruments for fitting.

9 Jobs on sawing filing and right angle fitting of MS flat.

10 Practical in more complex fitting job.

11 Operations of drilling, reaming, threading with tap and dies.

12 Introduction to tools and operations in sheet metal work

13 Making different types of sheet metal joints using G.I. sheets.

14 Making different types of sheet metal joints using G.I. sheets.

15 Introduction to welding equipment processes tools their use and precautions.

16 Jobs on ARC welding-lap joint, butt joint, T joint and corner joint in arc welding

17	Jobs on ARC welding-lap joint, butt joint, T joint and corner joint in arc welding
18	Jobs on ARC welding-lap joint, butt joint, T joint and corner joint in arc welding
19	Jobs on ARC welding-lap joint, butt joint, T joint and corner joint in arc welding
20	Gas welding practice lap butt and T joints
21	Introduction to metal casting equipment tools and their use
22	Mould making using one-piece pattern and two pieces pattern
23	Demonstration of mould making using sweep pattern and match plate patterns.
24	Introduction to machine ship machines and tools
25	Demonstration on process in machining and use of measuring instruments
26	Practical jobs on simple turning step turning
27	Practical job on taper turning drilling and threading
28	Operations on shaper and planer, changing to round .MS rod into square section on a shaper
29	Operations on shaper and planer, changing to round MS rod into square section on a shaper
30	Demonstration of important operations on a milling machine making a plot gear tooth forming and indexing
31	Demonstration of important operations on a milling machine making a plot gear tooth forming and indexing
32	Practical Exam

References

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2. Chapman WAJ. 1989. Workshop Technology (Part I and Part II). Arnold Publishers (India) Pvt. Ltd., AB/9 Safdarjung Enclave, New Delhi.
3. Raghuwamsi B S. 1996. (vol. I and II). A Course in Workshop Technology. Dhanpet Rai and Sons, 1682. Nai Darak, New Delhi.
4. Pakirappa and V.N Kumar. Workshop Technology. Radiant publishing house

SWCE 153 **2 (1+1)**

SOIL MECHANICS

Objective: Students will be trained on concepts and analysis of soil properties, stress conditions of loaded soil , consolidation and soil failure theories .The knowledge imparted will be used in higher level design considerations for constructions of soil and water conservation structures , irrigation and drainage structures

Lecture	Topic
Theory	
1	Introduction of soil mechanics, field of soil mechanics, phase diagram, physical and index properties of soil,
2	Classification of soils, effective and neutral stress
3	Elementary concept of Boussinesq and Wester guards analysis, new mark influence chart.
4	Seepage Analysis - Quick condition-two dimensional flow-Laplace equation, Velocity potential and stream function,
5	Flow net construction. Shear strength, Mohr stress circle,
6	Theoretical relationship between principle stress circle, theoretical relationship between principal stress, Mohr coulomb failure theory and effective stress principle.
7	Determination of shear parameters by direct shear test, triangle test & vane shear test.
8	Numerical exercise based on various types of tests.
9	Compaction, composition of soils standard and modified protector test, abbot compaction
10	Jodhpur mini compaction test, field compaction method and control.

11 Consolidation of soil - Consolidation of soils, one dimensional consolidation spring analogy

12 Terzaghi's theory, Laboratory consolidation test, calculation of void ratio and coefficient of volume change

13 Taylor's and Casagrande's method, determination of coefficient of consolidation.

14 Earth pressure - plastic equilibrium in soils, active and passive states

15 Rankine's theory of earth pressure, active and passive earth pressure for cohesive soils, simple numerical exercises.

16 Stability of slopes - introduction to stability analysis of infinite and finite slopes friction circle method, Taylor's stability number.

Practical

1 Determination of water content of soil.

2 Determination of specific gravity of soil

3 Determination of field density of soil by core cutter method,

4 Grain size analysis by sieving method (Dry sieve analysis)

5 Grain size analysis by hydro meter method

6 Determination of liquid limit of soil by Casagrande method

7 Determination of plastic limit

8 Determination of shrinkage limit.

9 Determination of coefficient of permeability by constant head method.

10 Determination of coefficient of permeability by variable head method.

11 Determination of compaction properties by standard proctor test.

12 Determination of shear parameters by direct shear test.

13 Determination of shear parameters by triaxial test.

14 Determination of unconfined compressive strength of soil.

15 Determination of consolidation properties of soil.

16 Practical examination

References

1	Soil Mechanics and Foundations	Punmia B C, Ashok Kumar Jain & Arun Kumar Jain – 16th edition 2005 - M/S Laxmi Publications(P)Ltd. 113, Golden House, Daryagani, New Delhi – 110002.
2	Basic and Applied Soil Mechanics	Ranjan Gopal and Rao A S R. 1993, Welley Easters Ltd., New Delhi.
3	Soil Engineering (Vol. I.)	Singh Alam. 1994, CBS Publishers and Distributions, Delhi.

SWCE 154 **2 (1+1)**

STRENGTH OF MATERIALS

Objective: The students will have acquired knowledge about the advanced aspects of engineering mechanics like tensile stress, compressive stresses, shear forces, bending moments in beams, columns, slabs, welded joints and trusses of engineering structures for applications in the designs of the structures

Lecture	Topic
Theory	
1	Introduction – Stresses, Tensile, Compressive and Shear- Strains, Units- Elastic Curve- Elastic Limit – Poisons Ratio. Elastic Constants- Young's Modulus (E), Bulk Modulus (K) and Shear Modulus (G) – Relation between them.
2	Stresses in uniformly tapered circular sections- Stresses in bars of composite sections. Thermal Stresses and Strains in simple bars and composite bars
3	Methods of finding out slopes & deflections of beams, Double integration method.
4	Slope and Deflection equations of a simply supported beam with a central point load, simply supported beam with eccentric point load.
5	Simply supported beam with a uniformly distributed load.
6	Columns and struts, Euler's column theory. Assumptions of Euler's column theory, Buckling load- derivations for buckling load of a column with one end fixed other free-with one end fixed and other hinged.
7	Expression for buckling load of a column with both ends hinged- with both ends fixed. Types of end conditions of columns; ends hinged, both ends fixed, one end fixed and other is hinged & one end fixed and other end is free.
8	Limitations of Euler's formula-Rankine's formula for columns
9	Design of riveted joints. Eccentric riveted connections. Riveted joints, types of joints- strength of a rivet and riveted joint-efficiency of a riveted joint.
10	Welded joints, types of welded joints- Strength of welded joints, technical terms.
11	Design of welded joints, eccentric welded joints.

12 Propped cantilever and beams – Fixed and continuous beams-Deflection and Slope equations

13 Dams, forces acting, stressed at the base width of dams

14 Stability of dams, design of base width of dams

15 Super position theorem- Claypeyron's theorem of three moments. Application of Clayperon's theorem of three moments.

16 Moment distribution methods- Analysis of statistically indeterminate beams

Practical

1 To perform the tension test on metal specimen M.S to observe stress – strain behavior, modulus of elasticity (E), ultimate stress, permissible stress, percent elongation etc., and to study its fracture

2 To perform the tension test on metal specimen C.I. to observe stress – strain behavior, modulus of elasticity (E), ultimate stress, permissible stress, percent elongation etc., and to study its fracture.

3 To perform compression test on concrete cylinders and cubes.

4 To perform compression test on CI, MS & wood material.

5 To perform the bending test on the specimens M.S & Wooden beam.

6 To perform the bending test on the specimens Plain concrete & R.C.C. beams.

7 To determine Young's modules E of beams with the help of deflection produced at centre due to loads placed at centre

8 To determine Young's modules 'E' of beams with the help of deflection produced at centre due to loads placed at quarter point

9 To study the behavior of materials (G.I. pipes, MS, CI) under torsion and to evaluate various elastic constants.

10 To study load deflection and other properties of closely coiled helical spring in tension and compression.

11 To perform the Rockwell, Vicker and Brinell's Hardness tests on the given specimens.

12 To perform the drop hammer test, Izod Test & Charpay's impact tests on the given specimens.

13	To determine compressive & tensile strength of cement after making cubes and briquettes; To measure workability of concrete (slump test, compaction factor test)
14	To determine voids ratio & bulk density of cement, fine aggregates and coarse aggregates; To determine the fatigue strength of a given specimen.
15	To write detail report emphasizing engineering importance of performing tension, compression, bending, torsion, impact and hardness tests on the materials.
16	Practical examination

References

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

AABS 201 **3 (1+2)**

COMPUTER PROGRAMMING AND DATA STRUCTURES

Objective To enable the students to apply computer programming techniques for finding analytical solutions to Agricultural Engineering problems by learning "C" programming and data structures and write the computer programs on their own by the end of course.

Lecture	**Topic**
Theory	
1	Introduction and historical background - brief description about the computer & its parts - processor - memory - secondary storage - display devices and other peripheral devices - basic computer organization - future trends
2	Introduction to high level languages - brief introduction to systems software - applications software and 'C' programming language.
3	Variable - variable definition - types of variables - fundamental attributes of variables - rules for declaring variables - typecasting.
4	Data types - define data type - defining data type using 'typedef' - integer (short/long) - character - float - double - enum data types.
5	Operators - explanation - assignment operators - arithmetic operator - increment operator (pre & post increments) - decrement operator (pre & post decrement) - relational operator - logical operator - bitwise operator.
6	Operators - conditional, '&', '|' and * (pointer) - comma, dot, arrow, [ ] and ( ) operators - building and evaluating expressions.
7	Standard library functions - input and output functions - standard library functions in C programming language - return values of printf() and scanf() - return type of getchar(), fgetc() and getc() - scansets in C - printing a string - puts() vs printf() - use of % in printf() - print % using printf() - differences between printf, sprintf and fprintf - differences between getc(), getchar(), getch() and getche()
8	Decision making & branching - if - if-else - nested if-else-else-if ladder - multiple conditions inside if - multiple statements in if block - introduction to switch statement - rules of using switch case - invalid ways of using switch case - conditional operator - :?: - jumping statements - goto statement - break statement.
9	Looping - for loop - introduction - flowchart - different ways of writing for

loop - nesting of the for loop - while loop - introduction - infinite while loop - do-while loop - differences - for loop vs while loop, for loop vs do-while loop and while loop vs do-while loop.

10 Standard library functions - managing input and output

11 Operations on files - concept of standard input and output files - formatting of data on input and output

12 Primary data types and user defined data types - variables - typecasting - operators - building and evaluating expressions

13 User defined functions - passing arguments and returning values - recursion - scope and visibility of a variable - string functions

14 Introduction to arrays - representation - operations on array elements

15 Structures - unions - pointers - overview - declaration

16 Data structures - stacks - push / pop operations - queues - insertion and deletion operations - linked lists

Practical

1 Familiarizing with Turbo 'C' IDE

2 Building an executable version of C program

3 Debugging a C program

4 Developing and executing simple programs

5 Developing and executing simple programs

6 Creating programs using decision making statements such as if, go to & switch.

7 Creating programs using decision making statements such as if, go to & switch

8 Developing program using loop statements while, do-while & for

9 Developing program using loop statements while, do-while & for

10 Using nested control structures

11 Using nested control structures

12 Familiarizing with one and two dimensional arrays

13	Writing C program with one and two dimensional arrays
14	Using string functions
15	Using string functions
16	Developing C programs with structure
17	Developing C programs with union
18	Creating programs with user defined functions
19	Creating programs with user defined functions
20	Using local, global & external variables
21	Writing programs for searching and sorting data
22	Writing programs using pointers
23	Writing programs using pointers
24	Writing programs for implementing stacks
25	Writing programs for implementing stacks
26	Implementing push/pop functions
27	Implementing queues
28	Developing linked lists in C language.
29	Developing linked lists in C language.
30	Performing insertion / deletion in data structures
31	Performing insertion / deletion in data structures
32	Practical examination

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FMPE 211 **2(2+0)**

MACHINE DESIGN

Objective To teach students how to apply the concepts of stress analysis, theories of failure and material science to analyze and design To illustrate to students the variety of mechanical components available and emphasize the need to continue learning. To teach students how to apply mechanical engineering design theory to identify and quantify machine elements in the design of commonly used mechanical systems.

Lecture	**Topic**
Theory	
1	Machine design - definition classification of machine design - general considerations in machine design - general procedure in machine design.
2	Fundamental units - mass and weight - inertia - laws of motion - force - moments of force - couple - mass density - torque - work - power and energy.
3	Fundamental units - mass and weight - inertia - laws of motion - force - moments of force - couple - mass density - torque - work - power and energy.
4	Common engineering materials and their mechanical properties.
5	Common engineering materials and their mechanical properties.
6	Types of loads and stresses - theories of failure - factor of safety - selection of allowable stress – stress concentration.
7	Types of loads and stresses - theories of failure - factor of safety - selection of allowable stress – stress concentration.
8	Elementary fatigue and creep aspects.
9	Cotter joints - knuckle joint - introduction - types of cotter joint - design of socket and spigot cotter joint.
10	Cotter joints - knuckle joint - introduction - types of cotter joint - design of socket and spigot cotter joint.
11	Pinned joints - turnbuckle.
12	Pinned joints - turnbuckle.
13	Design of welded joints subjected to static loads.
14	Design of threaded fasteners subjected to direct static loads - bolted joints

loaded in shear and bolted joints subjected to eccentric loading.

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

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

17 Design of shafts under torsion and combined bending and torsion.

18 Design of shafts under torsion and combined bending and torsion.

19 Design of shafts under torsion and combined bending and torsion.

20 Design of keys - design of muff, sleeve, and rigid flange couplings.

21 Design of keys - design of muff, sleeve, and rigid flange couplings.

22 Design of helical and leaf springs.

23 Design of helical and leaf springs.

24 Design of flat belt and V-belt drives and pulleys.

25 Design of flat belt and V-belt drives and pulleys.

26 Design of gears.

27 Design of gears.

28 Design of screw motion mechanisms like selection of anti-friction bearings. screw jack, lead screw, etc.

29 Design of screw motion mechanisms like selection of anti-friction bearings. screw jack, lead screw, etc.

30 Selection of anti-friction bearings.

31 Selection of anti-friction bearings.

32 Selection of anti-friction bearings.

Practical

References

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IRDE 221 **3 (2+1)**

FLUID MECHANICS AND OPEN CHANNEL HYDRAULICS

Objective To enable the students to design efficient water conveyance systems like canals, channels and pipes from places of origin to delivery points by acquiring knowledge on the principles of mechanics of fluids, water measurement and regulation and open channel hydraulic principles.

Lecture	**Topic**
Theory	
1	Properties of fluids - introduction - properties of fluids - mass density - specific weight - specific volume - specific gravity - viscosity - types of fluids.
2	Compressibility - surface tension - and capillarity.
3	Pressure and its measurement - fluid pressure at point - Pascal's law - absolute - gauge - atmospheric and vacuum pressure
4	Measurement of pressure - simple manometers - piezometer - U-tube manometer - single column manometer
5	Differential manometers - U-tube differential manometers - inverted U-tube differential manometer - mechanical gauges
6	Pressure forces on plane and curved surfaces - introduction - total pressure and center of pressure - vertical plane surface submerged in liquid
7	Horizontal plane surface submerged in liquid - inclined plane surface submerged in liquid
8	Curved surface sub-merged in liquid
9	Buoyancy and floatation - introduction - buoyancy - center of buoyancy - meta-centre.
10	Meta-centric height - analytical method for meta-centric height.
11	Conditions of floatation and stability of submerged and floating bodies.
12	Kinematics of fluid flow - introduction - methods of describing fluid motion - types of fluid flow - continuity equation - continuity equation in three-dimensions.
13	Description of the flow pattern - path lines - streak lines and stream lines - stream tube - rotational and irrotational flow and circulations and vorticity -

vortex motion - velocity potential - stream function – equi-potential lines and flow net.

14 Dynamics of flow - introduction - equations of motion - Euler's equation of motion - assumptions - Bernoulli's equation for real fluid

15 Venturimeter - practical applications of Bernoulli's equation - orifice meter - nozzle (pitot-tube) - siphon.

16 Laminar flow - introduction - relation between shear and pressure gradients in laminar flow - stress strain relationships - laminar flow between parallel plates - both plates at rest

17 Laminar flow between parallel plates - one plate moving and other at rest.

18 Turbulent flow - introduction - Reynolds experiment - frictional loss in pipe flow.

19 Shear stress in turbulent flow - velocity distribution in turbulent flow in pipes.

20 General equation of head loss - introduction - loss of energy in pipes - Darcy-Weisbach equation - Chezy's equation - Moody's diagram

21 Minor and major hydraulic losses through pipes and fittings - hydraulic gradient and energy line.

22 Flow through network of pipes - flow through pipes in series - flow through pipes in parallel - flow through branched pipes - power transmission through pipe - siphon.

23 Flow through notches, weirs - introduction - classification of notches and weirs - discharge over a rectangular notch or weir.

24 Discharge over a triangular notch or weir - discharge over a trapezoidal notch or weir

25 Discharge over a stepped notch - advantages of triangular notch or weir over rectangular notch or weir

26 Flow through orifices and mouth pieces - introduction - classification of orifices - classification of mouth piece - flow through an orifice - hydraulic coefficients - flow through an external cylindrical mouthpieces

27 Chezy's formula for loss of head in pipes - flow through simple and compound pipes

28 Open channel design and hydraulics - Chezy's formula - Bazin's formula

29 Kutter's Manning's formula - velocity and pressure profiles in open channels - hydraulic jump

30 Dimensional analysis and similitude - introduction - secondary or derived quantities - dimensional homogeneity - methods of dimensional analysis - Rayleigh's method

31 Buckingham's pi - theorem - types of similarities (similitude) - types of forces acting in moving fluid - dimensionless numbers

32 Introduction of fluid machinery - hydraulic accumulator - simple and differential types - hydraulic intensifier - hydraulic press - hydraulic crane - hydraulic lift - hydraulic ram air lift pump

Practical

1 Study of manometers

2 Study of pressure gauges

3 Verification of Bernoulli's theorem

4 Determination of coefficient of discharge of venturimeter

5 Determination of coefficient of discharge of orifice meter

6 Determination of coefficient of friction in pipeline

7 Determination of coefficient of discharge for rectangular and triangular notch

8 Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice

9 Determination of coefficient of discharge for mouth piece

10 Measurement of force exerted by water jets on flat and hemispherical vanes

11 Determination of meta-centric height

12 Determination of efficiency of hydraulic ram

13 Performance evaluation of Pelton and Francis turbine

14 Study of current meter

15 Velocity distribution in open channels and determination of Manning's coefficient of rugosity

16 Practical examination

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IRDE 222 **3 (2+1)**

IRRIGATION ENGINEERING

Objective To provide knowledge and exposure about various concepts of irrigation projects including efficiencies. Also, to enrich and acquaint the students in design of crop and irrigation water requirements, different surface irrigation methods, open channel, lined and unlined channels. By the end of the course, the students will be able to design any field with suitable irrigation systems.

Lecture	Topic
Theory	
1	Introduction - irrigation development and classification of irrigation projects - major, medium and minor irrigation schemes of India.
2	Environmental impact of irrigation projects - source of irrigation water - present status of development and utilization of different water resources of the country
3	Irrigation terminology - GCA - CCA - base period - crop period - delta - duty - relationship between duty and delta
4	Irrigation engineering - purpose of irrigation – advantages of irrigation
5	Measurement of irrigation water – units of measurements - methods of measurement - direct measurement of velocity by using the current meter - indirect methods - area – velocity method - ordinate method for measuring discharges from the pipes - dethridge meter and tracer method.
6	Direct measurement of discharges through the different devices such as weirs, flumes, orifices and other methods
7	Open channel water conveyance system- methods of conveyance of irrigation water.
8	Design capacity of open channel – velocity and discharge of flow in open channel - lining and un-lining of irrigation field channels.
9	Design capacity of open channel using Lacey’s and Kennedy’s theories and related problems.
10	On farm structures for water conveyance - structures to control erosion in irrigation channel- drop structure, pipe drop structure and chute spillways.
11	Water control - check gates, portable check gate, diversions and others

12 Lining canals - lining materials – cement concrete lining - bricks with sandwiched mortar lining - LDPE film

13 Underground pipe line water distribution system – types of pipes used for underground pipe lines- reinforced and non- reinforced concrete pipes - Testing of the pipe line and estimation of discharge capacity of pipelines

14 Design and installation of underground pipeline systems and common troubles of pipelines

15 Land grading - criteria for land leveling – soil profile condition - land slope - rainfall characteristics - cropping pattern - irrigation methods - and other conditions

16 Land leveling design methods- plane method and profile method

17 Land leveling design methods- plane inspection method and others

18 Estimation of earth work- end area method

19 Introduction to soil – water - plant relationship- soil physical properties such as soil texture, soil structure, capillary conductivity, soil consistency- volume- mass relationships of constituents.

20 Soil properties influencing the irrigation management - kinds of soil water - soil water movement- infiltration, accumulated infiltration rate – factors affecting the infiltration rate - measurement of infiltration in the field by using the curve fitting method.

21 Soil water potential - gravitational potential - pressure potential - matric potential - osmotic potential.

22 Soil moisture characteristics curve - soil moisture constants such as saturation capacity, field capacity, moisture equivalent and permanent wilting point - rooting characteristics - moisture use of crops.

23 Terminology related with the movement of water within soils - water intake, percolation, interflow, seepage, permeability, hydraulic conductivity and hydraulic gradient - measurement of soil moisture - gravimetric method, tensiometers, pressure membrane, pressure plate apparatus and others

24 Moisture movement under saturated conditions and unsaturated conditions of the soil - moisture stress and plant response

25 Evaporation - transpiration - concept of evapotranspiration (ET) - estimation of ET- Blaney- Criddle – Thornthwaite - Penman and modified

Penman and Penman- Monteith equations- potential ET

26 Water and irrigation requirement of crops-importance of water in plant growth - procedures for working out the net irrigation requirement (depth of irrigation), gross irrigation requirement and irrigation frequency

27 Irrigation efficiency- conveyance, application, storage, distribution and water use efficiency with related problems.

28 Surface methods of water application - classification - border, check basin and furrow irrigation methods - their advantages and disadvantages

29 Border irrigation – components of border irrigation- width, length and slope for different soils and adaptability - hydraulics of border irrigation

30 Design of border irrigation and derivation of Israelson's equation for the width of the border

31 Check basin irrigation – advantages and disadvantages - determination of infiltration under check basin conditions - adaptability and design consideration

32 Furrow irrigation system - advantages and disadvantages - estimation of infiltration depth in furrows by inflow and outflow method.

Practical

1 Measurement of soil moisture by different soil moisture measuring instruments

2 Measurement of irrigation water using weir, flume and orifice

3 Measurement of infiltration characteristics by using the double infiltrometer

4 Determination of bulk density, field capacity and wilting point and related problems

5 Measurement of evapotranspiration

6 Exercise on Land grading methods

7 Design of underground pipeline system

8 Problems on irrigation efficiencies

9 Study of advance, recession and computation of infiltration opportunity time

10 Design of border irrigation system

11	Design of furrow irrigation using inflow-outflow method
12	Evaluation of check basin irrigation method
13	Study on use of current meter and water meter
14	Visit to nearby water user associations
15	Visit to nearby the irrigation projects
16	Practical examination

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PRFE 231 **2(1+1)**

ENGINEERING PROPERTIES OF AGRICULTURAL PRODUCE

Objective To enable the students to understand the principles and concepts of various engineering properties of agricultural materials to design various processing equipment and Agricultural structures to ensure food quality and safety. They are the basis for measuring instruments and sensors.

Lecture	**Topic**
Theory	
1	Classification and importance of engineering properties of Agricultural Produce - Introduction - Engineering properties of food grains, fruits and vegetables useful in different unit operations - classification.
2	Engineering properties of agricultural produce based on shape, size, roundness, sphericity - definitions - methods of determination - equations - problem solving.
3	Engineering properties of agricultural produce based on volume, density, porosity - definitions - methods of determination - equations - problem solving
4	Engineering properties of agricultural produce based on specific gravity, surface area of grains - definitions - methods of determination - equations - problem solving
5	Engineering properties of agricultural produce based on specific gravity, surface area of fruits and vegetables - definitions - methods of determination - equations - problem solving
6	Thermal properties - heat capacity, specific heat, thermal conductivity - thermal diffusivity - heat of respiration - co-efficient of thermal expansion - definitions - methods of determination - equations - problem solving
7	Frictional properties - friction in agricultural materials - static friction - kinetic friction - rolling resistance - angle of internal friction - angle of repose - definitions - methods of determination - equations - problem solving
8	Flow of bulk granular materials - study of flow of bulk materials - types of flows in grain bins - gravity flow in bins & hoppers - flow behaviour - issues in bulk flow of granular materials
9	Aerodynamic properties - aero dynamics of agricultural products - drag coefficients - terminal velocity - definitions - methods of determination -

equation - problem solving

10 Rheological properties - force, deformation, stress, strain, elastic, plastic and viscous behaviour - definitions - classification based on rheology - ideal bodies

11 Rheological properties - ASTM standard definition of terms in rheology.

12 Rheological properties - visco-elasticity - Newtonian and Non-Newtonian fluid - definitions - criteria - time effects

13 Rheological properties - pseudo-plastic, dilatant, thixotropic, rheopectic and Bingham plastic foods - flow curves - definitions - criteria - differences between different fluids

14 Rheological properties - rheological models - Kelvin and Maxwell - electrical equivalence of mechanical models - derivation of equations

15 Electrical properties - dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant, method of determination - definitions - methods – importance

16 Application of engineering properties in handling processing equipment and storage structures

Practical

1 Determination of the shape and size of food grains

2 Determination of size and shape of fruits and vegetables

3 Determination of surface area of food material (egg)

4 Determination of bulk density of food grains

5 Determination of angle of repose of grains

6 Determination of the particle density / true density of solid grains

7 Determination of the porosity of solid grains

8 Finding the co-efficient of external and internal friction of different crops

9 Finding out the terminal velocity of grain sample

10 Study the separating behaviour in a vertical wind tunnel

11 Finding the thermal conductivity of different grains

12	Determination of specific heat of some food grains
13	Determination of hardness of food material
14	Determination of viscosity of liquid foods
15	Determination of hardness of food materials
16	Practical exam

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PRFE 232 **2(2+0)**

HEAT AND MASS TRANSFER

Objective To enable the students to know about the transport phenomenon in food materials through heat and mass transfer for applications in unit operations of dairy and food engineering

Lecture	**Topic**
Theory	
1	Concept - modes of heat transfer - thermal conductivity of materials - measurement - general differential equation of conduction.
2	One dimensional steady state conduction through plane and composite walls - theory, derivation of equation and problem solving.
3	One dimensional steady state conduction through tubes and spheres without heat generation - theory, derivation of equation and problem solving.
4	One dimensional steady state conduction through tubes and spheres with heat generation - theory, derivation of equation and problem solving.
5	Electrical analogy - conduction through multilayer tubes - conduction through materials in parallel and series - through plane walls, tubes.
6	Combined convection and conduction - derivation of equation for overall heat transfer coefficients - problem solving
7	Insulation materials - concept of critical thickness of insulation for a cylinder - derivation of equation and problem solving.
8	Fins - heat transfer through fins or extended surfaces - tutorials
9	Fins - types of fins, derivation of equation – tutorials
10	Free and forced convection - Newton's law of cooling - heat transfer coefficient in convection - derivation of equation - problem solving.
11	Dimensional analysis of free and forced convection - Buckinghum pi-theorem - derivation of equation for forced convection / free convection using dimensional analysis.
12	Useful non dimensional numbers - definition of non dimensional numbers – formulas
13	Equation of laminar boundary layer on flat plate and in a tube - theory and

derivation of equation.

14 Laminar forced convection on a flat plate and in a tube - theory and derivation of equation - combined free and forced convection

15 Solving problems on forced and natural convection

16 Radiation heat transfer - Introduction, absorptivity, reflectivity and transmissivity of radiation - black body and monochromatic radiation. theory and equations.

17 Planck's law - Stefan-Boltzman law - Kirchoff's law - theory, equations and problem solving.

18 Grey bodies and emissive power

19 Solid angle - intensity of radiation - theory and equations

20 Radiation exchange between black surfaces, geometric configuration factor - theory - derivation of equation - problem solving,

21 Heat transfer analysis involving conduction, convection and radiation by networks - theory and equations

22 Unsteady state heat transfer - unsteady state system with negligible internal thermal resistance- derivation of equations for different geometries.

23 Unsteady state heat transfer - errors in measurements using thermocouples

24 Heat exchangers - types of heat exchangers - classification - regeneration – applications

25 Fouling factor in heat exchangers - theory, effects, equations and problems on fouling.

26 Heat exchangers - log mean temperature difference - derivation of equation - problem solving.

27 Heat exchanger performance - transfer units - NTU analysis - derivation of equation and problem solving.

28 Heat exchanger analysis restricted to parallel and counter flow heat exchangers - theory and problem solving.

29 Heat exchangers – tutorials

30 Steady state molecular diffusion in fluids at rest and in laminar flow - Flick's law - theory - applications - equation - problem solving.

31 Mass transfer coefficients - theory - applications - Reynold's analogy.

32 Convective mass transfer - Theory and problems in convective mass transfer

Practical

References

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PRFE 233 **3 (2+1)**

THERMODYNAMICS, REFRIGERATION AND AIR CONDITIONING

Objective To enable the students to know about the thermodynamic laws and principles, gas laws, different thermodynamic cycles and their efficiencies for efficient designs of heat engines and to implement low-temperature food processing, cold storage applications, general refrigeration maintenance activities using theoretical background of air, vapour and ammonia refrigerants

Lecture	**Topic**
Theory	
1	Introduction to thermodynamics - units - thermodynamic properties – extensive & intensive properties.
2	Laws of thermodynamics – Zeroth law - First law - Second law of thermodynamics
3	Gas laws – laws of perfect gases - Boyle's law – Charles' law - Gay-Lussac law - general gas equation – Avogadro's law – universal gas constant - problem solving.
4	Classification of thermodynamic systems - closed system - open system - isolated system
5	Classification of thermodynamic processes - flow and non-flow processes – work done during non-flow process – derivation of equations – problem solving.
6	Application of first law in heating and expansion of gases in non-flow processes – reversible non-flow processes – internal energy - constant volume process – constant pressure process – hyperbolic process.
7	Application of first law in heating and expansion of gases in non-flow processes – reversible non-flow processes – constant temperature process – adiabatic process – polytropic process.
8	Application of first law of thermodynamics to a steady flow process - problem solving.
9	Cycles – Introduction - classification of thermodynamic cycles – terms used in thermodynamic cycles.
10	Carnot cycle - Carnot theorem – derivation of efficiency equation – problem solving

11	Entropy - physical concept of entropy - relation between heat and entropy - importance of entropy.
12	Change of entropy of gases - general expression for change of entropy of a perfect gas – change of entropy during constant volume process – constant pressure process - constant temperature process
13	Otto cycle - various processes of ideal Otto cycle - efficiency - problems solving
14	Diesel cycle - various processes of ideal diesel cycle – efficiency - problems solving
15	Dual combustion cycle - various processes of dual cycle - efficiency - problems solving
16	Principles of refrigeration - definition of refrigeration – units – terminology - major uses and applications
17	Principles of refrigeration - room air conditioner - domestic refrigerator - working substances in refrigerating machines - unit of refrigerating capacity - coefficient of performance - problems solving on refrigeration capacity
18	Production of low temperatures - expansion of a liquid with flashing - reversible adiabatic expansion of a gas - irreversible adiabatic expansion (throttling) of a real gas - thermoelectric cooling - adiabatic demagnetization. Comparison between refrigerating machine, heat engine and heat pump
19	Air refrigerators working on reverse Carnot cycle - reversed Carnot cycle - selection of operating temperatures - problems on reverse Carnot cycle and selection of operating temperatures
20	Air refrigerators working on Bell Coleman cycle - reversed Brayton or Joule or Bell Coleman cycle - analysis of gas cycle - polytropic and multistage compression - problems on Bell Coleman cycle
21	Vapour refrigeration mechanisms - vapour as a refrigerant in reversed Carnot cycle with P-V, T-S & P-H diagrams - problems on reversed Carnot cycle with vapour - gas as a refrigerant in reversed Carnot cycle - limitations of reversed Carnot cycle
22	Vapour compression cycles - vapour compression system – modifications in reverse Carnot cycle with vapour as a refrigerant (dry vs wet compression, throttling vs isentropic expansion) - vapour compression cycle - vapour compression system calculations

23	Vapour compression cycle - representation of vapour compression cycle on pressure – enthalpy diagram - super heating - sub cooling - problems on vapour compression cycle
24	Vapour - absorption refrigeration system - process - calculations - maximum coefficient of performance of a heat operated refrigerating machine - problems on vapour absorption refrigeration systems - common refrigerant - absorbent systems
25	Common refrigerants and their properties – desirable properties of an ideal refrigerant - design calculations for refrigeration system.
26	Cold storage plant - definition of cold storage - controlled atmosphere storage - factors affecting refrigerated cold storage - hypobaric storage
27	Thermodynamic properties of moist air - perfect gas relationship for approximate calculation - adiabatic saturation process - ideal gas law - Amagat's law - Dalton's law
28	Psychrometric chart - saturation pressure - absolute humidity - percentage humidity - humid volume - total heat – enthalpy - adiabatic processes - wet bulb temperature and its measurement
29	Psychrometric chart - psychrometric chart & its uses - elementary psychrometric processes – state factors – cooling – heating – mixtures – dehumidifying – drying - air conditioning
30	Air conditioning - principles - type and functions of air conditioning - meaning - factors affecting comfort air conditioning – classification - sensible heat factor - industrial air conditioning - problems on sensible heat factor
31	Air conditioning - winter air conditioning - summer air conditioning - year round air conditioning - unitary air conditioning systems - central air conditioning - problems on air conditioning - physiological principles in air conditioning - air distribution and duct design methods
32	Fundamentals of design of complete air conditioning systems - humidifiers and dehumidifiers - cooling load calculations - types of air conditioners – applications

Practical

1	Tutorials on thermodynamic air cycles
2	Study and application of P-V and T-S chart in refrigeration
3	Study and application of P-H chart (or) Molliar diagram in refrigeration

4	Study on air refrigeration cycle systems
5	Study on vapour compression cycle refrigeration system
6	Study of domestic water cooler
7	Study of domestic household refrigerator
8	Study of absorption type solar refrigeration system
9	Study of cold storage for fruit and vegetables
10	Freezing load and time calculations for food materials
11	Determination of refrigeration parameters using refrigeration tutor
12	Determination of air conditioning parameters using air conditioning tutor
13	Study on design of air conditioning systems
14	Study of window air conditioners
15	Study on repair and maintenance of refrigeration and air-conditioning systems.
16	Visit to chilling or ice making and cold storage plants

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RNEE 241 **3 (2+1)**

ELECTRICAL MACHINES AND POWER UTILIZATION

Objective To impart knowledge to students on the types of electrical machines, motors and generators and power utilization techniques for efficient energy utilization in agriculture, farm structures, dairy and food processing plants

Lecture	**Topic**
Theory	
1	Magnetic circuit - production of magnetic field - definitions of electro motive force - magneto motive force, magnetic flux, magnetic flux density, permeability, magnetic field intensity - reluctance and laws of magnetic circuits
2	Magnetic circuit - determination of ampere-turns for series and parallel magnetic circuits - comparison of magnetic and electric circuit
3	Magnetic circuit - hysteresis and eddy current losses
4	Transformer - principle of working - construction of single phase transformer - EMF equation
5	Transformer - types of transformers, core type, shell type transformers, difference between shell and core type transformers
6	Transformer - leakage reactance - voltage regulation - power and energy efficiency
7	Transformer - transformer tests - open circuit and short circuit tests
8	Transformer - losses in a transformer efficiency, condition for maximum efficiency, equivalent circuit of transformer, theory of an ideal transformer
9	Transformer - phaser diagram of an ideal transformer - phaser diagram of transformer on no load condition.
10	Transformer - phaser diagram of transformer on load - problem solving.
11	DC machines - DC generator - principles, operations, working, construction & performance
12	DC generator - armature, commutator & other accessories of DC generator
13	DC generator - EMF equation of DC generator, torque equation
14	DC generator - DC armature winding, lap winding, wave winding, terms used

	in armature winding
15	DC generator - armature reaction, demagnetizing & cross magnetising ampere turns, methods of compensating armature reaction
16	DC generator - excitation of DC generator, shunt generator, series generator, compound generator
17	DC generator - commutation - resistance commutation, EMF commutation
18	Characteristics of DC generators - separately excited, series, shunt and compound generator
19	DC motor - working principles - value of back EMF - voltage equation of DC motor
20	DC motor - characteristics of DC motor – starting of series, shunt and compound motor
21	DC motor - torque of DC motor, armature torque, shaft torque, efficiency of DC motor
22	DC motor - factors controlling the speed, speed control methods - field and armature control
23	Single phase induction motor - principle of operation, double field revolving theory
24	Single phase induction motor - equivalent circuit of single phase induction motor without core loss and with core loss
25	Single phase induction motor - characteristics, phase split, shaded pole motors
26	Poly phase / three phase induction motor - working principle, production of rotating field
27	Three phase induction motor - construction - stator - rotor - operation and phaser diagram - effect rotor resistance - torque equation - starters & speed control methods
28	Various methods of three phase power measurement - single watt meter - two watt meter method
29	Power factor - reactive and apparent power

30 Concept and analysis of balanced poly-phase circuits - series and parallel resonance.

31 Starter - motor starters and their necessity - types of starters

32 Starter - DOL, autotransformer, star delta starter

Practical

1 To get familiar with AC, DC machines and measuring instruments

2 To perform open circuit and short circuit tests on single phase transformers

3 To obtain load characteristics of DC shunt/series /compound generator

4 To study characteristics of DC shunt/ series motors

5 To study DC motor starters

6 To perform load-test on 3 phase induction motor & to plot torque vs speed characteristics

7 To perform no-load & blocked rotor tests on 3 phase induction motor to obtain equivalent circuit parameters & to draw circuit diagram

8 To study the speed control of 3 phase induction motor by cascading of two induction motors, i.e. by feeding the slip power of one motor into the other motor

9 To study star- delta starters physically and (a) to draw electrical connection diagram (b) to start the 3 phase induction motor using it. (c) to reverse the direction of 3 phase Induction motor.

10 To start a 3-phase slip –ring induction motor by inserting different levels of resistance in the rotor circuit and to plot torque–speed characteristics

11 To perform no load & blocked – rotor test on single phase induction motor & to determine the parameters of equivalent circuit drawn on the basis of double revolving field theory

12 To perform load –test on single phase induction motor & plot torque –speed characteristics

13 To study power consumed in a three-phase circuit

14 To study two lights in series controlled by one switch

15 To study two lights in parallel controlled by one switch

16 Practical exam

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

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

SWCE 251 **2 (1+1)**

DESIGN OF STRUCTURES

Objective The students will have acquired knowledge on the design principles of beams, slabs, columns, foundations and RCC structures, retaining walls and silos and other structures by the end of the course

Lecture	**Topic**
Theory	
1	Introduction to loads and BIS codes – loading of a bar - principle of superposition - classification of loaded bar - gradual, sudden, impact and shock loading - tension and compression - axially loaded bar
2	Design of connections
3	Design of thin cylindrical shells - failure of thin cylindrical shells, stresses in a thin cylindrical shell, circumferential stress, longitudinal stress, problems on thin cylindrical shells
4	Design of thick cylindrical shells – Lame's theorem, stress, stress in compound thick cylindrical shells, difference of radii of shrinkage, problems on thick cylindrical shells
5	Design of spherical shells, thick spherical shells, problems on thick spherical shells
6	Design of steel roof trusses
7	Analysis and designing of single reinforced sections – properties of reinforced concrete, advantages, assumptions, modular ratio, equivalent area of R.C.C., stress and strain diagram, neutral axis, moment of resistance, design of rectangular section
8	Analysis and designing of double reinforced sections – modular ratio for compression shell equivalent area of steel in compression, neutral axis, moment of resistance, steel beam theory, problems
9	Shear stresses in beams – shear stress induced in homogeneous and R.C. beams, nominal shear stress, varying depth, effect of shear in R.C. beams, failures, shear resistance of concrete without shear reinforcement
10	Bond and development of length – development of length, development of stress in R.C.C.

11	Design of flanges beams (T and I beams)
12	Design of one way slabs – loading on slabs, arrangement of reinforcement, design of one way slab
13	Axially loaded columns – types of columns, effective length of columns, long and short columns, composite columns
14	Foundations – types of foundations, design criteria
15	Retaining walls – earth pressure on a retaining wall, active earth pressure, passive earth pressure
16	Silos, circular or cylindrical tanks and design criteria – permissible stresses in concrete, permissible stresses in steel, base, minimum reinforcement, design, problems

Practical

1	Design and drawing of single reinforced beam
2	Problems on single reinforced beam
3	Design and drawing of double reinforced beam
4	Numerical problems on double reinforced beam
5	Design and drawing of steel roof trusses
6	Design and drawing of one way slabs
7	Numerical problems on one way slabs
8	Design and drawing of two way slabs
9	Numerical problems on two way slabs
10	Design and drawing of R.C.C. building
11	Problems on R. C. C. building
12	Design and drawing of retaining wall
13	Problems on retaining wall
14	Study on workability of cement by slump test
15	Study on workability of cement by compaction factor test
16	Practical examination

References

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2 Khurmi R. S. 2001. Strength of materials. S. Chand & Company Ltd., 7361, Ram Nagar, New Delhi – 110055.

3 Kumar Sushil 2003. Treasure of R.C.C. Design. R.K. Jain. 1705-A, Nai Sarak , Delhi-110006, P.B.1074.

AABS 202 **3 (2+1)**

ENGINEERING MATHEMATICS - III

Objective To impart the knowledge on advanced aspects of Mathematics in numerical analysis and statistical methods to enable the students to apply them for solving the engineering problems in the courses of agricultural engineering.

Lecture	Topic
Theory	
1	Numerical analysis - finite differences - interpolation with equal integrals - interpolation - extrapolation - explanation of forward, backward and central differences with suitable examples.
2	Various difference operators and their relationships - symbolic relations and separation of symbols.
3	Problems on Newton's forward interpolation formula - introduction - solving some suitable example problems by using Newton's forward interpolation formula.
4	Problems on Newton's backward interpolation formula - introduction - solving some suitable example problems by using Newton's backward interpolation formula.
5	Stirling's and Bessel's difference interpolation formula - introduction - solving example problems by using Stirling's and Bessel's formula.
6	Interpolation with unequal intervals - explanation of first, second and third order divided differences with table.
7	Newton's divided difference formula - introduction - solving problems on unequal intervals by using Newton's divided difference formula.
8	Lagrange's interpolation formula - introduction - problem solving on unequal intervals by using Lagrange's interpolation formula.
9	Numerical Differentiations - introduction - problems on numerical differentiation.
10	Numerical integrations - difference equations and their solutions - introduction - explanation with suitable examples.
11	Trapezoidal, Simpson's 1/3 and Simpson's 3/8 rule - introduction - solving problems on Trapezoidal, Simpson's 1/3 and Simpson's 3/8 rule.

12 Numerical solutions of ordinary differential equations by Picard's method - introduction - solving ordinary differential equations by using Picard's method.

13 Numerical solutions of ordinary differential equations by Taylor's series method - introduction - solving ordinary differential equations by using Taylor's series method.

14 Numerical solutions of ordinary differential equations by Euller's method - introduction - solving ordinary differential equations problems by using Euller's method.

15 Numerical solutions of ordinary differential equations by modified Euller's method - introduction - solving ordinary differential equations problems by using Modified Euller's method.

16 Numerical solutions of ordinary differential equations by Runge-Kutta method - introduction - Problem solving on ordinary differential equations by using Runge-Kutta method.

17 Laplace transformation - introduction of Laplace transformation - L.T of elementary functions - introduction - definition - linear property - Laplace transformations of various functions.

18 Properties of Laplace transformation - gamma function - unit step function - properties on Laplace transforms.

19 Laplace transformation of derivatives and integrals - explanation of formulas of Laplace transforms of derivative and Integrals - problem solving.

20 Multiplication by t^n and divided by t - explanation of formulas of multiplication by t and t^n, divided by t - problem solving.

21 Inverse Laplace transformation - introduction - linear property - inverse Laplace transform of various functions. Properties of inverse Laplace transforms.

22 Applications to the solutions of ordinary differential equations - working rule to solve the differential equation L.T. method - some example problems.

23 Applications to the solutions of simultaneous differential equations - working rule to solve the simultaneous differential equation by using L.T method - solving problems.

24 Statistics - testing of hypothesis- level of significance - introduction - mean, median, mode, null hypothesis, alternative hypothesis - sampling distribution - random sampling.

25 Degrees of freedom - statistical errors - introduction - types of errors with examples.

26 Large sample test (Z-test) - explanation of large sample tests - Z-test - if S.D is known and S.D is unknown - Problems on one sample and two sample Z-test.

27 Small sample test - t-test (One tailed, two tailed and Paired tests) – introduction - explanation of small sample tests - t-test. Problems on one sample, two sample, and paired t-test.

28 Testing of significance through variance (F-test) - explanation of small sample F-test - problem solving.

29 Chi -square test - contingency table - introduction - measuremental data - enumeration data - 2x2 contingency table - explanation of Chi-square test with examples.

30 Contingency tables - introduction on contingency tables of different types - some related problems.

31 Correlation - definition - types of correlation - methods - test of significance of correlation coefficient (direct and indirect method) - example problems.

32 Regression - definition - direct method - deviation method - properties of regression coefficient - problems on regression.

Practical

1 Problems on Newton’s forward and backward interpolation formula

2 Problems on Bessel's and Stirling’s difference interpolation formulae

3 Problems on Lagrange’s interpolation formula

4 Problems on numerical differentiations, numerical integrations

5 Problems on numerical solutions of ordinary differential equations by Picard’s & Taylor’s series

6 Problems on numerical differentiation and integration solutions of difference equations

7 Numerical solution of ordinary differential equations of first order and first degree

8 Problems on Laplace transformations and their application to solution of ordinary differential equation

9	Problems on inverse Laplace transformations and their application to solution of ordinary differential equation
10	Problems on Laplace transformations and their application to solution of simultaneous differential equation
11	Problems on one sample, two sample Z-tests when population S.D. is known
12	Problems on one sample, two sample Z-tests when population S.D. is unknown
13	Problems on one sample, two sample and paired t-test.
14	Problems on one sample, two sample and Chi-Square test
15	Problems on 2x2 and m x n, calculation of correlation coefficient and its testing.
16	Problems on one sample, two sample by F- test.

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5. Gupta S.C. Fundamental Applied Statistics.

AABS 203 **2(1+1)**

PRINCIPLES OF HORTICULTURAL CROPS AND PLANT PROTECTION

Objective To enable the students to understand the farming principles to grow plantation and orchard crops and all farming practices whose knowledge will help the students to understand the soil, crop and machine specific parameters for design and development of machinery, equipment and implements.

Lecture	**Topic**
Theory	
1	Definitions and division of Horticulture - importance and scope of Horticulture in national economy
2	Soil and climatic requirements for fruits, vegetables and floriculture - temperature, humidity, wind, rainfall and solar radiation
3	Criteria for selection of site – climate, soil, nearness to the market, transport facility, proximity to established orchards, availability of labour, social factors, presence of nurseries and cost of labour.
4	Layout, planting systems/methods - square, rectangular, quincunx, hexagonal, and contour planting with their merits and demerits
5	Pruning - definition – objectives of pruning - methods of pruning - thinning out, trimming, heading back, pollarding, pinching, disbudding, deblossoming, - season of pruning - pruning and manuring, care of pruned wounds.
6	Training - definition – objectives of training fruit trees - methods of training-central leader, open centre and modified leader system with merits and demerits.
7	Plant growing structures- green house, lath house, hot bed, cold frame, etc.
8	Macro-propagation methods – cuttings, layerings, budding and grafting and micro propagation methods
9	Harvesting – care during harvesting – methods of harvesting – grading and packaging and types of packaging material.
10	Post harvest practices – pre cooling methods – curing – ripening – waxing – storage – palletization
11	Nursery raising, commercial varieties / hybrids, sowing - planting types and methods - seed rate and seed treatment for vegetable crops.

12	Garden tools and their use in horticultural crops
13	Major pests and diseases and their management of vegetables and flowers
14	Major pests and diseases and their management of fruit crops
15	Crop – co-efficient, water requirement - critical stages of irrigation
16	Irrigation - methods of irrigation- surface check basin, furrow, ring basin , basin, flood, pitcher, drip and sprinkler irrigation system - fertilizer application in fruit crops - types of fertilizers - time of fertilizer application - methods of fertilizers application - broad casting - advantages and disadvantages - band placement - ring placement - foliar application - starter solutions - fertigation.

Practical

1	Identification and description of important fruit crops
2	Identification and description of important vegetable crops
3	Identification and description of important flower crops
4	Study of different garden tools
5	Study of seed viability and germination test
6	Preparation of nursery beds
7	Practice of pruning and training in some important crops
8	Determination of maturity for harvesting of various fruits / vegetables
9	Visit to commercial green house / poly house
10	Cultural operations followed in vegetable crops such as weeding, hoeing, earthing up
11	Cultural operations followed in vegetable crops like fertilizer application and irrigation
12	Seed extraction techniques in vegetable crops
13	Identification and important pests and diseases and their control in fruit crops
14	Identification and important pests and diseases and their control in vegetable crops

15 Identification and important pests and diseases and their control in flower crops

16 Visit to commercial horticultural fields

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FMPE 212 **2(0+2)**

AUTO CAD APPLICATIONS

Objective Computer-aided design (CAD) software is helpful for engineering students to design curves and figures in two-dimensional (2D) space; and solids in three-dimensional (3D) space. The objective of Auto CAD 2D, 3D is to introduce improved productivity techniques, creating, extracting, studying drawing tools; print and plot drawings, menu customization etc. Emphasis is on using the software tools and understanding the concepts and techniques students impart knowledge in creating, modifying, analysing, and designing.

Lecture	**Topic**
Theory	
Practical	
1	Computer Aided Design - introduction to CAD - application of computers for design in CAD.
2	Drawing screen - explanation of various options on the drawing screen.
3	Study of draw tool bar – line, circle, arc, 3-point arc and polygon commands.
4	Study of draw tool bar – trace, pline, donut, ellipse and solid commands.
5	Study of modify tool bar - move, rotate, mirror, copy, scale, oops, trim, Array commands.
6	Study of modify tool bar – erase, oops, fillet, chamfer, change, extend, offset, explode, undo, PEDIT and explode commands.
7	Practice on commands - OSNAP, dimension tool bar, line thickness, and format tool bar.
8	Practice on commands- creating boundary, region, hatch & gradient commands.
9	Practice of 2-D models.
10	Practice of 2-D models.
11	Practice of 2-D models.
12	Practice of 2-D models.
13	Practice of 2-D models.
14	Setting of view ports - sketched drawing and printing of selected view ports

in various paper sizes.

15 Practice on 2-D drawing of mating parts with all dimensions & allowances – foot step bearing.

16 Practice on 2-D drawing of mating parts with all dimensions & allowances – foot step bearing.

17 Practice on 2-D drawing of mating parts with all dimensions & allowances – stuffing Box.

18 Practice on 2-D drawing of mating parts with all dimensions & allowances – stuffing Box.

19 Practice on 2-D drawing of mating parts with all dimensions & allowances – knuckle joint.

20 Practice on 2-D drawing of mating parts with all dimensions & allowances – knuckle joint.

21 Sectioning - foot step bearing, knuckle joint and stuffing box.

22 Drawing - views of hexagonal nut.

23 Drawing - views of hexagonal bolt.

24 Practice on 3-D commands – extrusion.

25 Practice on 3-D commands - lift.

26 Practice on 3-D commands - sweep & press pull.

27 Practice on 3-D commands - revolving & joining.

28 Practice of 3-D drawing.

29 Practice of 3-D drawing.

30 Practice of 3-D drawing.

31 Practice of 3-D drawing.

32 Demonstration on CNC machine.

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FMPE 213 **3 (2+1)**

TRACTOR AND AUTOMOTIVE ENGINES

Objective A Complete knowledge on automotive mechanics of tractor will be discussed through internal combustion engine design and operating factors power transmission, electrical and lubricating systems.

Lecture	**Topic**
Theory	
1	Source of farm power - conventional & non conventional energy sources.
2	Classification of tractors and I.C. engines.
3	Study of Otto cycle principle of SI engine
4	Study of Diesel cycle principle of CI engine
5	Problems on efficiencies
6	Study of I.C. engine components and their construction, operating principles and functions.
7	Study of engine strokes and comparison of two stroke and four stroke engine cycles of CI and SI engines.
8	Study of engine strokes and comparison of two stroke and four stroke engine cycles of CI and SI engines.
9	Study of engine valve systems, valve mechanism, valve timing diagram, valve clearance adjustment.
10	Study of engine valve systems, valve mechanism, valve timing diagram, valve clearance adjustment.
11	Study of cam profile, valve lift and valve opening area.
12	Study of importance of air cleaning system.
13	Study of types of air cleaners and performance characteristics of various air cleaners.
14	Study of fuel supply system.
15	Study of fuels - properties of fuels - calculation of air-fuel ratio.
16	Study of tests on fuel for SI & CI engines.

17 Study of detonation and knocking in IC engines.

18 Study of carburetion system, carburettors and their main functional components.

19 Study of fuel injection system - injection pumps their types - working principles.

20 Fuel injector nozzles - their types and working principle.

21 Engine governing - need of governors - governor types and governor characteristics.

22 Engine governing - need of governors - governor types and governor characteristics.

23 Study of lubrication system - need - types - functional components.

24 Study of lubricants - physical properties - additives and their application.

25 Engine cooling system - cooling methods and main functional components.

26 Study of need and type of thermostat valve - additives in the coolant.

27 Study of radiator efficiency.

28 Study of ignition system of SI engine – types of ignition systems.

29 Study of electrical system – battery - starting motor battery charging, cut-out etc.

30 Study of electrical system – battery - starting motor battery charging - cut-out etc.

31 Comparison of dynamo and alternator.

32 Basics of engine testing – types of tests for engine.

Practical

1 Introduction to different systems of CI engine.

2 Engine parts and functions, working principles etc.

3 Determination of oil and fuel physical properties.

4 Air cleaning system.

5 Fuel supply system of SI and CI engines.

6	Diesel injection system & timing.
7	Cooling system, and its performance evaluation.
8	Engine governing and types of governors.
9	Lubricating system & adjustments.
10	Electrical system.
11	Starting and ignition units.
12	Tractor engine heat balanced and engine performance curves.
13	Visits to engine manufacturing / assembling / spare parts units.
14	Driving practice of a tractor.
15	Driving practice of a tractor.
16	Practical Examination.

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2	Rodichev V and G Rodicheva. Tractors and Automobiles.
3	Mathur ML and RP Sharma. A course in Internal Combustion Engines.
4	Singh Kirpal. Automobile Engineering – Vol II.
5	Heitner Joseph. Automotive Mechanics: Principles and Practices.

IRDE 223 **2 (1+1)**

SPRINKLER AND MICRO IRRIGATION SYSTEMS

Objective To impart knowledge and skills to students to design sprinkler and drip irrigation systems and enable them to understand installation, operation and maintenance and cost economics of micro-irrigation systems.

Lecture	**Topic**
Theory	
1	Sprinkler irrigation – historical development - scenario in the world, country and state - adoptability and limitations
2	Factors affecting the performance of sprinkler irrigation
3	Types of sprinkler irrigation systems - based on sprinkling mechanism and portability
4	Components of the sprinkler system - Pump set, main lines, sub lines, lateral lines, sprinkler heads, debris screens, desilting basins, booster pumps, take-off valves, flow control valves, fertigation equipment
5	Moisture distribution patterns - recommended sprinkler spacing - effect of wind speed on working of the system - importance of distribution uniformity - determination of Chrstiansen uniformity coefficient
6	Design of sprinkler system, layout, laterals and mains - Inventory of resources and conditions - types of system and layout - sprinkler selection and spacing - capacity of sprinkler systems - hydraulic design of sprinkler systems - selection of pump and power unit
7	Operation and maintenance of system - cost analysis
8	Micro Irrigation systems – types - drip, spray and bubbler systems
9	Drip irrigation – historical development - scenario in the world, country and state - advantages and limitations
10	Components of drip irrigation - head control system – water carrier system and water distribution system
11	Types of emitters and their discharge equation - types of filters and other important components
12	Design of drip irrigation system - general considerations, wetting patters, irrigation requirement, emitter selection

13 Manufacturing coefficient of variation - emission uniformity - hydraulics of drip irrigation system - design steps

14 Necessary steps for proper installation and operation of a drip irrigation system - maintenance of micro irrigation system - clogging problems, filter cleaning, flushing and chemical treatment

15 Fertigation - advantages and limitations of fertigation, fertilizers solubility and their compatibility - precautions for successful fertigation system

16 Fertigation frequency - duration and injection rate - methods of fertigation.

Practical

1 Study of different components of sprinkler irrigation system

2 Design and installation of sprinkler irrigation system

3 Determination of precipitation pattern, discharge and uniformity coefficient using catch cans.

4 Cost economics of sprinkler irrigation system

5 Tutorial class on design of sprinkler irrigation

6 Field visit to nearby places for studying sprinkler system

7 Study of different components of drip irrigation

8 Design and installation of drip irrigation system

9 Determination of pressure discharge relationship and emission uniformity for given emitter

10 Study of different types of filters and determination of filtration efficiency

11 Determination of rate of injection and calibration for chemigation / fertigation

12 Design of irrigation and fertigation schedule for crops

13 Cost economics of drip irrigation system

14 Tutorial class on design of drip irrigation system by renewal irrigation company experts

15 Field visit to drip irrigation system and evaluation of drip system

16 Practical Examination

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PRFE 234 **3 (2+1)**

POST HARVEST ENGINEERING OF CEREALS, PULSES AND OIL SEEDS

Objective To train students on unit operations of agricultural process engineering to acquaint with preliminary operations such as cleaning, size reduction, mixing, separation, filtration and materials handling equipment related to cereals, pulses and oil seeds.

Lecture	**Topic**
Theory	
1	Scope and importance of processing of cereals, pulses and oilseeds – principles and methods of food processing.
2	Cleaning and grading of cereals, pulses & oilseeds – principles
3	Theory of separation - types of separators - cyclone separators
4	Sieve analysis - size of screens – applications - particle size determination
5	Various types of separators - specific gravity, magnetic, disc, spiral separators
6	Separators - pneumatic, inclined draper, velvet roll, colour sorters, cyclone, shape graders
7	Size reduction – principle - Bond's law, Kick's law, Rittinger's law
8	Size reduction procedure - crushing, impact, cutting and shearing
9	Size reduction machinery - jaw crusher, hammer mill, plate mill, ball mill - material handling equipment
10	Types of conveyors - belt, roller, chain and screw.
11	Elevators – bucket - cranes & hoists
12	Trucks - refrigerated/ unrefrigerated - pneumatic conveying.
13	Drying - moisture content and water activity - free, bound and equilibrium moisture content – isotherms - hysteresis effect
14	EMC determination - psychrometric chart and its use in drying
15	Drying principles and theory - thin layer and deep bed drying analysis
16	Falling rate and constant rate drying periods - maximum and decreasing

drying rate period - drying equations

17 Mass and energy balance - Shedd's equation - dryer performance

18 Different methods of drying - batch-continuous - mixing-non-mixing – sun, mechanical, conduction, convection, radiation, superheated steam - tempering during drying,

19 Different types of grain dryers - bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray

20 Mixing - theory of mixing of solids and pastes - mixing index - types of mixers for solids, liquid foods and pastes

21 Milling of rice - conditioning and parboiling - advantages and disadvantages - traditional methods

22 CFTRI and Jadavpur methods - pressure parboiling method - types of rice mills - modern rice milling - different unit operations and equipment

23 Milling of wheat - unit operations and equipment

24 Milling of pulses - traditional milling methods - commercial methods - pre-conditioning

25 Dry milling and wet milling methods - CFTRI and Pantnagar methods

26 Pulse milling machines

27 Milling of corn and its products - dry and wet milling

28 Milling of oilseeds - mechanical expression, screw press

29 Hydraulic press - solvent extraction method - preconditioning of oilseeds - refining of oil

30 Stabilization of rice bran

31 Extrusion cooking – principle - factors affecting - single and twin screw extruders

32 By-products utilization.

Practical

1 Performance evaluation of different types of cleaners and separators

2 Determination of separation efficiency

3	Study of different size reduction machines and performance evaluation
4	Determination of fineness modulus and uniformity index
5	Study of different types of conveying and elevating equipments
6	Study of different types of mixers
7	Measurement of moisture content: dry basis and wet basis
8	Study on drying characteristics of grains and determination of drying constant
9	Determination of EMC (Static and dynamic method)
10	Study of various types of dryers
11	Study of different equipments in rice mills and their performance evaluation
12	Study of different equipments in pulse mills and their performance evaluation
13	Study of different equipments in oil mills and their performance evaluation
14	Type of process flow charts with examples relating to processing of cereals pulses and oil seeds
15	Visit to by-product utilization – briquetting
16	Visit to grain processing industries

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RNEE 242 **3 (2+1)**

FUNDAMENTALS OF RENEWABLE ENERGY SOURCES

Objective To enable the students to understand the principles and concepts of various sources of renewable energy. Also, enable to understand fundamentals of alternative energy conversion technologies towards sustainable agriculture and green world environment. Learn renewable energy harnessing sources via biomass, solar and wind etc.

Lecture	Topic
Theory	
1	Renewable Energy Sources (RES) - introduction to renewable energy sources - concept and its limitation - criteria for assessing the potential of RES
2	Renewable Energy Sources - classification of RES - solar energy, wind energy and biomass energy
3	Renewable Energy Sources (RES) - classification of other RES - geothermal energy, ocean energy sources, magneto-hydro dynamics, fuel cell technology - comparison of renewable energy sources with non renewable sources
4	Solar energy - characteristics of sun - instruments used for measuring solar radiation data
5	Solar energy - solar thermal energy conversion technologies-flat plate collectors and concentrating collectors
6	Solar energy - different solar thermal devices - principle of forced convection drying system
7	Solar energy - different solar thermal devices - principle of natural convection drying system
8	Solar photo voltaic (SPV) - introduction to solar photovoltaic, semiconductors, p-n junctions
9	SPV systems - introduction solar cells - SPV systems - stand alone, grid connected solar power station
10	SPV systems - solar cells, PV systems - flat plate system - fixed tilt system, tracking system and hybrid power system
11	SPV systems - calculation of energy through photovoltaic power generation

	and cost economics
12	Wind energy - introduction to wind energy - general formula - lift and drag.
13	Wind energy - basis of wind energy conversion - effect of density - frequency variances - angle of attack and wind speed
14	Wind energy - types of windmill rotors - determination of torque coefficient - induction type generators - working principle of wind power plant
15	Wind energy - types of windmill rotors - determination of torque coefficient, induction type generators - working principle of wind power plant
16	Bio-energy - classification of biomass - sources and characteristics of biomass - different biomass conversion technologies
17	Biomass thermal conversion process - definition of process - different types of bio-thermal conversion techniques
18	Pyrolysis - principles of pyrolysis and its methods - pyrolysis of biomass to produce solid fuels
19	Pyrolysis - production of liquid fuels through biomass pyrolysis process
20	Pyrolysis - production biomass based gaseous fuels through pyrolysis
21	Gasification - introduction to gasification - types of biomass gasifier - up draught gasifier, down draught gasifier, cross draught, fixed bed gasifier and fluidized bed gasifier
22	Gasification - types of biomass gasifiers, its construction and working principle
23	Gasification - chemistry of gasification process and application of gasifier
24	Gasification - various types of biomass cook stoves for rural energy needs
25	Biogas technology - introduction to biogas and principal of biogas conversion process
26	Important properties of biomass materials used for biogas production and its advantages and disadvantages
27	Floating drum type biogas plant - construction - working principle and its advantages and disadvantages

28	Fixed dome type biogas plant – construction - working principle and its advantages and disadvantages
29	Biogas generation - factors affecting biogas generation and usages
30	Biogas application technologies
31	Design consideration of biogas plants - advantages and disadvantages of biogas spent slurry
32	Problems on design of biogas plants

Practical

1	Study of different types of solar cooker-flat plate type
2	Study of different types of solar cookers- concentric type
3	Study on solar water heating system
4	Performance evaluation of natural convection solar dryer
5	Performance evaluation of natural convection solar dryer
6	Performance evaluation of forced convection solar dryer
7	Performance evaluation of forced convection solar dryer
8	Study on solar desalination unit
9	Solar greenhouse for agriculture production
10	Performance evaluation of biomass improved cook-stoves
11	Performance evaluation of solar photovoltaic system
12	Study on biomass gasifiers
13	Design of fixed dome biogas plants
14	Visit to biogas plants unit
15	Visit to biomass gasifiers unit
16	Practical exam

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

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SWCE 252 **2 (2+0)**

BUILDING COSTRUCTION AND COST ESTIMATION

Objective To enable the students to know about different materials used for Engineering Constructions like buildings, roads, farm structures and metals and other materials. For manufacturing farm equipment, implements, dairy and food processing equipment

Lecture	**Topic**
Theory	
1	Introduction to building materials - list
2	Rocks, stones - types uses for various civil constructions and other engineering uses
3	Bricks - types - their properties-manufacturing processes – tiles - types and properties of tiles
4	Lime - uses of lime - lime concrete - preparation and its strength aspects
5	Cement – types – properties – concrete - uses of concrete - various grades - preparation of concrete mix and their strengths aspects
6	Sand, glass, rubber, plastics - their types and properties
7	Iron, steel, aluminum, copper, nickel - timber types, their properties and their usage as building materials.
8	Building components - types – foundation - flooring-walls-roof –lintels etc.
9	Lintels, arches - the components – types of lintels-terminology connected-design criteria.
10	Stair cases-types- the principles in keeping the stair case and construction procedure
11	Different types of floors - thickness of the floor- requirement of a good floor-specification of floors-tiles-marbles-bricks etc.,
12	Finishing - wall finishing-slab finishing-floor finishing
13	Damp proofing and water proofing for floors and slabs - latest additions in DPC- their usage and importance in the building aesthetics and hygiene.
14	Plastering - pointing- the places of pointing examples- brick pointing-granite masonry pointing- the art involved in pointing work- specifications

15 White washing and distempering – painting- types of paints- varnishes- distempers used for buildings- the tools and equipment used for white washing and paintings.

16 Building design & design procedures - considerations to be taken care before taking up any building like water demand-floor requirements-ventilation-strength requirement for all the dimensions of walls- slabs-beams-columns and pillars

17 Technology - Building construction-procedures

18 Types of agricultural buildings and related needs - farm houses- workshop-poultry sheds-dairy barns

19 Design of a farm house and workshop

20 Design of a poultry and dairy barn

21 Application of design theory and practice to the conservation

22 Sloped and flat roof buildings - trusses- slabs

23 Construction economics – logistics - criteria for fixing the building cost based on its utility and life expectancy

24 Preliminary estimates - types- procedure of arriving at final estimate cost

25 Detailed estimates of buildings - calculation of quantities and abstract estimate- specifications to be followed in filling the columns of the estimate table for various items.

26 Source of cost information – SSR - local prevailing rates or nearby available source.

27 Use of cost analyses for controlling design

28 Factors affecting building costs

29 Cost evaluation of design and planning alternatives for building and estate development

30 Measurement and pricing

31 Economic methods for evaluating investments in buildings and building systems-annuity factors

32 Cost-in-use - benefit-to-costs and savings-to-investment ratios, rate of return, net benefits, payback

Practical

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

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

SWCE 253 **2 (1+1)**

WATERSHED HYDROLOGY

Objective To enable the students to acquire knowledge and skills on hydrological (rainfall and runoff) measurements in watersheds, hydrological design of structures, prediction of volume and rates of runoff with tools like hydrographs and unit hydrographs, reservoir planning with flood routing techniques for application in natural resources management

Lecture	**Topic**
Theory	
1	Hydrology - definition, hydrologic cycle and its components - forms of precipitation and measurement of precipitation – recording and non-recording rain gauges
2	Rain gauge network - preparation of rainfall data and mean precipitation over an area
3	Point rainfall - frequency analysis of point rainfall - mass curve, hyetograph - depth-area-duration and Intensity-duration-frequency relationships
4	Definition of interception - infiltration and factors influencing and determination of net effective rainfall-infiltration indices - phi index, W-index
5	Evaporation and its process - method of estimating lake evaporation - types of evaporimeters - measures to reduce lake evaporation - soil evaporation
6	Runoff – definition - components of runoff - direct runoff and base flow - overland flow and interflows - runoff characteristics of streams - factors affecting runoff - climatic factors and physiographic factors
7	Runoff estimation methods - rational method, Cooks method and SCS curve number method
8	Geomorphology of watersheds – linear, aerial and relief aspects of watersheds - stream order, drainage density and stream frequency
9	Hydrographs - definition and components, factors affecting flood hydrograph - hydrograph separation for simple and complex storms - straight line method and other two methods
10	Unit hydrographs - concept - three implications of the definition and the two basic assumptions (linear response and time invariant) - derivation of unit hydrograph from total hydrograph - average unit hydrographs from several

storms of the same duration

11 Derivation of unit hydrograph for complex storms - conversion of unit hydrograph duration - methods for unit hydrographs of different durations-method of superposition and S-Curve method

12 Synthetic unit hydrograph - need and concept - Snyder's synthetic unit hydrograph - formulas relating hydrograph features-basin lag, peak flow and time base of the unit hydrograph

13 Stream gauging - discharge rating curves - direct and indirect methods for determination of stream discharge - flood peak, design flood and computation of probable flood.

14 Flood routing – introduction - basic equation - two broad categories of flood routing

15 Reservoir routing and channel routing

16 Drought – classification - causes and impacts - drought management strategy

Practical

1 Visit to Meteorological observatory and study of different instruments

2 Design of rain gauge network

3 Tutorial on intensity-duration-frequency curves

4 Tutorial on depth-area-duration and double mass curves

5 Analysis of rainfall data and estimation of mean rainfall by different methods

6 Tutorial on frequency analysis of hydrological data and estimation of missing data, test for consistency of rainfall records

7 Tutorial on computation of infiltration indices

8 Computation of peak runoff and runoff volume by Cook's method and Rational method

9 Computation of runoff volume by SCS curve number method

10 Study of stream gauging instruments - current meter and stage level recorders

11 Tutorial on geomorphic parameters of watersheds

12 Tutorial on runoff hydrographs

13	Tutorial on unit hydrograph
14	Tutorial on synthetic hydrograph
15	Tutorial on flood routing
16	Practical examination

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AABS 301 **3 (2+1)**

APPLIED ELECTRONICS AND INSTRUMENTATION

Objective To impart knowledge on applied electronics to students to design and develop automated controls to operate agricultural engineering gadgets and instrumentation for various engineering measurements and operation.

Lecture	**Topic**
Theory	
1	Semiconductors - p-n junction – V-I characteristics of p-n junction.
2	Efficiency and ripple factor of half wave rectifier.
3	Efficiency and ripple factor of full wave rectifier (derivation) - related problems.
4	Chipping circuits - positive clipper - biased chipper - combination chipper
5	Clamping circuits - positive clamper negative clamper.
6	Diode circuits for OR & AND gates with truth table
7	Bipolar junction transistor – operating point, p-n-p transistor, n-p-n transistor
8	Transistor as CE amplifier - transistor load line analysis - current gain, voltage gain, power gain
9	Transistor connection – common base connection - expression for collector current and characteristics
10	Common emitter connection - relation between a^ and a’ - collector current.
11	Common collector connection - relation between “ and a’ - collector current.
12	Classification of amplifiers - class A , class B, class C amplifiers.
13	Various biasing methods - stability factor, thermal run way - base resistor method – fixed – self potential divider
14	Biasing with feedback resistor - voltage divider bias
15	Filter circuits – series induction filter - ripple factor regulation output voltage.
16	Shinot capacitor filter - ripple factor and regulation.
17	Pi filter - voltage multiplier.

18 Coupling of amplifiers – R-C coupled amplifier gain - frequency response decibel gain, band width – operation - Advantages.

19 Transformer coupled amplifier operation – advantages, disadvantages and applications.

20 Hybrid – parameters - hybrid equivalent circuit of common emitter amplifier - hybrid parameter model of a transistor.

21 Oscillators' principle - phase shift oscillator - frequency and condition of maintenance of oscillators - dram backs.

22 Operational amplifier – characteristics of an ideal OP–AMP operational amplifier stages - equivalent circuit of OP–AMP.

23 OP–AMP as integrator - OP–AMP as comparator and active rectifier

24 OP–AMP as differentiator, differential amplifier, adder, subtractor, instrumentation amplifier and oscillator

25 Regulated DC power plug - voltage regulation - minimum load resistance - zener diode voltage regulator

26 Transistor series voltage regulator.

27 Current limiting - OP–AMP as voltage regulator.

28 Basic theorem of Boolean algebra – OR laws, AND laws, NOT laws commutative laws, associative laws, distributive laws absorptive laws

29 Combinational logic circuits – basic gates - Sum of Products form (SOP) - Karnaugh–map (Kmap) - binary ladder – D/A converter- successive approximation A/D converter.

30 Generalized instrumentation - measurement of displacement, temperature, velocity, force and pressure using potential meter.

31 Thermocouples – Thomson effect, Peltier effect, Seebeck effect - resistance thermometers - semi-conductor based sensors - humidity Sensors - pressure sensor - temperature sensor - gas sensors.

32 Bourclen tube – LVDT – strain gauge and tacho-generator

Practical

1 To study a diode as clipper and clamper

2	Study of triode characteristics
3	To study a zener regulator circuit
4	To study V–I characteristics of P–N junction diode
5	To study RC coupled amplifier, RC phase shift oscillator.
6	To familiarize with various types of transducers
7	To study half wave, full wave and bridge rectifier
8	To design and study fixed and self bias transistor
9	To study a OP-AMP IC 741 as differentiator and integrator to study a differential amplifier using two transistor
10	To study transistor characteristics in CE configurations
11	To design and study potential divider bias transistor
12	To study a OP-AMP IC 741 as differential amplifier
13	To study a OP-AMP IC 741 as a active rectifier
14	To study a OP-AMP IC 741 as inverting and non- inverting amplifier
15	To study a OP-AMP IC 741 as a comparator
16	Study of temperature characteristics of resistor

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3	Roy Chowdary. Integrated Electronics. John Wiley International.
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FMPE 311 **3 (2+1)**

FARM MACHINERY AND EQUIPMENT - I

Objective Primary and secondary tillage implements along with earth moving machinery, seeding and plant protection equipment will be discussed to get awareness on the mechanical part of the agricultural engineering

Lecture	Topic
Theory	
1	Introduction to farm mechanization
2	Classification of farm machines
3	Unit operations in crop production
4	Identification & selection of machines for various operations on the farm
5	Hitch systems and controls of farm machinery
6	Calculation of field capacities and field efficiency
7	Calculation of field capacities and field efficiency
8	Calculation for economics of machinery usage - comparison of ownership with hiring of machines.
9	Introduction to seed-bed preparation and its classification
10	Earth moving equipment – terminology
11	Earth moving equipment
12	Introduction to machines used for primary tillage
13	Introduction to machines used for primary tillage
14	Introduction to machines used for secondary tillage
15	Introduction to machines used for rotary tillage, deep tillage & minimum tillage
16	Introduction to machines used for rotary tillage, deep tillage & minimum tillage
17	Measurement of draft of tillage tools and calculation for power requirement for the tillage machines

18	Measurement of draft of tillage tools and calculation for power requirement for the tillage machines
19	Identification of major functional components attachments with tillage machinery
20	Introduction to sowing & planting equipment
21	Introduction to sowing & planting equipment
22	Introduction to transplanting equipment
23	Introduction to seed drills, no-till drills and strip-till drills
24	Introduction to metering system in drill and planters
25	Calibration of seed-drills/planters
26	Introduction to materials used in construction of farm machines
27	Heat treatment processes and their requirement in farm machines
28	Heat treatment processes and their requirement in farm machines
29	Properties of materials used for critical and functional components of agricultural machines
30	Properties of materials used for critical and functional components of agricultural machines
31	Introduction to steels and alloys for agricultural application
32	Identification of heat treatment process specially for the agricultural machinery components

Practical

1	Familiarization with different farm implements & tools
2	Study of hitch system
3	Problems on machinery management
4	Study of primary tillage and Secondary tillage machinery construction, operation adjustment.
5	Study of primary tillage and Secondary tillage machinery construction, operation adjustment.
6	Calculation of power and draft requirement.

7	Calculation of power and draft requirement
8	Study of sowing and planting equipment
9	Study of sowing and planting equipment - construction types - calculation for calibration and adjustments
10	Study of sowing and planting equipment - construction types - calculation for calibration and adjustments
11	Study of transplanters - paddy, vegetables etc.
12	Study of transplanters – paddy, vegetables etc.
13	Identification of materials of construction in agricultural machinery
14	Study of material properties
15	Study of heat treatment processes subjected to critical components of agricultural machinery
16	Study of heat treatment processes subjected to critical components of agricultural machinery

References

1. Kepner RA, Roy Barger & EL Barger. Principles of Farm Machinery
2. Smith HP and LH Wilkey. Farm Machinery and Equipment
3. Culpin Claude. Farm Machinery
4. Srivastava AC. Elements of Farm Machinery
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FMPE 312 **3 (2+1)**

TRACTOR SYSTEMS AND CONTROLS

Objective To enable the students for acquiring the knowledge pertaining to systems like transmission system clutch, types of clutches, types of gear, sliding, constant mesh type tractor power out lets like P.T.O, belt pulley drawbar, traction theory, rolling resistance, rim pull, crawler tractor.

Lecture	Topic
Theory	
1	Transmission system - types, major functional systems.
2	Transmission system - types, major functional systems.
3	Study of clutch - types - functional requirements - constructions and principle of operation.
4	Familiarization with single plate, multiple plate centrifugal and dual clutch systems.
5	Study of gear box - gearing theory - principle of operation - gear box types - functional requirements and calculation for speed ratio.
6	Study of gear box - gearing theory - principle of operation - gear box types – functional requirements and calculation for speed ratio.
7	Study of differential system - functional components - construction – calculation for speed reduction - study of final drive.
8	Study of differential system - functional components - construction – calculation for speed reduction - study of final drive.
9	Study of brake system - principle of operation – construction - calculation for braking torque.
10	Study of brake system - principle of operation – construction - calculation for braking torque.
11	Study of steering system - steering geometry characteristics - functional components - calculation for turning radius.
12	Study of steering system - steering geometry characteristics - functional components - calculation for turning radius.
13	Familiarization with Ackerman steering - steering systems in track type

tractors.

14 Study of hydraulic system - principle of operation - types - main functional components – functional requirements - hydraulic system adjustment and ADDC.

15 Study of hydraulic system - principle of operation - types - main functional components - functional requirements - hydraulic system adjustment and ADDC.

16 Study of hydraulic system - principle of operation - types -main functional components - functional requirements - hydraulic system adjustment.

17 Study of tractor power outlets – PTO - PTO standards - types and functional requirements.

18 Introduction to traction - traction terminology.

19 Theoretical calculations of shear force and rolling resistance on traction device.

20 Theoretical calculations of shear force and rolling resistance on traction device.

21 Study of wheels and tyres - solid tyres and pneumatic tyres - tyre construction and tyre specification - study of traction aids.

22 Study of wheels and tyres - solid tyres and pneumatic tyres - tyre construction and tyre specification - study of traction aids.

23 Study of traction mechanics - forces acting on tractor and determination of CG of a tractor – methods to determine CG.

24 Study of traction mechanics - forces acting on tractor and determination of CG of a tractor – methods to determine CG.

25 Study of tractor equilibrium - tractor stability - determination of maximum drawbar pulls.

26 Study of tractor equilibrium - tractor stability - determination of maximum drawbar pulls.

27 Problems on tractor stability and tractor chassis.

28 Familiarization with tractor as a spring mass system.

29	Ergonomics and operational safety - definition and operational requirements - VO2 max – Anthropometry - types and principles of anthropometry.
30	Ergonomics and operational safety - definition and operational requirements - VO2 max - Anthropometry - types and principles of anthropometry.
31	Introduction to tractor testing – terminology - engine test codes.
32	Introduction to tractor testing – terminology - engine test codes.

Practical

1	Introduction to transmission systems and components.
2	Calculations of speed ratios, construction and types of gear box.
3	Study of constructional details of differential and final drive.
4	Appraisal of various controls in different makes of tractors in relation to anthropometric measurements.
5	Determination of centre of gravity in tractors.
6	Study of clutch system.
7	Study of brake system and design problems.
8	Study of steering geometry and adjustments.
9	Study of hydraulic system and design problems.
10	Study of tractor power out lets.
11	Study of tractor power out lets.
12	Study of tractor chassis.
13	Driving practice of tractor.
14	Driving practice of tractor.
15	Driving practice of tractor.
16	Practical examination.

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1	Liljedahl J B and Others. Tractors and Their Power Units.
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3 Singh Kirpal. Automobile Engineering – Vol I.

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5 C.B.Richey. Agricultural Engineering Handbook.

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7 Relevant BIS Test Codes for Tractors

IRDE 321 **2 (1+1)**

DRAINAGE ENGINEERING

Objective To enable the students to design and execute proper surface and sub-surface drainage systems in salt affected and water logged areas in agricultural lands and to improve land productivity by controlling the twin problems of water logging and salinity and thereby to enhance the crop production and productivity.

Lecture	**Topic**
Theory	
1	Drainage - definition, objectives and types, familiarization with the drainage problems (twin problems of water logging and salinity) and its extent in irrigated areas of the state
2	Water logging – causes of water logging and impacts - surface drainage, effects of poor drainage, areas requiring drainage, factors affecting drainage requirement, drainage coefficient, determination of drainage coefficient based on different water logging criteria
3	Types of surface drainage - random field drain system, bedding system, parallel field drain, parallel lateral open ditch, cross slope drain system interception system - design of open drainage channels using Manning's equation and alignment of open ditches (radius of curvature)
4	Investigations on drainage design parameters, hydraulic conductivity, drainable porosity, fluctuations of depth to water table in the areas, methods of determining hydraulic conductivity - single auger hole method.
5	Sub-surface drainage systems - purpose and benefits, types of sub-surface systems, tile drains, mole drains, drainage wells, deep open drains and combinations and their suitability for different conditions.
6	Components of sub-surface drainage system - layouts and types- random type, herring bone, grid iron, cut-off or interceptor drains, depth and spacing of drains, size of the pipe drains using Manning's equation, drain materials of burnt clay, perforated corrugated and solid PVC and cement concrete, slope/grade for the drains
7	Envelope materials for sub-surface drains and selection criteria for uniform soils and graded soils, geo-textile and nylon mesh, outlets for sub-surface drainage, gravity and pumped outlets

8 Design of sub-surface drains under steady state (equilibrium) conditions and derivation of Hooghoudt's equation for 'K' with assumptions and its limitations

9 Derivation of Ellipse (Hooghoudt's) equation- q= $v = \frac{8K_b Dh + 4K_a h^2}{S^2}$

10 Derivation of The Ernst's drain spacing (L) equation $h = q(\frac{D_v}{K_v} + \frac{L^2}{8\sum(KD)_h} + \frac{L}{\pi K_r} \ln \frac{aD_r}{u})$ as combination of horizontal, vertical and radial flows

11 Glover-Dumm equation (only) for spacing under non-steady state conditions of water table to drop from 'm_0' to 'm' in time 't'

12 Drainage structures, loads on conduits, ditch conduit conditions and projecting conduit conditions

13 Construction and installation of surface and sub-surface drainage systems

14 Bio-drainage, vertical drainage and drainage of irrigated and humid areas - conjunctive use of fresh and saline water.

15 Salt balance, classification and reclamation of saline and alkaline soils, soil amendments, leaching requirement - leaching ratio - LR = $\frac{D_{dw}}{D_{iw}} = \frac{EC_{iw}}{EC_{dw}}$, changes in soil salinity levels with evaporation

16 Economic aspects of drainage with a typical example for total cost estimation of SSD system and benefit-cost ratio

Practical

1 In-situ measurement of hydraulic conductivity by single auger hole method

2 In-situ measurement of hydraulic conductivity by inverse auger hole method

3 Installation of piezometer and observation well

4 Preparation of iso-bath and iso-bar maps

5 Determination of chemical properties of soil and water

6 Design of surface drainage system

7 Determination of drainage coefficient

8	Design of subsurface drainage system
9	Determination of loads on projecting type conduits and ditch type conduits
10	Determination of drainable porosity
11	Problems on salinity control and leaching requirements
12	Visit to nearby surface and subsurface drainage systems
13	Design of outlets & gravel envelop
14	Cost analysis of surface and subsurface drainage systems
15	Working on a case study of nearby problematic area
16	Practical Examination

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PRFE 331 **3 (2+1)**

AGRICULTURAL STRUCTURES AND ENVIRONMENTAL CONTROL

Objective To enable the student to understand the principles and acquire the knowledge on various aspects in farmstead design and construction and also design and construction of farm structures like dairy barns, barn for poultry, compost pit, fodder silos, farm fencing, implement sheds, rural grain storage structures, silos, rural roads and septic tank.

Lecture	Topic
Theory	
1	Planning and layout of farmstead - location – definition and arrangement, location of various buildings – Scope, importance and need for environmental control
2	Farm service buildings - site selection, planning farm service buildings, factors effecting planning of farmstead
3	Physiological reactions of livestock to solar radiation (dairy cattle, poultry, beef cattle and sheep)
4	Influence of climate and thermoregulation - temperature, relative humidity, direct effect of temperature, direct effect of solar radiation
5	Environmental factors effecting design of farm residence or animal shelter - temperature, relative humidity, air purity, air movement, light, heat and moisture production
6	Livestock production facilities - water and electricity, sanitary requirements, etc.
7	BIS standards for dairy, piggery, poultry and other farm structures
8	Design, construction and cost estimation of farm structures - animal shelters, dairy barn, compost pit, fodder silo
9	Cost estimation of different farm buildings - method of building estimates - actual cost - detailed estimates of main items of work
10	Fencing - design and construction of farm fences, planning of farm fences
11	Type of farm fences - wooden fencing, woven wire fencing, barbed wire fencing, plain wire fencing and electrical fencing.
12	Cost estimation of farm fences - wooden fencing, woven wire fencing, barbed

wire fencing, plain wire fencing and electrical fencing - cost estimation

13 Implement shed - requirements of farm machinery and implement shed - requirements of farm work shop

14 Planning and construction of shed and pump houses - problems and layout

15 Threshing and drying yards - design and construction of drying and threshing floors

16 Barn for cows, buffalo - planning and design of different barns

17 Types of dairy barns based on construction - housing systems - stable barns, free stalls and milking parlor barn layout

18 Poultry houses – Classification - planning and requirements, environmental requirements

19 Modern poultry houses - deep litter housing, building of poultry houses

20 Storage of grains - causes of spoilage - water activity for low and high moisture food and its limits for storage

21 Moisture and temperature changes in grain bins - requirements of good storage structures

22 Types of grain storage structures - Traditional storage structures and their improvements - construction of Bhukari, Morai, Kothari type storage structures

23 Improved grain storage structures (CAP, hermetic storage, Pusa bin, RCC ring bins)

24 Design consideration for grain storage godowns, Bag storage structures, Shallow and Deep bin

25 Calculation of pressure in bins

26 Silo - design and construction of silos in respect of farm uses - types of silos - pit silo, tower silo, trench silo, bunkers

27 Storage of seeds

28 Engineering for rural living and development

29 Rural roads - design and construction of farm road - Construction cost of different roads, repair and maintenance

30 Sources of water supply, norms of water supply for human being and

	animals, drinking water standards and water treatment suitable to rural community
31	Site and orientation of building in regard to sanitation, community sanitation system - Sewage system and its design, cost and maintenance, design of septic tank for small family
32	Estimation of domestic power requirement, source of power supply and electrification of rural housing

Practical

1	Measurements for environmental parameters and cooling load of a farm building
2	Design and layout of dairy farm
3	Design and layout of poultry house
4	Visit to dairy farm
5	Visit to poultry house
6	Design and layout of a sheep/goat house
7	Visit to grain storage structure
8	Design and layout of farm-fencing system
9	Design of ventilation system for dairy barns
10	Design of ventilation system for poultry house
11	Design of a feed/fodder storage structures-silos
12	Design and layout of commercial bag & bulk storage facilities
13	Design and layout of grain storage structures
14	Study and performance evaluation of different domestic storage structure
15	Tutorial on cost estimation of farm building, animal shelters
16	Design of a composite pit, dairy barn.

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RNEE 341 **3 (2+1)**

RENEWABLE POWER SOURCES

Objective To enable the students to understand the principles and concepts of various sources of renewable energy. Also enable to understand of alternative power technologies towards sustainable agriculture and green world environment. There are the basis renewable energy harnessing sources via biomass, solar and wind mainly which can effectively generate power with intervention of power conversion technologies.

Lecture	Topic
Theory	
1	Energy consumption pattern and energy resources in India
2	Renewable energy options - potential and utilization
3	Biogas technology and mechanisms
4	Generation of power from biogas
5	Power generation from biomass (gasification)
6	Power generation from biomass (Dendro thermal)
7	Power generation from urban & municipal waste
8	Power generation from industrial waste
9	Design & use of different commercial sized biogas plant
10	Design & use of different commercial sized biogas plant
11	Solar thermal system - solar power generation
12	Storage of solar energy
13	Solar driven vapour compression system
14	Solar operated vapour absorption system
15	Solar photovoltaic systems for power generation - ccomponents of solar photovoltaic systems and solar street lights
16	Working and components of solar water pump
17	Solar PV based power generating systems

18	Maintenance aspects of photovoltaic systems
19	Central receiver (chimney) and distributed type solar power plant
20	Ocean Thermal Energy Conversion (OTEC) - introduction to ocean energy, methods of OTEC power conversion systems
21	Open cycle OTEC system and closed cycle OTEC system for power generation
22	Magneto hydro-dynamic generator (MHD) - introduction to MHD energy sources
23	MHD system and its working principle - open cycle system and closed cycle system
24	Hydrogen and fuel cell technology - introduction to hydrogen fuel cell technology and its applications - working of fuel cell
25	Fuel cells and its associated parameters - introduction to fuel cells - types of fuel cells and its applications
26	Wind farms - introduction to wind farms and applications
27	Design consideration and classification of wind farms
28	Wind mill - aero-generator systems
29	Wind power generation system - generator characteristics and stability
30	Wind energy devices - collection and transmission network – energy storage - electricity cost and trends
31	Mini and micro small hydel plants - definition of mini, micro and small hydel plants – equipment
32	Mini and micro small hydel plants – layout - design specification and its power generation mechanism

Practical

1	Performance evaluation of solar water heater
2	Performance evaluation of solar cooker
3	Performance evaluation of solar cooker
4	Characteristics of solar photovoltaic panel

5	Characteristics of solar photovoltaic panel
6	Evaluation of solar air heater
7	Evaluation of solar air dryer
8	Performance evaluation of biomass gasifier engine system (throat less)
9	Performance evaluation of biomass gasifier engine system (downdraft)
10	Performance evaluation of a fixed dome type biogas plant
11	Performance evaluation of floating drum type biogas plant
12	Estimation of calorific value of biogas
13	Estimation of calorific value of producer gas
14	Testing of diesel engine operation using dual fuel and gas alone
15	Visit to solar power plant
16	Final practical examination

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SWCE 351 **3 (2+1)**

SOIL AND WATER CONSERVATION ENGINEERING

Objective To enable the students to acquire knowledge on different soil loss estimation models, runoff estimation by rational, curve number, Cook's etc., land use capability classification, land treatment works like contour bunding, terracing, bench terraces, contour trenches and their types and complete design calculations. Also to enrich the students and familiarize the students in the design of various gully control structures, temporary and permanent, their designs with a due importance to hydrologic, hydraulic and structural phases of design.

Lecture	Topic
Theory	
1	Introduction - Soil and Water Conservation Research Centre - its sub-centers in India- soil conservation programmes in India
2	Causes and agents of erosion - factors affecting erosion - effects of soil erosion
3	Soil Erosion - geologic, accelerated erosion, water erosion - forms of water erosion - splash, rill, sheet, gully, ravines and stream bank erosion
4	Mechanics of water erosion - hydraulic action, abrasion, attrition, saltation, transportation and deposition
5	Gullies and their classification - stages of gully development.
6	Soil loss estimation - Universal soil loss equation and modified soil loss equation – A = RKLSCP - expansion of various terms - estimation of their various parameters - modified USLE.
7	Rainfall erosivity - estimation by KE > 25 and EI_{30} methods
8	Soil erodibility - topography, crop management and conservation practice factors
9	Measurement of soil erosion - runoff plots, soil samplers - multislot devisor, Coshocton wheel sampler.
10	Land use capability classification based on different criteria with a special reference to slope

11	Erosion control measures - agronomical measures - contour farming, strip cropping, conservation tillage and mulching.
12	Erosion control measures - mechanical or engineering measures – bunds, terraces, trenches - classification of bunding system
13	Contour bunds - design of contour bunds - horizontal interval - vertical interval - cross section of the contour bunds - seepage line consideration
14	Contour bunds - design of contour bunds - length of contour bund, earth work of contour bund
15	Determination of height of bund - loss of area due to bunding - construction of contour bunds in field
16	Graded bunds - design of graded bunds - construction and alignment of bunds - design of surplus arrangements
17	Terraces - classification of terraces – level and graded terraces, narrow based and broad based terraces
18	Contour stone wall/stone terracing - measures for controlling land slides
19	Design of graded terrace - runoff from terrace - terrace channel capacity
20	Bench terraces - types of bench terraces – planning & design of bench terraces - derivation for an equation for finding out vertical interval–terrace width and gradient
21	Layout procedure for bench terraces - alignment, area lost for cultivation
22	Graded terrace construction and maintenance
23	Contour trenching - staggered and continuous trenches - adaptability and types
24	Principles of gully control – stabilization of gully head - vegetative measures and diversion drains
25	Temporary gully control structures – design - types like brush wood dams - wire mesh dams etc. - introduction to permanent gully control structures - design phases - components of permanent structures.
26	Vegetated waterways - types of water ways based on shapes - expressions for wetted perimeters – areas - hydraulic radii - types of vegetation - roughness of different grasses - design of vegetated waterways
27	Wind erosion - factors affecting wind erosion, mechanics of wind erosion

28 Soil loss estimation - wind erosion control measures - vegetative, mechanical measures

29 Wind breaks & shelter belts - sand dunes stabilization

30 Sedimentation - sedimentation in reservoirs and streams - estimation and measurement - sediment delivery ratio

31 Trap efficiency, silt monitoring and storage loss in tanks

32 Estimation of useful life of reservoir based on sedimentation

Practical

1 Study of different types and forms of water erosion

2 Problems on Universal soil loss equation. Soil loss estimation using erosivity index and erodibility index

3 Determination of length of slope (LS) and cropping practice (CP) factors for soil loss estimation by USLE and MUSLE.

4 Study of rainfall simulators for erosion assessment

5 Estimation of soil loss from runoff plots

6 Estimation of soil loss using Coshocton wheel sampler & multi slot divisor

7 Design of contour bunding system

8 Design of graded bunding system

9 Design and layout of broad based terraces

10 Design and layout of bench terracing systems

11 Determination of rate of sedimentation and storage loss in reservoir/tanks

12 Design of vegetative water ways in the field

13 Computation of soil loss by wind erosion

14 Design of shelter belts and wind breaks

15 Field visit to study different soil conservation structures & gully control structures

16 Practical examination

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5 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.

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

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

SWCE 352 **2 (1+1)**

WATERSHED PLANNING AND MANAGEMENT

Objective To train the students in the multi disciplinary subject of watershed management for effective conservation of land using engineering and agronomic practices, control of soil loss in watershed, participatory management teams in small as well as large watersheds for increasing the productivity and preparation of necessary project proposals.

Lecture	Topic
Theory	
1	Watershed - Introduction – concept and characteristics - watershed development – watershed area, command area and identification of watershed problems and prospects
2	Major investigations on topographical survey, soil characteristics, vegetative cover, present land use practices and socio-economic factors.
3	Watershed management - concept, objectives, factors affecting, watershed planning based on land capability classes
4	Geomorphology of watersheds - size and shape of watershed, slope, order, number of streams in a basin, stream pattern and others
5	Evolution of effects of watershed management treatments - statistically, hydrological sediment yield and scatter diagrams.
6	Hydrologic data for watershed planning, watershed codification, delineation and prioritization of watersheds
7	Sediment yield – factors affecting the sediment yield – measurement and sediment yield index- controlling sedimentation, water budgeting in a watershed
8	Management measures - rainwater conservation technologies - *in-situ* and *ex-situ* storage - water harvesting and recycling- advantages and benefits
9	Dry farming techniques - inter-terrace and inter-bund land management. Forest plantation – terracing, surface cover brushwood and planting
10	Integrated watershed management – concept, objectives, components, arable lands - agriculture and horticulture, non-arable lands - forestry, fishery and animal husbandry

11 Effect of cropping systems, land management and cultural practices on watershed hydrology

12 Watershed programme - execution - project implementation and evaluation, follow-up practices - characteristics of forest watersheds, forest plantation, streams and soils

13 Watershed programme – maintenance and control measurements, monitoring, evaluation and reporting

14 Participatory watershed management - role of watershed associations, user groups and self-help groups

15 Planning of project proposal for watershed management programme including cost-benefit analysis.

16 Formulation of project proposal for watershed management programme including cost-benefit analysis.

Practical

1 Tutorial on delineation of watersheds using toposheets.

2 Surveying and preparation of watershed map.

3 Quantitative analysis of watershed characteristics

4 Quantitative analysis of watershed parameters

5 Watershed investigations for planning and development

6 Analysis of hydrologic data for planning watershed management.

7 Water budgeting of watersheds.

8 Prioritization of watersheds based on sediment yield index.

9 Study on functional requirement of watershed development structures.

10 Study on watershed management technologies.

11 Practice on softwares for analysis of hydrologic parameters of watershed.

12 Study on role of various functionaries in watershed development programmes.

13 Techno-economic viability analysis of watershed projects.

14 Visit to watershed development project areas.

15 Visit to watershed development project areas.

16 Practical examination

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

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13 Will critchley.2013.water harvesting. A manual for the design and construction of water harvesting schemes for plant production.

AABS 302 **3 (2+1)**

ENTREPRENEURSHIP DEVELOPMENT AND BUSINESS MANAGEMENT

Objective To train the students to become successful entrepreneurs and employers in their chosen field of agricultural engineering with management skills coagulated with motivation by way of considering the social and political systems and to perform SWOT analysis for the technological innovations. To impart knowledge on management functions and agribusiness management.

Lecture	Topic
Theory	
1	Agribusiness management – the distinctive features of agribusiness management – the importance of good management – definitions of management.
2	Entrepreneurship - concept of entrepreneur and entrepreneurship.
3	Management functions – management cycle, planning organization, direction, motivation, ordering, leading, supervision, co-ordination, communication and control.
4	Capital – meaning – working capital – gross working capital – net working capital – permanent working capital – temporary working capital – balance sheet working capital – cash working capital
5	Financial management – importance of financial statements – balance sheet – profit and loss statement.
6	Analysis of financial statements – liquidity ratios – leverages ratios - coverage ratios – turnover ratios – profitability ratios.
7	Agro-based industries – importance – need – procedure to be followed to set up agro-based industries – constraints in establishing agro-based industries.
8	Project – meaning – definition – project cycle – identification – formulation – appraisal – monitoring – evaluation.
9	Project appraisal and evaluation techniques – undiscounted measures – payback period – proceeds per rupee of outlay.
10	Discounted measures – Net Present Value (NPV) – Benefit-Cost Ratio (BCR) – Internal Rate of Return (IRR) – Net benefit investment ratio (N / K ratio) – sensitivity analysis

11 Role of financial institutions for funding enterprises.

12 Principles of taxation and tax structure in India.

13 Overview of Agricultural Engineering industry - characteristics of Indian farm machinery industry.

14 International trade – definition, comparison between international trade and inter regional trade, free trade vs protectionism, methods of protectionism.

15 General agreement on trade and tariff (GATT), WTO - objectives, functions and structure of WTO, why WTO, ten benefits of WTO.

16 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).

17 Entrepreneurship Development (ED) - assessing overall business environment in Indian economy.

18 Entrepreneurial and managerial characteristics

19 Entrepreneurship development programmes (EDP)

20 Generation, incubation and commercialization of ideas and innovations.

21 Motivation and entrepreneurship development

22 Globalization and the emerging business entrepreneurial environment.

23 Managing an enterprise - importance of planning, budgeting, monitoring evaluation and follow-up managing competition.

24 Government schemes and incentives for promotion of entrepreneurship. Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors.

25 Role of ED in economic development of a country.

26 Overview of Indian social, political systems and their implications for decision making by individual entrepreneurs.

27 Economic system and its implications for decision making by individual entrepreneurs.

28 Joint ventures (JV), Public-Private Partnerships (PPP).

29 Venture capital (VC), Contract farming (CF).

30 Social responsibility of business - morals and ethics in enterprise management

31 SWOT analysis

32 Capital Markets

Practical

1 Analysis of balance sheet.

2 Analysis of income statement

3 Break even analysis

4 Financial ratio analysis

5 Methods of estimation of depreciation

6 Compounding & discounting techniques

7 Project appraisal techniques – I, PBP,ROR& NPW

8 Project appraisal techniques-II, BCR &IRR

9 Project appraisal techniques-III N/K Ratio& Sensitivity Analysis

10 Visit to public enterprise.

11 Visit to private enterprise.

12 Visit & study of profile of agro based industry

13 SWOT analysis of public enterprises.

14 SWOT analysis of private enterprises.

15 Formulation of project feasibility reports.

16 Farm machinery project proposals as entrepreneur – individual and group.

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FMPE 313 **3 (2+1)**

FARM MACHINERY AND EQUIPMENT - II

Objective To enable the students to understand the basic principles of cutting mechanisms and various available harvesting machines. To know the working and functions of various machine parts of mowers, reapers, windrowers, forage harvesters, threshers, corn harvesters, cotton strippers, cotton pickers, groundnut and potato harvesters, combines, sugarcane harvesters. Students can also understand the importance of testing and evaluation of agricultural machines and different standard codes available for testing in India.

Lecture	Topic
Theory	
1	Introduction to plant protection equipment.
2	Classification of sprayers, sprays and types of nozzles.
3	Calculations for calibration of sprayers and chemical application rates.
4	Introduction to intercultural equipment.
5	Weeders - study of functional requirement of weeder and main components.
6	Weeders - study of functional requirement of weeder and main components.
7	Familiarisation of fertilizer application equipment.
8	Study of harvesting operation - harvesting methods - harvesting terminology.
9	Study of mowers - types - construction details - working and adjustments.
10	Study of shear type harvesting devices - cutter bar, inertial forces counter balancing terminology, cutting pattern.
11	Study of reapers, binders and windrowers - principle of operation and constructional details.
12	Importance of hay conditioning.
13	Methods of hay conditioning and calculation of moisture content of hay.
14	Introduction to threshing systems - manual and mechanical systems - types of threshing drums and their application.
15	Introduction to threshing systems - manual and mechanical systems - types of

threshing drums and their application.

16 Type of threshers - tangential and axial - their constructional details and cleaning systems.

17 Type of threshers - tangential and axial - their constructional details and cleaning systems.

18 Study of factors affecting thresher performance.

19 Study of grain combines, combine terminology - classification of grain combines - study of material flow in combines.

20 Computation of combine losses, study of combine troubles and troubleshooting.

21 Study of chaff cutters and capacity calculations.

22 Study of straw combines - working principle and constructional details.

23 Study of root crop diggers - principle of operation - blade adjustment - approach angle and calculation of material handled.

24 Study of root crop diggers - principle of operation - blade adjustment and approach angle - calculation of material handled.

25 Study of root crop diggers - principle of operation - blade adjustment and approach angle - calculation of material handled.

26 Study of potato digger.

27 Study of groundnut digger.

28 Study of cotton harvesting - cotton harvesting mechanisms - study of cotton pickers and strippers functional components.

29 Study of cotton harvesting - cotton harvesting mechanisms, study of cotton pickers and strippers functional components.

30 Study of cotton harvesting - cotton harvesting mechanisms, study of cotton pickers and strippers functional components.

31 Study of maize harvesting combines.

32 Introduction to vegetables and fruit harvesting equipment and tools.

Practical

1	Study of plant protection equipment.
2	Study of sprayers, types and functional components.
3	Study of dusters, types and functional components.
4	Calculations for chemical application rates.
5	Study of nozzle type sand spread pattern using patternator.
6	Study of manual weeder & power weeder.
7	Study of fertilizer application equipment.
8	Study of mower, reaper and reaper binder.
9	Study of threshing systems, cleaning systems in thresher.
10	Calculations of losses in threshers.
11	Study of grain combines and their types & grain losses in a combine.
12	Study of root crop diggers.
13	Study of cotton harvesters.
14	Study of maize harvester.
15	Study of vegetable and fruit harvester.
16	Practical exam.

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

FMPE 314 **2(0+2)**

TRACTOR AND FARM MACHINERY OPERATIONS AND MAINTENANCE

Objective To enable the students for acquiring the knowledge pertaining to maintenance of tractors like periodical maintenance (50 to 100 hours, 200 to 250, 480 to 500 engine working hours, 960-1000 hours) and trouble shooting of all systems like fuel system, lubrication systems, cooling system and ignition system and remedial measures for above system.

Lecture	**Topic**
Theory	
Practical	
1	Familiarization with different makes & models of agricultural tractors.
2	Identification of functional systems - fuel system - cooling system transmission system - steering and hydraulic system.
3	Study of maintenance, points to be checked before starting a tractor.
4	Familiarization with instrumentation panel & controls.
5	Safety rules and precautions to be observed while driving a tractor.
6	Driving practice.
7	Driving practice.
8	Driving practice.
9	Driving practice with a trail type trolley - forward and in reverse direction.
10	Driving practice with a trail type trolley - forward and in reverse direction.
11	Driving practice with a trail type trolley - forward and in reverse direction.
12	Driving practice with a trail type trolley - forward and in reverse direction.
13	Practice of operation of tillage tools.
14	Study of field pattern while operating a tillage implement.
15	Hitching and de-hitching of mounted and trail type implement to the tractor.
16	Hitching and de-hitching of mounted and trail type implement to the tractor.
17	Introduction to tractor maintenance - precautionary and break down

	maintenance.
18	Introduction to trouble shooting of tractor.
19	Introduction to trouble shooting of tractor.
20	Introduction to trouble shooting of tractor.
21	Top overhauling and fuel saving tips.
22	Preparation of the tractor for storage.
23	Care and maintenance procedure of agricultural machinery.
24	Care and maintenance procedure of agricultural machinery.
25	Repair and maintenance of implements - adjustment of functional parameters in tillage implements.
26	Replacement of broken components in tillage implements.
27	Replacement of furrow openers and change of blades of rotavator.
28	Maintenance of cutter bar in a reaper.
29	Adjustments in a thresher for different crops.
30	Replacements of V-belts on implements.
31	Setting of agricultural machinery workshop.
32	Practical exam.

References

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

IRDE 322 **3 (2+1)**

GROUNDWATER, WELLS AND PUMPS

Objective To introduce the ground water hydrology concepts to the under graduate students in order to provide basic knowledge about the aquifers, wells and pumps and its characteristics and to impart the skills for design of various wells, pumps according to the site specific situations.

Lecture	**Topic**
Theory	
1	Introduction - role of ground water in water resources - global water scenario - water resources status in India – water budget in India - classification of ground water and it's vertical distribution - occurrence and movement of ground water
2	Aquifer - its types - unconfined aquifers, confined aquifer, leaky aquifer and idealized aquifer - diagrammatic representations
3	Classification of wells - based on type of aquifer, depth of the well and method of construction of the well - types of flows in wells - fully penetrating tube wells and open wells, familiarization of various types of bore wells
4	Design of open wells – site for an open well and it's types – design procedure for open wells
5	Groundwater replenishment and methods of ground water recharge - groundwater exploration techniques - test drilling, geophysical methods, electrical resistivity method, gamma ray logging, electrical resistivity surveying, seismic refraction surveying etc.
6	Methods of drilling of wells - percussion, rotary, reverse rotary - common drilling difficulties
7	Design of tube well - well diameter and yield, thickness of the casing pipe and well screen, well depth, length of well screen etc.
8	Deign of gravel packing - installation of well screen and its types, losses - material of the well screens - completion and well development
9	Groundwater hydraulics - static water level - piezometric water level - pumping water level, drawdown, area of the influence and well yield etc. - aquifer characteristics influencing yield of wells - hydraulic conductivity, transmissibility etc.

10 Determination of aquifer parameters – flow through steady state unconfined aquifer and steady state confined aquifers - Dupit-Thiem equations

11 Determination of aquifer parameters under unsteady state conditions in confined aquifer by Theis method

12 Chow's method for finding out aquifer parameters in confined aquifer under unsteady state conditions

13 Jacob method – Theis recovery test for unsteady state aquifer

14 Well interference and it's design - multiple well systems

15 Estimation of ground water potential

16 Quality of ground water and suitability for irrigation

17 Artificial ground water recharge techniques - direct method, indirect method and combination methods using remote sensing and GIS.

18 Pumping systems and water lifting devices, classification of pumps – indigenous water lifting devices such as swing basket, *don*, Archimedean screw, water wheel, Persian wheel, chain pump, rope and bucket lift etc.

19 Wind powered water lifts – solar powered and biogas operated water lifts

20 Reciprocating pumps - single and double acting pumps - problems on reciprocating pumps

21 Components of centrifugal pumps - volute and diffuser principles and diagrammatic representation - classification of centrifugal pumps based on the different criteria - necessity of priming.

22 Terminology and problems on horse power - water horse power - shaft horse power - brake horse power - kilowatt – input to motor – drive efficiency and motor efficiency.

23 Selection of pump - installation, trouble shooting of pumps - design of centrifugal pumps

24 Performance curve, effect of speed on capacity, head, power and efficiency curves

25 Effect of change of impeller dimensions on performance or characteristics - related problems

26 Hydraulic ram and its working principle

27	Propeller pumps and mixed flow pumps - their performance characteristics
28	Mixed flow pumps - their performance characteristics
29	Jet pumps and air lift pumps with their working principle
30	Deep well turbine pump - construction, installation and maintenance
31	Submersible pumps - construction, installation and maintenance
32	Cost economics of motor and pump sets – fixed costs, variable costs, operational cost etc.

Practical

1	Verification of Darcy's law
2	Study of different drilling equipments
3	Sieve analysis for gravel and well screens design
4	Estimation of specific yield and specific retention
5	Study on testing of well screen
6	Estimation of aquifer parameters by Theis method, Coopers-Jacob method, Chow method and Theis recovery method
7	Well design under confined and unconfined conditions
8	Study on well losses and well efficiency
9	Estimating groundwater potential based on ground water balance
10	Study of artificial ground water recharge structures
11	Study of radial flow and mixed flow centrifugal pumps
12	Study of multistage centrifugal pumps, turbine, propeller and other pumps
13	Installation of centrifugal pump, turbine and submersible pumps
14	Testing of centrifugal pump, submersible pump and study of cavitations
15	Problems on cost analysis of pumping systems
16	Practical examination

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

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

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

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5 H M Raghunath, 2014. Hydrology principles, analysis and design, New age international publications.

PRFE 332 **3 (2+1)**

DAIRY AND FOOD ENGINEERING

Objective Knowledge on milk and food processing unit operations offers strength to students to handle pasteurization, sterilization, homogenization, packaging, etc., of dairy products and control spoilage of food through process operations such as evaporation, freezing, membrane processing etc.

Lecture	**Topic**
Theory	
1	Deterioration in food products and their controls, physical, chemical, and biological methods of food preservation - description - principles of food preservation - food preservation methods - causes of food spoilage and classification of food with respect to spoilage and consumption
2	Deterioration in food products and their controls - effects of pH and water content on growth of microorganisms, methods of controlling water content, effect of water activity, methods of measuring a_w, oxidation - reduction potential effect on microorganisms
3	Dairy development in India - introduction, statistics of production and consumption - activities of NDDB, Indian dairy products with brief description
4	Properties of milk - engineering, thermal and chemical properties of milk and milk products - composition of milk, effects of pH, developed acidity, natural acidity, total acidity, density, specific gravity, freezing point, colour and flavour.
5	Process flow charts for product manufacture - unit operations of various dairy and food processing systems - milk receiving - principles and equipment - quantity determination - quality evaluation - milk grading - cleaning and sanitation of milk handling equipment - facilities - procedures for reception and returns.
6	Pasteurization - purpose - introduction to microorganisms - enzymes and their reaction to temperature and other influences - bacteria in milk.
7	Pasteurization - flow chart - principles and details of equipment related to pasteurization - vat, tubular heat exchanger, plate heat exchanger - effect of heat treatment.
8	Standardization of milk - standardization by Pearson square method and mass

	and material balance method - problem solving
9	Sterilization - principles and equipment - UHT method - direct and indirect heating - sterilization in the package - temperature and pressure patterns - equipment for sterilizing goods in the package - batch autoclaves, continuously operating sterilizers
10	Homogenization - emulsion - types of emulsions - principles - application, mode of operation, technical execution, effect on the product - equipment related to homogenization.
11	Centrifugation and cream separation - principles - application of separation in the dairy industry, velocity of particles in a gravitational field - distribution of fat globule diameters in milk - velocity of particles in a centrifugal field - problem solving
12	Centrifugation and cream separation - equipment related to separation - disc bowl centrifuge - cyclone separator for gas phase - problem solving
13	Cheese manufacture - classification of cheese - technology of cheese making - selection of milk - heat treatment - standardizing of cheese milk - starter culture and rennet - processing of curd - filling, shaping, turning, pressing, salting, ripening and final treatment
14	Paneer manufacture - selection of milk - standardization - heat treatment - coagulation - hooping & pressing - packaging and storage.
15	Butter manufacture - principle - treatment of cream - churning - overrun - factors affecting churnability - methods (butter churn, continuous butter making) - butter oil and special butter products
16	Ice cream manufacturing - flow chart - classification - composition - equipment - methods – overrun
17	Filling and packaging of milk and milk products - milk and milk product packaging materials - filling and metering - packaging methods - packaging of milk, cultured milk, cheese, butter, concentrated milk and dried milk
18	Dairy plant design and layout - target of minimum cost, factors in planning, importance of site selection, location of building, size and type of dairy building, advantages of good plant layout, functional design, flow plan
19	Dairy plant design and layout - operating schedule and layout, process selection, single and multi-level construction of buildings, floor space, walls and ceiling, ventilation, doors, windows and lighting, flooring, drainage

20 Plant utilities - electricity, water, boilers, air moving equipment - refrigeration and air conditioning

21 Principles of operation and equipment for thermal processing - principles - process of canning and aseptic processing

22 Evaporation - applications - functions - factors affecting rate of evaporation - basic evaporator construction - factors affecting liquid boiling point - thermodynamics of evaporation (phase change, boiling point elevation, Dühring plot).

23 Evaporation - heat and mass transfer in evaporator - factors influencing the overall heat transfer coefficient - influence of feed liquor properties on evaporation - factors influencing the economy of evaporation - boiling at a submerged surface - steam economy

24 Evaporation - types of evaporation equipment - natural circulation evaporators – batch type, horizontal short tube, vertical short tube, natural circulation with external calandria, long tube - forced circulation (general forced circulation, plate, expanding flow, mechanical / agitated thin film), single effect, multiple effect evaporators, feeding methods of multiple effect evaporation systems, vapour recompression

25 Drying of liquid and perishable foods - principles of drying - spray drying, drum drying - freeze drying

26 Filtration - principle - types of filtration - types of filters - filter presses, cartridge filters, continuous rotary vacuum filter, filter centrifuges

27 Membrane separation – introduction - membrane separation methods - RO, nano-filtration methods, equipments and applications

28 Membrane separation - membrane separation methods - ultra filtration and macro-filtration methods, equipments and applications.

29 Thermal processing - reaction kinetics - principle, effect of time and temperature - temperatures vs time, thermal death time curve

30 Non-thermal and other alternate thermal processing techniques in food processing - basics of high hydrostatic pressure, microwave heating, radio frequency, ultrasound, food irradiation, pulsed electric field, ohmic heating

31 Nanotechnology - history - fundamental concepts - tools and techniques

32	Nanotechnology - nanomaterials - applications in food packaging and products – implications - environmental impact of nanomaterials and their potential effects on global economics - regulation of nanotechnology

Practical

1	To study properties of milk
2	To study various parts of pasteurizer and it's working
3	To study various parts of sterilizer and it's working
4	To study various parts of homogenizer and it's working
5	To study various parts of cream separator and it's working
6	To study various parts of butter churner and it's working
7	To study various parts of evaporator and it's working
8	To study various parts of milk dryer and it's working
9	To study various parts of freezer and it's working
10	Study of filtration equipment in food industry
11	Study on membrane separation equipment
12	Design of food processing plants & preparation of layout
13	Visit to multi-product dairy plant
14	Estimation of steam requirement in dairy & food plant
15	Estimation of refrigeration requirement in dairy & food plant
16	Visit to food industry

References

1	Ahmed, T. 1997. Dairy Plant Engineering and Management. 4th Ed. Kitab Mahal
2	McCabe, W.L. and Smith, J. C. 1999. Unit Operations of Chemical Engineering. McGraw Hill.
3	Rao, D.G. Fundamentals of Food Engineering. PHI learning Pvt. Ltd. New Delhi.

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

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

6 Kessler, H. G., 1981. Food Engineering and Dairy Technology. Verlag A. Kessler, Freising.

7 Sukumar, D. C., 2005. Outlines of Dairy Technology. Oxford University Press, New Delhi.

PRFE 333 **2 (1+1)**

POST HARVEST ENGINEERING OF HORTICULTURAL CROPS

Objective This course enables the students to acquaint with optimum storage methods of harvested fruits and vegetables, cleaning, grading, handling, transportation, storage, caning, preservation methods and packaging materials etc., to increase the shelf life and minimize the post harvest losses.

Lecture	**Topic**
Theory	
1	Importance of processing of fruits and vegetables, spices, condiments and flowers. Characteristics and properties of horticultural crops important for processing
2	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.
3	Blanching - importance and objectives - blanching methods, effects on food (nutrition, colour, pigment, texture).
4	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)
5	Effect on food during chilling and freezing - cold storage heat load calculations and cold storage design - refrigerated vehicle and cold chain system
6	Dryers for fruits and vegetables - osmo-dehydration
7	Packaging of horticultural commodities - packaging requirements (in terms of light transmittance, heat, moisture and gas proof, micro organisms, mechanical strength)
8	Different types of packaging materials commonly used for raw and processed fruits and vegetables products
9	Bulk and retail packages and packaging machines - handling and transportation of fruits and vegetables - pack house technology - minimal

processing

10 Common methods of storage - low temperature storage - evaporative cooled storage - controlled atmospheric storage - modified atmospheric packaging

11 Preservation technology - general methods of preservation of fruits and vegetables

12 Brief description, advantages and disadvantages of different physical / chemical and other methods of preservation

13 Flowcharts for preparation of different finished products of horticultural crops - study on food supply chain

14 Important parameters and equipment used for different unit operations

15 Post harvest management and equipment for spices and flowers

16 Quality control in fruit and vegetable processing industry

Practical

1 Measurement of physical properties of fruits and vegetables

2 Performance evaluation of peeler and slicer

3 Performance evaluation of juicer and pulper

4 Performance evaluation of blanching equipment

5 Performance evaluation of freezer

6 Testing adequacy of blanching

7 Study of cold storage and its design

8 Study of CAP and MAP storage

9 Minimal processing of vegetables

10 Preparation of value added products

11 Visit to fruit and vegetable processing industry

12 Visit to spice processing plant

13 Study of packaging material and their properties

14 Study of controlled atmospheric storage systems for horticultural produce

15 Extraction of oleoresins and essential oils from aromatic crops

16 Visit to cold chain

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

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

3 Pandey, R.H. 1997. Postharvest Technology of fruits and vegetables (Principles and practices). Saroj Prakashan, Allahabad

4 Sudheer, K P. and Indira, V. 2007. Post Harvest Engineering of horticultural crops. New india Publishing House.

RNEE 342 **3 (2+1)**

BIO-ENERGY SYSTEMS: DESIGN AND APPLICATIONS

Objective To enable the students to understand the design and application of various sources of bio energy systems. Also, enable to understand alternative power technologies towards sustainable agriculture and green world environment. Understand various bio energy conversion methods via fermentation, landfill, biomass conversion, bio hydrogen etc., harnessing energy to effectively generate power

Lecture	**Topic**
Theory	
1	Fermentation - introduction to fermentation processes and its general requirements
2	Fermentation - definition of aerobic fermentation process - an overview and factors affecting the process and its uses
3	Fermentation - aerobic fermentation process technologies and their industrial application
4	Fermentation - definition of anaerobic fermentation process - an overview and factors affecting the process and its uses
5	Fermentation - industrial application of fermentation processes
6	An overview of anaerobic digestion system - heat transfer processes in anaerobic digestion system
7	Anaerobic digestion - anaerobic digestion system heat transfer model for cold weather
8	Landfill Gas Technologies (LFG) - landfill gas technology and potential uses
9	Landfill Gas Technologies (LFG) - methodologies of landfill gas recovery - maintenance and its monitoring
10	Landfill Gas Technologies (LFG) - landfill gas technology - fuel cell technology, conversion of CH_4 from LFG to CNG
11	Biomass production – wastelands - classification and their use through energy plantation
12	Biomass production - selection of species - methods of field preparation and

	transplanting
13	Biomass production - harvesting of biomass and coppicing characteristics
14	Biomass conversion technologies - biomass preparation techniques for harnessing (size reduction, densification and drying) energy
15	Biomass conversion technologies - thermo-chemical degradation and chemistry of gasification process
16	Gas producer - history of small producer gas engine system
17	Gas producer - types of producer gas technologies - operating principle
18	Gas producer - gasifier fuels and properties
19	Gas producer - preparation and conditioning of producer gas
20	Gas producer – application and shaft power generation
21	Gas producer - thermal application and economics
22	Bio fuels - introduction to bio fuels - source of bio fuels biomass - characteristics of biodiesel produced - applications
23	Bio fuels - various technologies used for biodiesel production
24	Bio fuels - trans-esterification process for biodiesel production
25	Bio-hydrogen - introduction to bio-hydrogen production process - different feed stocks for bio-hydrogen production
26	Bio-hydrogen - a range of bio-hydrogen production routes
27	Bio-hydrogen - technology for bio hydrogen production from lignocellulose biomass
28	Bio-hydrogen - technology for bio hydrogen production from various biomass
29	Bio-energy - introduction to bio-energy - potential and its distribution in Indian context
30	Bio-energy - application of bio-energy as cooking fuel - biogas - power and heat generation
31	Bio-energy - environmental aspect of bio-energy
32	Bio-energy - assessment of greenhouse gas mitigation potential

Practical

1	Study of anaerobic fermentation system for industrial application
2	Study of gasification for industrial process heat
3	Study of biodiesel production unit
4	Study of biomass densification technique (briquetting)
5	Study of biomass densification technique (pelletization and cubing)
6	Integral bio-energy system for industrial application
7	Study of bio-energy efficiency in industry and commercial buildings
8	Study and demonstration of energy efficiency in buildings
9	Measuring efficiency of different insulation techniques
10	Study of Brayton cycles
11	Study of Stirling cycles
12	Study of Rankine cycles
13	Study of modern greenhouse technologies - cooling
14	Study of modern greenhouse technologies - climate control
15	Visit to bio-energy based industry
16	Final practical

References

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

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

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

SWCE 353 **3 (2+1)**

WATER HARVESTING AND SOIL CONSERVATION STRUCTURES

Objective To enable the students to acquire knowledge on rain water harvesting and storage, land treatment works and their complete design. Also, to enrich and familiarize the students in the design of various soil erosion control structures with a due importance to hydrological, hydraulic and structural phases of design.

Lecture	**Topic**
Theory	
1	Water harvesting – principles - advantages and disadvantages of water harvesting - importance and issues
2	Water harvesting techniques - classification based on source - storage and use.
3	Runoff harvesting – short-term and long-term techniques.
4	Short-term harvesting techniques - terracing, bunding, rock ground catchments and mechanical measurements.
5	Long-term harvesting techniques - purpose and design criteria.
6	Structures - farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes.
7	Farm pond - components, site selection, design criteria, capacity
8	Earth embankment – types - site selection – construction details of embankment - design criteria - seepage analysis - capacity – calculation.
9	Emergency spillways - cost estimation and construction.
10	Percolation pond - site selection - design and construction details - design considerations of *nala* bunds.
11	Soil erosion control structures - introduction, classification and functional requirements.
12	Permanent erosion control structures uses – advantages, adaptabilities and limitations
13	Stages of gully development - classification of gullies - methods for gully

control - check dams - types of check dams

14 Types of permanent structures - drop spillways – chute and drop inlet spillways

15 Drop spillways – uses – guidelines for selection - construction details.

16 Design of drop spillways for gully control - hydrologic, hydraulic and structural design – related problems

17 Design of chute spillways for gully control - hydrologic, hydraulic and structural design- planning for design of the spillways

18 Drop inlet spillways – use - design of structures - requirements, planning for design of the spillways - related problems

19 Gully control measures - causes and process

20 Hydraulic jump - advantages of hydraulic jump - jump in channels - energy loss equation - height of jump and length of the jump - classification of jump and its application - related problem on energy loss

21 Drop spillway – applicability - types - straight drop, box type inlet, straight apron and stilling basin outlet - functional use of drop spillways - advantages and disadvantages of the spillways

22 Description of box type inlet spillways - hydraulic design of box-type inlet spillways – related problems

23 Description of straight apron and stilling basin outlet

24 Design of straight apron and stilling basin outlet - related problems

25 Structural components and functions of drop spillways

26 Loads on head wall - variables affecting equivalent fluid pressure

27 Triangular load diagram for various flow conditions

28 Creep line theory in a load diagram

29 Uplift pressure estimation - safety against sliding - overturning, crushing and tension on spillways

30 Chute spillway - description, components, energy dissipaters

31 Design criteria of Saint Antony Falls (SAF) stilling basin - limitations.

32 Drop inlet spillway - description, functional use - design criteria of the drop

inlet spillway

Practical

1	Study of different types of farm ponds.
2	Computation of storage capacity of embankment type of farm ponds.
3	Design of dugout farm ponds
4	Design of percolation pond
5	Design of nala bunds
6	Runoff measurement using H-flume
7	Tutorials on hydraulic jump and energy dissipation in water flow
8	Tutorials on hydrologic, hydraulic and structural design of drop spillway and stability analysis.
9	Design of SAF stilling basins in chute spillway.
10	Tutorial on hydrologic, hydraulic and structural design of drop inlet spillway.
11	Design of small earthen embankment structures.
12	Practice on softwares for design of soil and water conservation structures.
13	Field visit to watershed project areas treated with soil conservation measures
14	Field visit to water harvesting measures
15	Field visit to water conservation structures
16	Practical examination

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4. Murthy VVN. 2013. Land and Water Management Engineering. Kalyani

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FMPE 411 **3 (2+1)**

MECHANICS OF TILLAGE AND TRACTION

Objective To enable the students to understand the mechanics of tillage tools in relation with soil. Designing the soil engaging elements. To know the design of soil engaging elements, measurement of shear, compressive, tensile strength of soil and also getting knowledge on tread design, traction and transport devices.

Lecture	**Topic**
Theory	
1	Introduction to mechanics of tillage tools.
2	Introduction to mechanics of tillage tools.
3	Introduction to mechanics of tillage tools.
4	Engineering properties of soil principles and concepts, stress strain relationship.
5	Engineering properties of soil principles and concepts, stress strain relationship.
6	Engineering properties of soil, principles and concepts, stress strain relationship.
7	Engineering properties of soil, principles and concepts, stress strain relationship.
8	Engineering properties of soil, principles and concepts, stress strain relationship.
9	Engineering properties of soil, principles and concepts, stress strain relationship.
10	Design of tillage tools.
11	Design of tillage tools.
12	Design of tillage tools.
13	Principles of soil cutting.
14	Design equation, force analysis.
15	Application of dimensional analysis in soil dynamics and traction prediction

equation.

16 Principles of soil cutting, design equation, force analysis, application of dimensional analysis in soil dynamics and traction prediction equation.

17 Principles of soil cutting, design equation, force analysis, application of dimensional analysis in soil dynamics and traction prediction equation.

18 Principles of soil cutting, design equation, force analysis, application of dimensional analysis in soil dynamics and traction prediction equation.

19 Principles of soil cutting, design equation, force analysis, application of dimensional analysis in soil dynamics and traction prediction equation.

20 Introduction to traction and mechanics.

21 Introduction to traction and mechanics.

22 Introduction to traction and mechanics.

23 Off road traction and mobility, traction model.

24 Off road traction and mobility, traction model.

25 Off road traction and mobility, traction model.

26 Traction improvement, tyre size, tyre lug geometry and their effects.

27 Traction improvement, tyre size, tyre lug geometry and their effects.

28 Traction improvement, tyre size, tyre lug geometry and their effects.

29 Traction improvement, tyre size, tyre lug geometry and their effects.

30 Tyre testing, soil compaction and plant growth, variability.

31 Application of GIS in soil dynamics.

32 Application of GIS in soil dynamics.

Practical

1 Measurement of static and dynamic soil parameters related to tillage.

2 Measurement of static and dynamic soil parameters related to tillage.

3 Measurement of static and dynamic soil parameters related to tillage.

4 Measurement of soil parameters related to puddling and floatation.

5	Measurement of soil parameters related to puddling and floatation.
6	Measurement of for passive rotary and oscillating tools.
7	Measurement of for passive rotary and oscillating tools.
8	Measurement of slip and sinkage under dry and wet soil conditions and load and fuel consumption for different farm operations.
9	Measurement of slip and sinkage under dry and wet soil conditions and load and fuel consumption for different farm operations.
10	Measurement of slip and sinkage under dry and wet soil conditions and load and fuel consumption for different farm operations.
11	Weight transfer and tractor loading including placement and traction aids.
12	Weight transfer and tractor loading including placement and traction aids.
13	Studies on tyres, tracks and treads under different conditions, and soil compaction and number of operations.
14	Studies on tyres, tracks and treads under different conditions, and soil compaction and number of operations.
15	Studies on tyres, tracks and treads under different conditions, and soil compaction and number of operations.
16	Practical exam.

References

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2	Liljedahl JB and others. Tractor and Power Units.
3	Daniel Hill. Fundamentals of Soil Physics.
4	Terzaghi K & Peck Ralph B. Soil Mechanics in Engineering Practices.

FMPE 412 **3 (2+1)**

FARM MACHINERY DESIGN AND PRODUCTION

Objective To enable the students to understand the different processes and machinery involved in manufacturing the agricultural machines and to acquire knowledge on CNC tooling, turning tools, milling tools, drilling tools, finishing tools.

Lecture	**Topic**
Theory	
1	Introduction to design parameters of agricultural machines & design procedure.
2	Characteristics of farm machinery design - research and development aspects of farm machinery.
3	Characteristics of farm machinery design - research and development aspects of farm machinery.
4	Design of standard power transmission components used in agricultural machines - mechanical & hydraulic units.
5	Design of standard power transmission components used in agricultural machines - mechanical & hydraulic units.
6	Design of standard power transmission components used in agricultural machines - mechanical & hydraulic units.
7	Introduction to safety in power transmission.
8	Introduction to safety in power transmission.
9	Application of design principles to the systems of selected farm machines - critical appraisal in production of agricultural machinery.
10	Application of design principles to the systems of selected farm machines - critical appraisal in production of agricultural machinery.
11	Application of design principles to the systems of selected farm machines - critical appraisal in production of agricultural machinery.
12	Application of design principles to the systems of selected farm machines - critical appraisal in production of agricultural machinery.
13	Advances in material used for agricultural machinery.
14	Advances in material used for agricultural machinery.

15 Cutting tools including CNC tools and finishing tools.

16 Cutting tools including CNC tools and finishing tools.

17 Cutting tools including CNC tools and finishing tools.

18 Advanced manufacturing techniques powder metallurgy.

19 Advanced manufacturing techniques, EDM (Electro-Discharge Machining).

20 Heat Treatment of steels including pack carburizing, shot pining process.

21 Heat Treatment of steels including pack carburizing, shot pining process.

22 Heat Treatment of steels including pack carburizing, shot pining process.

23 Limits, fits & tolerances, jigs & fixtures.

24 Limits, fits & tolerances, jigs & fixtures.

25 Limits, fits & tolerances, jigs & fixtures.

26 Industrial lay-out planning.

27 Industrial lay-out planning.

28 Quality production management - reliability.

29 Quality production management - reliability.

30 Economics of process selection.

31 Familiarization with project report.

32 Familiarization with project report.

Practical

1 Familiarization with different design aspects of farm machinery and selected components.

2 Familiarization with different design aspects of farm machinery and selected components.

3 Familiarization with different design aspects of farm machinery and selected components.

4 Solving design problems on farm machines & equipment.

5 Solving design problems on farm machines & equipment.

6 Solving design problems on farm machines & equipment.

7	Visit to agricultural machinery manufacturing industry.
8	Visit to tractor manufacturing industry.
9	Jigs and fixtures – study in relation to agricultural machinery - fits, tolerances and limits.
10	Jigs and fixtures – study in relation to agricultural machinery - fits, tolerances and limits.
11	Layout planning of a small scale industry.
12	Problems on economics of process selection.
13	Problems on economics of process selection.
14	Preparation of a project report - case study for manufacturing of simple agricultural machinery.
15	Preparation of a project report - case study for manufacturing of simple agricultural machinery.
16	Practical exam.

References

1	Richey, C.B. Agricultural Engineering Handbook.
2	Adinath M and AB Gupta. Manufacturing Technology.
3	Sharma PC and DK Aggarwal. Machine Design
4	Narula V. Manufacturing process.
5	Singh S. Mechanical Engineer’s Handbook.
6	Chakrabarti NR. Data book for Machine Design

FMPE 413 **3 (2+1)**

HUMAN ENGINEERING AND SAFETY

Objective To enable the students to study the human relationship with the environmental factors, study of anthropometry, study of safety gadgets for spraying, chaff cutting and tractor & trailer operator.

Lecture	**Topic**
Theory	
1	Human factors in system development – concept of systems - basic processes in system development, performance reliability, human performance.
2	Human factors in system development – concept of systems - basic processes in system development, performance reliability, human performance.
3	Human factors in system development – concept of systems - basic processes in system development, performance reliability, human performance.
4	Information input process - visual displays, major types and use of displays, auditory and factual displays
5	Information input process - visual displays, major types and use of displays, auditory and factual displays
6	Information input process - visual displays, major types and use of displays, auditory and factual displays
7	Information input process - visual displays, major types and use of displays, auditory and factual displays.
8	Information input process, visual displays, major types and use of displays, auditory and factual displays.
9	Speech communications.
10	Speech communications.
11	Biomechanics of motion, types of movements, range of movements, strength and endurance, speed and accuracy, human control of systems.
12	Biomechanics of motion, types of movements, range of movements, strength and endurance, speed and accuracy, human control of systems.
13	Biomechanics of motion, types of movements, range of movements, strength

and endurance, speed and accuracy, human control of systems.

14 Biomechanics of motion, types of movements, range of movements, strength and endurance, speed and accuracy, human control of systems.

15 Human motor activities, controls, tools and related devices.

16 Human motor activities, controls, tools and related devices.

17 Human motor activities, controls, tools and related devices.

18 Human motor activities, controls, tools and related devices.

19 Anthropometry - arrangement and utilization of work space, atmospheric conditions, heat exchange process and performance, air pollution.

20 Anthropometry: arrangement and utilization of work space, atmospheric conditions, heat exchange process and performance, air pollution.

21 Anthropometry - arrangement and utilization of work space, atmospheric conditions, heat exchange process and performance, air pollution.

22 Anthropometry - arrangement and utilization of work space, atmospheric conditions, heat exchange process and performance, air pollution.

23 Anthropometry - arrangement and utilization of work space, atmospheric conditions, heat exchange process and performance, air pollution.

24 Dangerous machine (regulation) act.

25 Rehabilitation and compensation to accident victims.

26 Safety gadgets for spraying.

27 Safety gadgets for threshing.

28 Safety gadgets for chaff cutting.

29 Safety gadgets for tractor & trailer operation.

30 Safety gadgets for tractor & trailer operation.

31 Safety gadgets for tractor & trailer operation.

32 Safety gadgets for tractor & trailer operation.

Practical

1 Calibration of the subject in the laboratory using bi-cycle ergo-meter.

2	Calibration of the subject in the laboratory using bi-cycle ergo-meter.
3	Study and calibration of the subject in the laboratory using mechanical treadmill.
4	Study and calibration of the subject in the laboratory using mechanical treadmill.
5	Use of respiration gas meter from human energy point of view.
6	Use of respiration gas meter from human energy point of view.
7	Use of respiration gas meter from human energy point of view.
8	Use of heart rate monitor.
9	Study of general fatigue of the subject using blink ratio method.
10	Study of general fatigue of the subject using blink ratio method.
11	Familiarization with electro-my graph equipment, anthropometric measurements of selected subjects.
12	Familiarization with electro-my graph equipment, anthropometric measurements of selected subjects.
13	Optimum work space layout and locations of controls for different tractors.
14	Familiarization with the noise and vibration equipment.
15	Familiarization with safety gadgets for various farm machines.
16	Practical exam.

References

1	Chapanis A. 1996. Human Factors in System Engineering. John Wiley & Sons, New York.
2	Dul J. and Weerdmeester B.1993. Ergonomics for Beginners. A Quick Reference Guide. Taylor and Francis, London.
3	Mathews J. and Knight A. A. 1971. Ergonomics in Agricultural Equipment Design. National Institute of Agricultural Engineering.
4	Astrand P. And and Rodahl K. 1977. Textbook of Work Physiology. Mc Hill Corporation, New York.
5	Mark S. Sanders and Ernest James McCormick. 1993. Human Factors in

Engineering and Design. Mc Hill Corporation, New York.

6 Keegan J J, Radke AO. 1964. Designing vehicle seats for greater comfort. SAE Journal;72:50~5.

7 Yadav R, Tewari V.K. 1998. Tractor operator workplace design-a review. Journal of Terra mechanics 35: 41-53

FMPE 414 **3 (2+1)**

TRACTOR DESIGN AND TESTING

Objective To enable the students to know the development of agricultural tractors and different operations performed by the tractors. To know the different trouble shootings and remedies, design of different parts. To get knowledge on different tests performed on tractors.

Lecture	Topic
Theory	
1	Procedure for design and development of agricultural tractor.
2	Procedure for design and development of agricultural tractor.
3	Procedure for design and development of agricultural tractor.
4	Study of parameters for balanced design of tractor for stability & weight distribution.
5	Study of parameters for balanced design of tractor for stability & weight distribution.
6	Study of parameters for balanced design of tractor for stability & weight distribution.
7	Study of parameters for balanced design of tractor for stability & weight distribution.
8	Traction theory- study of traction force and rolling resistance.
9	Traction theory- study of traction force and rolling resistance.
10	Hydraulic lift and hitch system design.
11	Hydraulic lift and hitch system design.
12	Design of mechanical power transmission in agricultural tractors.
13	Design of mechanical power transmission in agricultural tractors.
14	Single disc, multi disc and cone clutches.
15	Single disc, multi disc and cone clutches.
16	Rolling friction and anti-friction bearings.
17	Rolling friction and anti-friction bearings.

18	Rolling friction and anti-friction bearings.
19	Design of Ackerman Steering.
20	Design of Ackerman Steering.
21	Design of Ackerman Steering.
22	Tractor hydraulic steering.
23	Tractor hydraulic steering.
24	Study of special design features of tractor engines and their selection.
25	Study of special design features of tractor engines and their selection.
26	Study of special design features of tractor engines and their selection.
27	Design of seat and controls of an agricultural tractor.
28	Design of seat and controls of an agricultural tractor.
29	Design of seat and controls of an agricultural tractor.
30	Tractor testing.
31	Tractor testing.
32	Tractor testing.

Practical

1	Design problem of tractor clutch – single/ multiple disc clutch.
2	Design problem of tractor clutch – single/ multiple disc clutch.
3	Design of gear box - synchromesh/constant mesh - variable speed constant mesh drive.
4	Design of gear box - synchromesh/constant mesh - variable speed constant mesh drive.
5	Selection of tractor tires – problem solving.
6	Problem on design of governor.
7	Problem on design of governor.
8	Design and selection of hydraulic pump.
9	Design and selection of hydraulic pump.

10	Engine testing as per BIS code.
11	Drawbar performance in the lab.
12	PTO test and measure the tractor power in the lab / field.
13	Determining the turning space, turning radius and brake test.
14	Hydraulic pump performance test and air cleaner and noise measurement test.
15	Visit to tractor testing centre/industry.
16	Practical exam.

References

1	Liljedahl J B & Others. Tractors and Their Power Units.
2	Raymond N, EA Yong and S Nicolas. Vehicle Traction Mechanics.
3	Maleev VL. Internal Combustion Engines.
4	Kirpal Singh. Automobile Engineering – Vol I and Vol II.
5	Richey C.B. Agricultural Engineering Handbook.
6	Mehta ML, SR Verma, SK Mishra, VK Sharma. Testing & Evaluation of Agricultural Machinery.
7	Yadav R, Tewari V.K. 1998. Tractor operator workplace design-a review. Journal of Terra mechanics 35: 41-53.

FMPE 415 **3 (2+1)**

HYDRAULIC DRIVES AND CONTROLS

Objective The students will be trained to highlight the usage and operation of hydraulic and pneumatic controls required for operation of automated farm machinery with hydraulic and pneumatic systems.

Lecture	**Topic**
Theory	
1	Hydraulic basics - Pascal's law, flow, energy, work, and power.
2	Hydraulic systems - color coding, reservoirs, strainers and filters - filtering material and elements.
3	Hydraulic systems - color coding, reservoirs, strainers and filters - filtering material and elements.
4	Hydraulic systems - color coding, reservoirs, strainers and filters - filtering material and elements.
5	Accumulators, pressure gauges and volume meters.
6	Hydraulic circuit, fittings and connectors.
7	Hydraulic circuit, fittings and connectors.
8	Pumps - pump classifications, operation, performance, displacement.
9	Design of gear pumps.
10	Design of gear pumps.
11	Design of vane pumps.
12	Design of vane pumps.
13	Design of piston pumps.
14	Design of piston pumps.
15	Hydraulic actuators, cylinders, construction and applications - maintenance, hydraulic motors.
16	Hydraulic actuators, cylinders, construction and applications - maintenance, hydraulic motors.
17	Hydraulic actuators, cylinders, construction and applications, maintenance,

hydraulic motors.

18 Valves, pressure-control valves, directional-control valves, flow-control valves.

19 Valves, pressure-control valves, directional-control valves, flow-control valves.

20 Valve installation, valve failures and remedies.

21 Valve assembly, troubleshooting of valves.

22 Hydraulic circuit diagrams and troubleshooting.

23 United States of American Standards Institute USASI graphical symbols - tractor hydraulics, nudging system, ADDC.

24 United States of American Standards Institute USASI graphical symbols tractor hydraulics, nudging system, ADDC.

25 United States of American Standards Institute USASI graphical symbols tractor hydraulics, nudging system, ADDC.

26 Pneumatics - air services, logic units, fail safe and safety systems.

27 Pneumatics - air services, logic units, fail safe and safety systems.

28 Robotics - application of hydraulics and pneumatics drives in agricultural systems.

29 Robotics - application of hydraulics and pneumatics drives in agricultural systems.

30 Programmable Logic Controls (PLCs).

31 Programmable Logic Controls (PLCs).

32 Programmable Logic Controls (PLCs).

Practical

1 Introduction to hydraulic systems.

2 Introduction to hydraulic systems.

3 Study of hydraulic pumps.

4 Study of hydraulic pumps.

5 Study of actuators.

6	Study of hydraulic motors.
7	Study of hydraulic valves, colour codes and circuits.
8	Study of hydraulic valves, colour codes and circuits.
9	Building simple hydraulic circuits.
10	Hydraulics in tractors.
11	Introduction to pneumatics.
12	Introduction to pneumatics devices, pneumatics in agriculture.
13	Introduction to pneumatics devices, pneumatics in agriculture.
14	Use of hydraulics and pneumatics for robotics.
15	Use of hydraulics and pneumatics for robotics.
16	Practical exams.

References

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

FMPE 416 **3 (2+1)**

PRECISION AGRICULTURE AND SYSTEM MANAGEMENT

Objective To enable the students to know the development of high precession agricultural machinery viz. sowing, planting spraying equipment. To get knowledge on different functional requirements of precession agricultural machinery.

Lecture	**Topic**
Theory	
1	Introduction to precision agriculture – need and functional requirements.
2	Introduction to precision agriculture – need and functional requirements.
3	Introduction to precision agriculture – need and functional requirements.
4	Familiarization with issues relating to natural resources.
5	Familiarization with issues relating to natural resources.
6	Familiarization with equipment for precision agriculture including sowing and planting machines.
7	Familiarization with equipment for precision agriculture including sowing and planting machines.
8	Familiarization with equipment for precision agriculture including power sprayers, land clearing machines.
9	Familiarization with equipment for precision agriculture including power sprayers, land clearing machines.
10	Familiarization with equipment for precision agriculture including laser guided land levelers.
11	Familiarization with equipment for precision agriculture including straw-chopper, straw-balers, grain combines etc.
12	Familiarization with equipment for precision agriculture including straw-chopper, straw-balers, grain combines etc.
13	Familiarization with equipment for precision agriculture including straw-chopper, straw-balers, grain combines etc.
14	Introduction to GIS based precision agriculture and its applications.

15 Introduction to GIS based precision agriculture and its applications.

16 Introduction to GIS based precision agriculture and its applications.

17 Introduction to sensors and application of sensors for data generation.

18 Introduction to sensors and application of sensors for data generation.

19 Database management - system concept - system approach in farm machinery management, problems on machinery selection, maintenance and scheduling of operations.

20 Database management - system concept - system approach in farm machinery management, problems on machinery selection, maintenance and scheduling of operations

21 Database management - system concept - system approach in farm machinery management, problems on machinery selection, maintenance and scheduling of operations.

22 Database management - system concept - system approach in farm machinery management, problems on machinery selection, maintenance and scheduling of operations.

23 Database management - system concept - system approach in farm machinery management, problems on machinery selection, maintenance and scheduling of operations.

24 Database management - system concept - system approach in farm machinery management, problems on machinery selection, maintenance and scheduling of operations.

25 Application of PERT and CPM for machinery system management.

26 Application of PERT and CPM for machinery system management.

27 Application of PERT and CPM for machinery system management.

28 Application of PERT and CPM for machinery system management.

29 Application of PERT and CPM for machinery system management.

30 Application of PERT and CPM for machinery system management.

31 Application of PERT and CPM for machinery system management.

32 Application of PERT and CPM for machinery system management.

Practical

1	Familiarization with precision agriculture problems and issues.
2	Familiarization with various machines for resource conservation.
3	Familiarization with various machines for resource conservation.
4	Familiarization with various machines for resource conservation.
5	Solving problems related to various capacities, pattern efficiency, system limitation etc
6	Solving problems related to various capacities, pattern efficiency, system limitation etc.
7	Solving problems related to various capacities, pattern efficiency, system limitation etc
8	Solving problems related to various capacities, pattern efficiency, system limitation etc.
9	Problems related to cost analysis and inflation.
10	Problems related to cost analysis and inflation.
11	Problems related to cost analysis and inflation.
12	problems related to selection of equipment, replacement, break-even analysis, time value of money etc.
13	problems related to selection of equipment, replacement, break-even analysis, time value of money etc.
14	problems related to selection of equipment, replacement, break-even analysis, time value of money etc.
15	problems related to selection of equipment, replacement, break-even analysis, time value of money etc.
16	Practical examination.

References

1	Kuhar J E. The Precision Farming Guide for Agriculturist.
2	Dutta SK. Soil Conservation and land management.
3	Sigma and Jagmohan. Earth Moving Machinery.

4 Wood and Stuart. Earth Moving Machinery.

5 DeMess MN. Fundamentals of Geographic Information System

6 Hunt Donnell. Farm Power and Machinery Management.

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

FMPE 417 **3(3+0)**

ARTIFICIAL INTELLIGENCE

Objective To enable the students to know the basic concepts of artificial intelligence, different programming languages, algorithms, LISP, PROLONG, fuzzy and other reasoning and robotic technology.

Lecture	**Topic**
Theory	
1	Introduction to artificial intelligence.
2	Foundation and history of artificial intelligence.
3	Foundation and history of artificial intelligence.
4	Problems and techniques of artificial intelligence.
5	Problems and techniques of artificial intelligence.
6	AI programming languages.
7	Introduction to LISP and PROLOG.
8	Introduction to LISP and PROLOG.
9	Problem spaces and searches, blind search strategies, breadth first - depth first- heuristic search techniques.
10	Problem spaces and searches, blind search strategies, breadth first - depth first- heuristic search techniques.
11	Problem spaces and searches, blind search strategies, breadth first - depth first- heuristic search techniques.
12	Hill climbing - best first-A* algorithm.
13	Hill climbing - best first-A* algorithm.
14	AO* algorithm.
15	AO* algorithm.
16	Game tree, min, max algorithms, game playing - alpha beta pruning.
17	Game tree, min, max algorithms, game playing - alpha, beta pruning.
18	Knowledge representation issues, predicate logic - logic programming,

semantic.

19 Knowledge representation issues, predicate logic - logic programming, semantic.

20 Knowledge representation issues, predicate logic - logic programming, semantic.

21 Knowledge representation issues, predicate logic - logic programming, semantic.

22 Nets- frames and inheritance, constraint propagation, representing knowledge using rules, rules based deduction systems.

23 Nets- frames and inheritance, constraint propagation, representing knowledge using rules, rules based deduction systems.

24 Nets- frames and inheritance, constraint propagation, representing knowledge using rules, rules based deduction systems.

25 Reasoning under uncertainty, review of probability.

26 Reasoning under uncertainty, review of probability.

27 Baye's probabilistic interferences and Dempster shafer theory.

28 Baye's probabilistic interferences and Dempster shafer theory.

29 Heuristic methods, symbolic reasoning under uncertainty.

30 Heuristic methods, symbolic reasoning under uncertainty.

31 Statistical reasoning, fuzzy reasoning, temporal reasoning, non monotonic reasoning.

32 Statistical reasoning, fuzzy reasoning, temporal reasoning, non monotonic reasoning.

33 Statistical reasoning, fuzzy reasoning, temporal reasoning, non monotonic reasoning.

34 Planning and planning in situational calculus.

35 Representation for planning, partial order planning algorithm.

36 Examples, discovery as learning, learning by analogy, explanation based learning, neural nets, genetic algorithms.

37 Examples, discovery as learning, learning by analogy, explanation based

learning, neural nets, genetic algorithms.

38 Examples, discovery as learning, learning by analogy, explanation based learning, neural nets, genetic algorithms.

39 Examples, discovery as learning, learning by analogy, explanation based learning, neural nets, genetic algorithms.

40 Principles of natural language processing, rule based systems architecture, expert systems, knowledge acquisition concepts.

41 Principles of natural language processing, rule based systems architecture, expert systems, knowledge acquisition concepts.

42 Principles of natural language processing, rule based systems architecture, expert systems, knowledge acquisition concepts.

43 Principles of natural language processing, rule based systems architecture, expert systems, knowledge acquisition concepts.

44 AI application to robotics, and current trends in intelligent systems.

45 AI application to robotics, and current trends in intelligent systems.

46 AI application to robotics, and current trends in intelligent systems.

47 AI application to robotics, and current trends in intelligent systems.

48 AI application to robotics, and current trends in intelligent systems.

Practical

References

1 Russell, S. and P. Norvig. 1998. Artificial Intelligence: A Modern Approach. Prentice Hall.

2 Rich, Elain and Kevin Knight. 1991. Artificial Intelligence. TMH.

3 Patrick Henry Winston. 1992. Artificial intelligence. Addition Wesley 3rd Ed.

4 Nilson Nils J. Principles of Artificial Intelligence. Norsa Publishing House.

FMPE 418 **3 (2+1)**

MECHATRONICS

Objective At the end of the course students shall be familiar with the basic concepts of mechatronics required for application of sensors, hydraulic systems, and robotics in agriculture and allied sectors

Lecture	**Topic**
Theory	
1	Introduction to mechatronics - mechatronics in manufacturing - products and design - comparison between traditional and mechatronics approach.
2	Review of fundamentals of electronics - data conversion devices, sensors, micro sensors, transducers, signal processing devices, relays, contactors and timers - microprocessors - controllers and PLCs.
3	Brief overview of measurement systems - classification - characteristics and calibration of different sensors.
4	Measurement of displacement, position, motion, force, torque, strain gauge, pressure flow, temperature sensors & proximity sensor.
5	Transducer - definition - classification (active, passive, primary, secondary, mechanical, electrical, analog, digital, photo-electrical, flow & optical transducers) - selection criteria - sources of error for parameter under measurement - transducer specifications - test condition & operating conditions.
6	Hydraulic systems - flow, pressure and direction control valves, actuators - supporting elements - hydraulic power packs, pumps - design of hydraulic circuits - pneumatics - production, distribution and conditioning of compressed air, system components and graphic representations, design of systems.
7	Actuators - definition, example, types, selection - pneumatic actuator - electro-pneumatic actuator.
8	Hydraulic actuator - control valves - valve sizing - valve selection.
9	Drives - stepper motors, servo drives - ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer systems.
10	Electrical actuating systems - solid-state switches, solenoids, voice coil - electric motors - DC motors, AC motors - single phase motor, 3-phase motor

- induction motor, synchronous motor, stepper motors.

11 Piezoelectric actuator - characterization, operation, and fabrication - shape - memory alloys.

12 Basic elements of digital signal processing - concept of frequency in analog and digital signals - measurement systems - pulse modulations - data presentation system.

13 System modelling & control - mathematical models - modelling dynamic systems - transfer functions - control models.

14 Evolution of microprocessors and microcontrollers - memory devices - number system - architecture - interrupts instruction set and computer interfacing.

15 Micro-controllers - application of microcontrollers.

16 History and developments in industrial automation - vertical integration of industrial automation - control elements in industrial automation - PLC introduction.

17 Basics of PLC - advantages - capabilities of PLC - architecture of PLC - scan cycle - types of PLC - types of I/O modules - configuring a PLC - PLC wiring.

18 Installation and maintenance procedures for PLC - troubleshooting of PLC - PLC networking - networking standards & IEEE standards - protocols - field bus - process bus and ethernet.

19 Applications of PLC - case studies of machine automation - process automation - selection parameters for PLC - introduction to programmable automation controller.

20 Description of PID controllers - CNC machines and part programming.

21 Robotics - introduction - brief history, types, classification and usage, science and technology of robots.

22 Positions, orientations and frames - mappings - changing descriptions from frame to frame - operators - Translations, rotations and transformations - transformation arithmetic - D-H representation - forward and inverse kinematics of six degree of freedom robot arm – robot arm dynamics.

23 Robot drive mechanisms - hydraulic - electric – servomotor - stepper motor -

pneumatic drives.

24 Mechanical transmission method - gear transmission, belt drives, cables, roller chains, link - rod systems - rotary-to-rotary motion conversion, rotary-to-linear motion conversion, rack and pinion drives, lead screws, ball bearing screws.

25 Trajectory planning and avoidance of obstacles - path planning - skew motion - joint integrated motion – straight line motion.

26 Robot languages - computer control and robot software.

27 Robot applications in manufacturing - material transfer and machine loading / unloading.

28 Robotics applications in processing operations like welding & painting, assembly operations.

29 Robotics applications in inspection automation.

30 Robotics applications in farm operations.

31 Robotics applications in operation of off road vehicles.

32 Future applications of robotics in agriculture.

Practical

1 Selection of sensor for a particular application from catalogue / internet.

2 Temperature measurement using semi-conductor temperature sensor.

3 Pressure & displacement measurement by Linear Variable Displacement Transducers (LVDT).

4 Torque measurement by Strain Gauge Transducers.

5 Measurement of speed using Magnetic Pick-Up Proximity Sensor.

6 Study of load cell - to study the load cell behavior for tensile & compressive load.

7 Design a mechatronics product / system and incorporate application of mechatronics for enhancing product values.

8 Study the hardware and software of mechatronics kit.

9 Study the movement of actuating cylinders and sensors.

10	Running a motor with PLC and conveyor with computer.
11	Study of different types of robots based on configuration and application.
12	Study of different type of links and joints used in robots.
13	Study of components of robots with drive system and end effectors.
14	Determination of maximum and minimum position of links.
15	Robot programming exercises.
16	Practical examination.

References

1	Bolton, W. Mechatronics. Pearson Education Asia.
2	Wolfram, Stadler. Analytical Robotics and Mechatronics. Mc-Graw Hill.
3	Doeblin E.O. Measurement Systems. Mc-Graw Hill.
4	Mahind, A.P. Introduction to Digital Computer Electronics. TMH.
5	Niku, S.Y. Introduction to Robotics: Analysis, systems and applications", Pearson Education Asia.
6	Craig, J.J. Introduction to Robotics. Pearson Education Asia.
7	Mikell P. Groover et. al., "Industrial Robots - Technology, Programming and Applications", McGraw Hill, New York, 2008.
8	Herbert E. Merritt. Hydraulic Control Systems.John Wiley & Sons, New York
9	K.Uma Rao & Andhe Pallavi. Microcontrollers, Architecture and programming and Applications -Pearson, 2009.

IRDE 421 **3 (2+1)**

MANAGEMENT OF CANAL IRRIGATION SYSTEM

Objective At the end of the course, student shall be able to design irrigation field channels and manage canal irrigation systems and gain knowledge in various aspects of irrigation canals for supplying water to the agricultural crops based on their water requirement

Lecture	Topic
Theory	
1	Irrigation - definition, purpose, benefits and ill effects
2	Typical network of canal irrigation system and its different physical components - planning and layout of distribution systems
3	Canal classification based on source of water, financial output, purpose, discharge
4	Canal alignment - general conditions for alignment of canals, distribution system for canal irrigation - factors affecting the canal alignment and curves in channels
5	Certain important definitions related to command area - GCA, CCA, intensity of irrigation, time factor, capacity factor, full supply coefficient, nominal duty etc.
6	Performance indicators for canal irrigation system evaluation
7	Estimation of water requirements for canal command areas and determination of canal capacity - inductive methods
8	Critical growth period method and consumptive use method
9	Water duty and delta - duty at various places - flow duty and quantity duty - factors affecting duty - importance of duty and duty of some important crops - measures for improving duty
10	Relationship between duty, base period and delta - related problems
11	Computing the design discharge capacity of an irrigation canal
12	Estimation of water losses in canals - evaporation, seepage with empirical formulas and canal regulation
13	Design of channels - design of non- alluvial channels

14	Design of lined canals - triangular section and trapezoidal section
15	Design of alluvial channels by Kennedy's Silt theory
16	Design of alluvial channels by Kennedy's theory
17	Design of alluvial channels by Lacey's regime theory
18	Design of alluvial channels by Lacey's basic regime equations
19	Drawbacks of Kennedy's theory and Lacey's theory - comparison of Kennedy's theory and Lacey's theory
20	Maintenance of unlined irrigation canals - silting of canals, weed and plant growth - failure of weaker banks and canal breaches
21	Measurement of discharge in channels - related problems
22	Rostering (canal running schedule) and warabandhi
23	Canal lining - necessity, advantages and disadvantages - types of canal lining
24	Desirable characteristics of the suitability of lining materials - in-situ concrete lining, precast concrete lining, cement mortar lining, lime concrete lining
25	Brick lining, stone block lining or boulder lining, asphalt concrete lining, buried membrane lining, earth lining and porous lining
26	Canal regulation works - functions of distributary head and cross regulators and it's design.
27	Devices for sediment control and silt - selective distributary head regulator
28	Canal falls - necessity and factors affecting canal fall
29	Development of different types of canal falls and classification of falls based on approach conditions.
30	Surplus water escape, canal scouring escape and tail escape
31	Canal outlets - requirements of a good canal outlet - types of outlets
32	Criteria for selection of outlet capacity - non-modular and modular outlets

Practical

1	Layout of canal alignments on topographic maps
2	Problems on relationship between duty, base period and delta
3	Estimation of consumptive use or evapotranspiration
4	Estimation of water requirements for canal command areas and determination of canal capacity
5	Computing the design discharge capacity of an irrigation canal
6	Problems on design of non-alluvial channels
7	Problems on design of lined canals with triangular section and trapezoidal section
8	Problems on design of alluvial channels by Kennedy's silt theory
9	Problems on design of alluvial channels by Kennedy's theory
10	Problems on design of alluvial channels by Lacey's regime theory
11	Problems on design of alluvial channels by Lacey's basic regime equations
12	Problems on measurement of discharge in channels and problems
13	Formulation of warabandhi – preparation of irrigation schedule
14	Study of canal outlets and regulators
15	Study of escapes and canal falls
16	Final practical examination

References

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

IRDE 422 **3 (2+1)**

MINOR IRRIGATION AND COMMAND AREA DEVELOPMENT

Objective To enable the students to understand the principles and to acquire knowledge on minor irrigation projects, plan, design and execute tanks, wells, pumping houses, diversion schemes, open field channels for efficient conveyance and application of irrigation water and for development of command areas of different sources under minor irrigation**.**

Lecture	**Topic**
Theory	
1	Introduction to minor irrigation - classification of irrigation projects - major, medium and minor projects
2	Comparative performance of the irrigation projects - Factors affecting performance of irrigation projects
3	Development and utilization of water resources through different minor irrigation schemes - types of minor irrigation systems in India
4	Tank irrigation - components of irrigation tanks - earthen bund, surplus weir, sluices and channels - grouping of tanks - basis for formation of tanks
5	Storage capacity and number of fillings of tanks, number of rainy days and working table
6	Earthen bunds - reasons for general failure - filter criteria, cut-off, upstream blanket, prevention of breaching of tanks
7	Bank section - stability of side slopes, top widths and free boards - failure by slipping or sliding, failure by over topping
8	Diversion schemes - hydrology - components of diversion schemes - locations and design of weirs
9	Surplus weirs - estimation of flood discharge entering the tanks, design of surplus weirs, length, crest width and base width
10	Lift irrigation - assessment of feasibility of lift irrigation projects, water availability, water lifting from canals, water lifting permission
11	Types of river and canal pumping systems - design of lift irrigation systems - intake structure - type of pumping stations and their site selection - main points to be considered for designing intake structure and intake pipe

12	Intake pipe – supporting strength and vertical load, design problem
13	Command area development programme (CAD) – basic concept - components - need, scope and development approaches, historical perspective
14	Command area development authorities - functions and responsibilities
15	Interaction / collaboration of irrigation water use efficiency and agricultural production
16	Pumping well - size of sump well, pump house structure, foundation, basement, flooring, superstructure, roof, doors, windows and ventilators, location of starters, design dimensions of the pump houses
17	Planning and execution of on farm development activities within the scope of command area development
18	Open channel distribution in command areas - design of open channels - definitions - estimation of velocity, discharge capacity, unlined field channels
19	Lined channels, materials for lining, cement concrete, cement mortar, bricks lining, asphalt membrane, LDPE, anti weed treatment
20	Pre-cast concrete channel sections - optimum length of lining - on-farm structures for conveyance, control and distribution
21	Use of remote sensing techniques for command area development (CAD)
22	Irrigation wells - steady state flow to unconfined aquifer and confined aquifer
23	Measurement of irrigation water - units and methods, current meter, flow in pipes measurement, water meter, venturi meter - coordinate method
24	Weirs and flumes, rectangular, trapezoidal, triangular weirs, parshall flumes, cut throat flumes
25	Water requirement of crops - FAO Penman-Montieth based combination formula for estimating reference evapotranspiration - wind pressure, atmospheric pressure, slope of saturation vapour pressure (contd in next lecture)
26	Psychrometric constant - mean saturation vapour pressure - vapour pressure deficit - extraterrestrial radiation - daylight hours - net solar radiation (contd)
27	Net long wave radiation, net radiation, soil temperature
28	Design of an underground pipe line irrigation system - friction losses and determination of pipe size

29 Underground pipe line structures - inlet structures - pump stands, gate stands, air vents, end plugs - outlets - riser valves, hydrants, gated pipes

30 Water productivity - concepts and measures for enhancing water productivity - farmers' participation in command area development

31 Case studies of some selected commands.

32 Economic evaluation of minor irrigation projects - net present worth - internal rate of return - net benefit-cost ratio

Practical

1 Preparation of command area development layout plan

2 Irrigation water requirement of crops

3 Irrigation water requirement of crops

4 Preparation of irrigation schedules

5 Planning and layout of water conveyance system

6 Design of surplus weir of tanks

7 Determination of storage capacity of tanks

8 Design of intake pipe and pump house

9 Design of lift irrigation systems

10 Use of remote sensing techniques for CAD works

11 Measures for enhancing water productivity

12 Farmers' participation in command area development

13 Visit to nearby tank irrigation system

14 Visit to nearby lift irrigation system

15 Visit to nearby command area

16 Practical examination

References

1 Arora, K.R. 2001. Irrigation, Water Power and Water Resources Engineering. Standard Publishers Distributors, Delhi.

2 Garg S. K. 2014. Irrigation Engineering and Hydraulic Structures, Khanna Publishers New Delhi.
3 Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Publ.House New Delhi.
4 Sahasrabudhe SR. 2011. Irrigation Engineering and Hydraulic structures. SK Kataria & Sons. Reprint 2015.

IRDE 423 **3 (2+1)**

PRECISION FARMING TECHNIQUES FOR PROTECTED CULTIVATION

Objective To know about the precision farming to get more profit with high water use efficiency. Construction and operational details of the green / poly houses will lead the students not only to grow crops with profits but also use the greenhouses for off-season usage and also to manage them commercially.

Lecture	Topic
Theory	
1	Protected cultivation - introduction - history, origin, development, national and international scenario.
2	Types of green houses, polyhouses / shade nets.
3	Components of green house, polyhouses / shade nets.
4	Different types of cladding materials for green houses, polyhouses / shade net houses.
5	Plant environment interactions – principles of limiting factors - solar radiation and transpiration.
6	Greenhouse effect - light, temperature, relative humidity, carbon dioxide enrichment.
7	Design of green houses – site selection, orientation, design.
8	Construction of green houses.
9	Design for ventilation requirement using exhaust fan system - selection of equipment.
10	Greenhouse cooling system – necessity, methods – ventilation with roof and side ventilators (natural ventilation)
11	Greenhouse cooling system - evaporative cooling system
12	Greenhouse cooling system – fog cooling system
13	Combined fogging and fan - pad cooling system
14	Design of cooling system of cooling and ventilation systems, pad care etc.
15	Maintenance of cooling and ventilation systems, pad care etc.

16 Greenhouse heating – necessity, equipment, methods and design of heating system in green houses.

17 Root media – types – soil and soil less media, composition, estimation, preparation and disinfection, bed preparation.

18 Suitable crops under greenhouse / net houses and planting techniques.

19 Irrigation in greenhouse and net house – water quality, methods and components of irrigation system.

20 Design, installation and material requirement for irrigation systems in greenhouse and shade net house .

21 Fogging system for humidity control in greenhouses and net houses – introduction, benefits, design.

22 Installation and material requirement for fogging system for greenhouses and shade net houses.

23 Maintenance of irrigation and fogging systems.

24 Fertilization – nutrient deficiency symptoms - functions of essential nutrient elements - methods for fertilizer application.

25 Principles of selection of proper application of fertilizers - fertilizer scheduling - rate of application of fertilizers.

26 Automated fertilizer application in the greenhouses and net houses.

27 Greenhouse climate measurement, control and management practices.

28 Insect and disease management in greenhouse and net houses.

29 Selection of crops for greenhouse cultivation, major crops in greenhouse and their irrigation requirement.

30 Fertilizer management, cultivation, harvesting and post harvest techniques for different crops under greenhouse.

31 Economic analysis of greenhouse cultivation.

32 Economic analysis of shade net house cultivation.

Practical

1 Design of green houses / polyhouses, shade net houses.

2 Estimation of material requirement (BOQ) for construction of greenhouse.

3	Determination of fertilization schedule and rate of application for various crops
4	Estimation of material requirement for preparation of root media.
5	Root media preparation, bed preparation and disinfections.
6	Study of different planting techniques.
7	Design and installation of irrigation system.
8	Design and installation of fogging system.
9	Study of greenhouse heating.
10	Study of different greenhouse environment control instruments.
11	Study of operation, maintenance and fault detection in irrigation system.
12	Study of operation, maintenance and fault detection in fogging system.
13	Economic analysis of greenhouses and net houses.
14	Economic analysis of shade net houses.
15	Visit to greenhouses / poly houses, shade net houses.
16	Final practical examination

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2. Sharma P. 2007. Precision Farming. Daya Publishing House New Delhi.
3. K. Radhamanohar & C. Igathinathane, 2013. Green House Technology and Management, BS Publications

IRDE 424 **3 (2+1)**

WATER QUALITY AND MANAGEMENT MEASURES

Objective At the end of the course student shall be able to understand water quality importance, characteristics of water, water pollution, quality standards and purification of water for industrial and agricultural usage

Lecture	Topic
Theory	
1	Introduction to agricultural water pollution - water quality as a global issue and scope of the problem. Natural factors affecting quality of surface water and groundwater - water quality objectives in relation to domestic, industrial and agricultural activities
2	Agricultural impacts on water quality - types of impacts - irrigation impacts on surface water quality and public health impacts.
3	Quality of irrigation water - parameters for water quality assessment.
4	Salinity hazard, sodicity hazard and toxicity hazard.
5	Water quality criteria for its suitability - quality of surface and groundwater sources
6	Classification of irrigation water as per USSL and All Indian Coordinated Research Project (AICRP) criteria.
7	Management practices for sustained saline water use - irrigation with poor quality of water - water quality guidelines for irrigation.
8	Point and non-point water pollution sources - classes of point and non-point water pollution sources - scope of the problem
9	Water demand - various types of water demand - per capita demand - factors affecting per capita demand.
10	Quality of surface and groundwater for public water supply - comparative study of surface and groundwater supplies.
11	Characteristics of water - physical characteristics of water and their measurement
12	Chemical characteristics of water and their estimation
13	Bacterial and microscopical characteristics of water - pathogenic and non-

pathogenic bacteria and their testing through MPN index

14 Quality standards of drinking water - municipal or domestic supplies as per WHO and BIS specifications.

15 Quality standards for industrial water supplies & irrigation water

16 Water contamination due to inorganic and organic compounds, water contamination related to agricultural chemicals, food industry, hydrocarbon and synthetic organic compounds

17 Water pollution by sediments - physical and chemical pollutants - control measures

18 Water contamination related to agricultural chemicals - fertilizers & pesticides as water pollutants - control measures

19 Arsenic contamination in ground water - remedial measures

20 Fluoride contamination in ground water - remedial measures

21 Water decontamination technologies - purification of water supplies - methods of purification of water

22 Screening - coarse and fine screens and their working

23 Plain sedimentation - theory of sedimentation

24 Sediment tanks - types of sediment tanks - design concepts of sediment tanks

25 Sedimentation aided with coagulation - analysis of flocculent settling

26 Chemicals used for coagulation and their chemical reactions

27 The constituents of a coagulation sediment plant

28 Filtration - theory of filtration - filter materials - type of filters and their classification

29 Sterilization - methods of disinfection and chlorination

30 Water softening - methods of removing temporary and permanent hardness - related problems

31 Removal of colours, odours and tastes from water

32 Removal of salts and dissolved solids from water i.e. desalination

Practical

1	Water quality analysis and classification according to USSL and AICRP criteria
2	Soil chemical analysis and estimation of lime and gypsum requirements
3	Determination of suspended and dissolves solids
4	Determination of total solids
5	Determination of turbidity
6	Determination of temporary hardness
7	Determination of permanent hardness
8	Field visit to industrial effluent disposal sites
9	Study of contamination movement and transport in soil profile
10	Study of different water decontamination techniques
11	Problems on design of sedimentation tanks & required quantity of coagulants
12	Problems on design of slow sand filter beds
13	Problems on rapid gravity filters
14	Study of different cultural and management practices for using poor quality water for irrigation
15	Study of salinity development under shallow and deep water table conditions
16	Final theory examination

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2. Gray, N.F. Water Technology. Raj Kamal Electric Press, Kundli, Haryana.
3. Hussain, S.K. 1986. Text Book of Water Supply and Sanitary Engineering. Oxford & IBH Publishing Co. New Delhi.
4. Manahan, S.E. 2009. Fundamentals of Environmental Chemistry. CRC Press, New York.
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6. Minhas, P.S. and Tyagi, N.K. 1998. Guidelines for irrigation with saline and

alkali waters. Bull. No, 1/98, CSSRI, Karnal, p. :36.

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IRDE 425 **3 (2+1)**

LANDSCAPE IRRIGATION DESIGN AND MANAGEMENT

Objective To design and maintain a landscape irrigation system with different traditional and modern equipment. Also, to learn automation techniques in design and scheduling of the landscape irrigation systems

Lecture	**Topic**
Theory	
1	Historical importance of Indian gardens and history of gardening in different areas.
2	Famous gardens of India and study of their methods of irrigation systems.
3	Definition of landscape - conventional methods of landscape irrigation - study of hose irrigation system - components
4	Study of components of portable sprinkler with hose pipes.
5	Merits and demerits of conventional landscape irrigation systems
6	Types of modern landscape irrigation methods - merits and demerits
7	Pop-up sprinklers – spray pop-up sprinklers - components - selection criteria.
8	Design criteria for pop-up sprinkler systems in landscaping
9	Shrub adopter system – features - accessories.
10	Types of drip irrigation methods adopted in landscaping and their components.
11	Design and layout of drip irrigation system in landscaping.
12	Design of bubbler irrigation system - selection and design criteria
13	Types of landscapes -natural landscapes and human made landscapes
14	Basic theme of gardens viz. circular, rectangular and diagonal themes
15	Factors affecting landscape design viz., initial approach, view, human choice, simplicity and topography etc.
16	Suitability of different types of irrigation systems for landscapes
17	Study of water requirements for different landscapes - numerical problems

	on water requirements of landscapes
18	Study of segments of landscape irrigation systems.
19	Main components of modern landscape irrigation systems and their selection criteria
20	Types of pipes and pressure ratings in landscape irrigation
21	Study of economics of pipe selection, pipe sizing and selection criteria.
22	Numerical problems on economics of pipe selection.
23	Study of different automation system for landscape irrigation
24	Study of main components, types of controllers and their application in automation system.
25	Design and layout of modern landscape irrigation systems
26	Problems on design and layout of modern landscape irrigation systems
27	Study of operation of landscape irrigation systems.
28	Study of maintenance of landscape irrigation systems.
29	Study of use of AutoCAD and ArchiCAD
30	Study of AutoCAD and ArchiCAD in garden designing
31	Study of AutoCAD in designing landscape irrigation system.
32	Study of ArchiCAD in designing landscape irrigation system.

Practical

1	Study of various irrigation systems and equipment for landscapes
2	Determination of water requirement for different landscapes
3	Design and installation of irrigation system for landscape
4	Determination of power requirements for irrigation systems
5	Tutorial problems on pump selection and power requirement
6	Preparation of irrigation scheduling of landscapes
7	Study of irrigation controllers and other equipments
8	Acquaintance in use of AutoCAD and ArchiCAD

9	Use of AutoCAD in designing of gardens
10	Use of AutoCAD in design of irrigation systems
11	Study of blocks & symbols, head layout
12	Study of zoning and valves layout
13	Study of pipe sizing, pressure calculations
14	Visit to nearby landscape irrigation system
15	Evaluation of landscape irrigation system observed in field visit
16	Final practical examination

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IRDE 426 **3 (2+1)**

PLASTIC APPLICATIONS IN AGRICULTURE

Objective To know about the plasti-culture and quality of plastics used in soil and water conservation, production agriculture and post harvest management. To get knowledge on the use of plastics in various fields like protected cultivation, water management in both irrigation and drainage systems, soil and water conservation measures, storage and packing of produce, aquacultural engineering and animal husbandry.

Lecture	**Topic**
Theory	
1	Introduction of plasticulture - types and quality of plastics used in soil and water conservation, production agriculture and post harvest management.
2	Quality control measures - present status and future prospective of plasticulture in India.
3	Different types of the plastic material and its raw material.
4	Characteristics of different plastic materials and its market potential.
5	Use of plastics in in-situ moisture conservation as water management technique.
6	Use of plastics in rain water harvesting.
7	Plastic film lining in canal, pond and reservoir.
8	Plastic pipes for irrigation water management.
9	Plastic pipes for bore-well casing.
10	Plastic pipes for subsurface drainage.
11	Plastic pipes use in sprinkler irrigation system – advantages and various components of sprinkler irrigation systems.
12	Plastic pipes use in drip irrigation system – advantages and various components of drip irrigation systems.
13	Manufacturing of plastic pipes - various process steps involved in the manufacture of plastic pipes.
14	Use of polymers in control of percolation losses in fields.

15 Plastics use in soil conditioning - soil solarisation.

16 Effects of different coloured plastic mulching in surface covered cultivation.

17 Nursery management - use of plastics in nursery raising, nursery bags, trays etc.

18 Controlled environmental cultivation - plastics as cladding material in green / poly houses.

19 Controlled environmental cultivation - plastics as cladding material in shade net houses.

20 Controlled environmental cultivation - plastics as cladding material in poly tunnels.

21 Plastic nets for crop protection - anti insect nets, bird protection nets - plastic fencing.

22 Plastics use in drying of agricultural produce.

23 Plastics use in preservation of food.

24 Handling and storage of agricultural produce.

25 Innovative plastic packaging solutions for processed food products.

26 Plastic CAP (cover and plinth) material for storage of food grains in open.

27 Use of plastics as alternate material for manufacturing farm equipment and machinery.

28 Plastics for aquacultural engineering for inland fisheries.

29 Plastics for animal husbandry - animal shelters, vermi-beds etc.

30 Silage film technique for fodder preservation.

31 Agencies involved in the promotion of plasticulture in agriculture at national and state level.

32 Human resource development in plasticulture applications.

Practical

1 Design, estimation and laying of plastic films in lining of canal & reservoir.

2 Design, estimation and laying of plastic films in water harvesting ponds.

3	Study of plastic components of sprinkler irrigation system.
4	Study of plastic components of drip irrigation system.
5	Study of components of subsurface drainage system.
6	Study of different colour plastic mulch laying.
7	Design, estimation and installation of green / poly houses.
8	Design, estimation and installation of shade net houses.
9	Design, estimation and installation of low tunnels.
10	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.
11	Study on use of plastics in nursery and plant protection.
12	Study on use of plastics in aquaculture.
13	Study on use of plastics in animal husbandry.
14	Study of plastic parts in making farm machinery.
15	Visit to nearby manufacturing units / dealers of PVC pipes, drip and sprinkle irrigation systems, greenhouse / polyhouse / shadenet house etc.
16	Final practical examination

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PRFE 431 **3 (2+1)**

FOOD QUALITY AND CONTROL

Objective To enable the students to understand the principles and concepts of various aspects of food quality, quality standards and control mechanisms to make the food manufacturing safe and within the limits of the safety standards put forth by various National and International organizations and encourage students to start their own high standard enterprises in food manufacturing sector.

Lecture	**Topic**
Theory	
1	Basics of food science and food analysis - importance of food science - composition of food - equipment used to analyse food components.
2	Basic food microbiology - classification of microorganisms - importance & effects of microorganisms in food quality
3	Concept, objectives and need of food quality - definition of food quality - types of food spoilage - food preservation techniques.
4	Objective and subjective measurement of food quality
5	Measurement of colour & flavour - their relationship with food quality and composition - instruments used - importance in assessing the quality of food.
6	Measurement of consistency & viscosity - their relationship with food quality and composition - instruments used - importance in assessing the quality of food.
7	Measurement of texture - its relationship with food quality and composition - instruments used - importance in assessing the quality of food.
8	Sampling - purpose - sampling techniques in food quality assessment
9	Sampling procedures for liquid, powdered and granular materials
10	Quality control - quality control tools
11	Quality control - statistical quality control
12	Sensory evaluation methods - panel selection methods - interpretation of sensory results
13	Instrumental method for testing quality - solid foods

14 Instrumental method for testing quality - liquid foods

15 Food adulteration and food safety - food grains

16 Food adulteration and food safety - fruits & vegetables

17 TQM and TQC - total quality control - principles of quality management and control.

18 Consumer preferences and acceptance

19 Food safety management systems - safety standards, practices and systems

20 GAP, GHP, GMP - definitions, standards and features

21 Hazards and HACCP (hazard analysis and critical control point) - principles and factors to be considered in HACCP

22 Application of HACCP concept to milk and milk products – problems in implementing HACCP

23 Sanitation in food industry (SSOP) - introduction, importance, methods of maintaining sanitation in food industry

24 Food laws and regulations in India - history of food laws and regulations in India – features

25 FSSAI - introduction

26 FSSAI - salient features of FSSAI - compliance

27 Food grades and standards – BIS & AGMARK - specifications and standards

28 Food grades and standards – PFA & FPO - specifications and standards

29 ISO 9000, 22000 series - introduction and features.

30 CAC (*Codex Alimantarious Commission*) – description - features

31 Traceability and quality assurance system in a process plant

32 Bio safety and Bioterrorism

Practical

1 Examination of cereals & pulses from one of go-downs and market shops in relation to FPO and BIS specifications.

2 Detection of adulteration and examination of ghee for various standards of AGMARK & BIS standards

3	Detection of adulteration and examination of spices for AGMARK and BIS standards.
4	Detection of adulteration and examination of milk and milk products for BIS standards.
5	Detection of adulteration and examination of fruit products such as jams, jellys, marmalades for FPO specification.
6	Visit to food quality control laboratory.
7	Case study of statistical process control in food processing industry.
8	Study of registration process and licensing procedure under FSSAI.
9	Study of sampling techniques from food processing establishments.
10	Visit to food processing laboratory and study of records and reports maintained by food processing laboratory.
11	Conducting sensory analysis on a developed food product like flavoured butter milk or fruit juice compared with similar market product and interpretation of data.
12	Determination microbial load (total plate count) on any food product
13	Preparation of ready reckoner of change in unit weight of food grains as affected by change in its moisture content (w.b.) (5-25%)
14	Determination of adulteration in turmeric or honey.
15	Milling quality of paddy.
16	Study of process plant hygiene

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PRFE 432 **3 (2+1)**

FOOD PLANT DESIGN AND MANAGEMENT

Objective This course provides knowledge on layout and design of food plants, development of process flow diagrams for different food materials, food marketing and management, entrepreneurship development policies and licensing procedures, etc.

Lecture	**Topic**
Theory	
1	Food plant location - selection criteria – factors in selecting a plant - selection of the plant site - preparation of the layout
2	Selection of processes – comparison of different processes - batch versus continuous operation
3	Plant capacity – equipment design and specifications - scale-up in design - safety factors - specifications - materials of construction
4	Requirements of plant building and its components
5	Project design – process design development - general overall design considerations - cost estimation - factors affecting profitability of investments - optimum design (economics and operation)
6	Project design – practical considerations in design - design approach
7	Project design – types of designs - feasibility survey - process development design - construction and operation - design information from the literature
8	Flow diagrams – qualitative and quantitative flow diagrams
9	Selection of equipments – preliminary design - problem statement - literature survey - material and energy balance - equipment design and selection - problems – economics
10	Handling equipments – selection - factors - pumps - piping - fittings - solid feeders - plant layout
11	Process and controls – control systems, instrumentation control, maintenance, computer aided design
12	Objectives and principles of food plant layout
13	Salient features of processing plants for cereals

14	Salient features of processing plants for pulses
15	Salient features of processing plants for oilseeds
16	Salient features of processing plants for horticultural crops
17	Salient features of processing plants for vegetable crops
18	Salient features of processing plants for poultry
19	Salient features of processing of fish processing plant
20	Salient features of processing of meat processing plant
21	Salient features of milk and milk products processing plants
22	Introduction to finance, food product marketing - food business analysis and strategic planning
23	Introduction to marketing and food marketing management
24	Introduction to supply chain management for retail food products
25	Entrepreneurship development in food industry
26	SWOT analysis - generation - incubation and commercialization of ideas and innovations
27	New product development processes
28	Government schemes and incentive for promotion of entrepreneurship
29	Govt. policy on small and medium scale food processing enterprise
30	Export and import policies relevant to food processing sector
31	Procedure of obtaining license and registration under FSSAI
32	Cost analysis and preparation of feasibility report.

Practical

1	Visit to a food industry
2	Survey of food industries in the district
3	Preparation of project report of food processing industry
4	Preparation of feasibility report of a food industry
5	Salient features and layout of pre processing house

6	Salient features and layout of milk and milk product plants
7	Evaluation of given layout
8	Salient features, design and layout of modern rice mill
9	Salient features, design and layout of bakery and related product plant
10	Salient features, design and layout of fruits and vegetables processing plant
11	Salient features, design and layout of poultry products
12	Study of different types of records relating to production of a food plant
13	Study of different types of records relating to finance of a food plant
14	Study of different types of records relating to marketing of a food business
15	Brain storming and SWOT analysis to start a food processing business
16	Study of supply chain management of retail food products / eggs

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PRFE 433 **3 (2+1)**

FOOD PACKAGING TECHNOLOGY

Objective To enable the student to understand the principles and acquire the knowledge on various aspects of food packaging materials and environmental control of for different foods for handling, transportation and also to extend the shelf life. Provides knowledge on spoilage of food materials, various packaging systems, different packaging materials and their properties, testing of packaging materials and packaging equipments

Lecture	Topic
Theory	
1	Shelf life of Foods - factors affecting shelf life of food material during storage
2	Interactions of spoilage agents with environmental factors such as water, oxygen, light, pH, etc.
3	General principles of control of the spoilage agents
4	Difference between food infection, food intoxication and allergy
5	Packaging of foods - requirement, importance and scope
6	Packaging of foods - frame work of packaging strategy, environmental considerations.
7	Packaging systems - types - flexible and rigid - retail and bulk
8	Levels of packaging - special solutions
9	Packaging machines – description - features
10	Technical packaging systems and data management packaging systems.
11	Different types of packaging materials - key properties and applications
12	Metal cans - manufacture of two piece and three piece cans
13	Plastic packaging - different types of polymers used in food packaging and their barrier properties
14	Manufacture of plastic packaging materials - profile extrusion, blown film / sheet extrusion
15	Manufacture of plastic packaging materials by blow molding, extrusion blow

molding

16 Manufacture of plastic packaging materials by injection blow molding, stretch blow molding, injection molding

17 Glass containers, types of glass used in food packaging

18 Manufacture of glass and glass containers - closures for glass containers

19 Paper and paper board packaging - paper and paper board manufacture process

20 Modification of barrier properties - characteristics of paper / boards

21 Relative advantages and disadvantages of different packaging materials - effect of these materials on packed commodities

22 Nutritional labelling on packages

23 CAS and MAP - shrink and cling packaging - vacuum and gas packaging

24 Active packaging - smart packaging - intelligent packaging

25 Packaging requirement for raw and processed foods and their selection of packaging materials

26 Factors affecting the choice of packaging materials - disposal and recycle of packaging waste

27 Printing and labelling – lamination - package testing

28 Testing methods for flexible materials, rigid materials and semi rigid materials

29 Tests for paper – thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply bond test, surface oil absorption test etc.

30 Tests for plastic film and laminates - thickness, tensile strength, gloss, haze, burning test to identify polymer etc.

31 Tests for aluminium foil - thickness, pin holes, etc. - glass containers -visual defects, colour, dimensions, impact strength etc.

32 Tests for metal containers - pressure test, product compatibility etc.

Practical

1 Identification of different types of packaging materials

2	Determination of tensile / compressive strength of given material / package
3	To perform different destructive tests for glass containers
4	To perform different non-destructive tests for glass containers
5	Vacuum packaging of agricultural produce
6	Determination of tearing strength of paper board
7	Measurement of thickness of packaging materials
8	To perform grease-resistance test in plastic pouches
9	Determination of bursting strength of packaging material
10	Determination of water-vapour transmission rate
11	Shrink wrapping of various horticultural produce
12	Testing of chemical resistance of packaging materials
13	Determination of drop test of food package
14	visit to relevant food packaging industries
15	visit to relevant fruit and vegetable packaging industries
16	Visit to canning industries

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PRFE 434 **3 (2+1)**

DEVELOPMENT OF PROCESSED PRODUCTS

Objective To enable the students to understand the process design and flow chart with mass and energy balance, unit operations and equipments for processing. Developing technologies for value added products from cereals, pulses, oilseeds, fruits, vegetables and spices, extruded products, canned and frozen foods, fruit juices. Developing technology for animal produce processing.

Lecture	Topic
Theory	
1	Process design, process flow chart with mass and energy balance
2	Conservation of heat energy and mass - heat, mass and material balance – related problems
3	Unit operations and equipments for processing - cleaning, grading, size reduction, separation, evaporation, distillation, crystallization, filtration, sedimentation and centrifugation
4	Equipment for various unit operations for food processing
5	Equipment for various unit operations for food processing
6	New product development – principles – process – requirements
7	Technology for value added products from cereals
8	Technology for value added products from pulses
9	Technology for value added products from oil seeds
10	Milling - terminology related to rice milling, wheat milling, pulse milling – processing operations, equipment
11	Puffing and flaking – rice flakes, flaking machinery
12	Roasting - process & equipment
13	Bakery products & snack food - process technology - equipment
14	Bakery products & snack food - batch and semi-continuous ovens, continuous ovens, control of ovens
15	Extruded products – extrusion cooking theory - equipment – single screw extruders - twin screw extruder - applications

16 Oil extraction and refining – composition and nutritive value - refining and processing of fats, emulsions - rancidity - supercritical fluid extraction process and its applications

17 Technology for value added products from fruits - processed fruit products - fruit beverages - sugar based products – by-product utilization of fruits

18 Technology for value added products from vegetables - processed vegetable products - beverages

19 Technology for value added products from spices

20 Canned foods – introduction - canning operations – preparation of food, filling, exhausting, sealing, thermal processing and cooling

21 Frozen foods – concept of freezing - freezing equipment - effect of freezing and frozen storage on foods

22 Dried foods – theory of drying - drying equipment - effect of nutritional qualities on dried foods

23 Fried foods – theory of frying - frying equipment - effect of heating and cooking on foods

24 Fruit juices & sauce – introduction - preparation of fruit juice – extraction, clarification, filtration, de-aeration - flow charts for different fruit juices & sauce

25 Sugar based confectionary & candy – ingredients - chocolate and cocoa products - confectionery manufacturing practices - nutritive value - properties and uses of sugar - sugar related products

26 Fermented food products – methods of fermentation – lactic acid fermentation, ethanolic fermentation, mixed alcoholic acid fermentation – definition - benefits of fermentation - microbial changes in foods - controlling fermentations in various foods, microorganisms as direct foods

27 Spice extracts – general functions of spices - flavouring extracts and their medicinal value

28 Technology for animal produce processing – meat - grading, slaughtering - structure and composition of meat - rigor mortis - ageing, tenderizing, smoking or curing of meat - meat pigments and colour changes - storage of fresh meat, cooking

29 Technology for processing of poultry – production considerations - processing plant operations - nutritive value - poultry meat products -

preservation and storage

30 Processing of fish – classification of sea foods - composition and nutritive value - storage and preservation

31 Processing of egg products – composition - quality factors - egg storage - bacterial infection and pasteurization - freezing, drying - effect of cooking on nutritive value of egg

32 Health foods - nutra-ceuticals, fortified food, organic food and functional food

Practical

1 Process design

2 Preparation of process flow chart

3 Preparation of different value added products from cereals

4 Preparation of different value added products from pulses

5 Preparation of different value added products from fruits

6 Preparation of different value added products from Dairy / meat / vegetables

7 Study on roller wheat flour milling

8 Study on rice milling

9 Study on spice grinding

10 Study on milk processing

11 Study on pulse processing

12 Study on oil seeds processing

13 Study on fruit / vegetable processing

14 Study of machinery in fruit / vegetable processing

15 Process flow diagram and study of various models of the machines used in a sugar mill

16 Visit to processed food industry

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PRFE 435 **3 (2+1)**

PROCESS EQUIPMENT DESIGN

Objective This course enables the students to gain knowledge on process equipment design, nature of the process equipment, material used for equipment, design considerations and application of design engineering for process equipments.

Lecture	Topic
Theory	
1	Introduction on process equipment design - nature of process equipment - general design procedure - equipment classification - fabrication techniques
2	Equipment classification - fabrication techniques
3	Applications of design engineering for processing equipments
4	Design parameters and general design procedure - design codes
5	Design considerations - design pressure - design temperature.
6	Design parameters and general design procedure
7	Design parameters and general design procedure - thermal stress and criteria of failure.
8	Material Specifications – properties - resistance to corrosion - choice of material
9	Material specifications - protective coatings - lining for plants and equipments.
10	Types of materials for process equipments - metals, glasses, polymers, ceramics, composites, linings and coatings.
11	Pressure vessel design - introduction, operating conditions, pressure vessel codes, selection of materials, vessels operating at low temperatures.
12	Pressure vessel design - design conditions and stresses, design of shell and its components.
13	Pressure vessel design - thermal stresses in cylinder shells - fabrication
14	Pressure vessel design - stress from loads and its components, supports.
15	Pressure vessel design - tutorials

16 Design of cleaners – introduction - types of cleaners.

17 Heat exchangers – introduction - types of heat exchangers

18 Design of tubular heat exchanger

19 Design of tubular heat exchanger - tutorial

20 Design of shell and tube heat exchangers

21 Design of shell and tube heat exchangers - tutorial

22 Design of plate heat exchangers - numerical problems

23 Design of conveyors – introduction - types of conveyors

24 Design of belt conveyor - design considerations - numerical problems

25 Design of screw conveyor and bucket elevator - design considerations – tutorial

26 Design of dryers – introduction - types of dryers - batch type dryers, continuous dryers

27 Design of dryers – tutorial

28 Design of milling equipment – introduction - types of milling equipment, design considerations – tutorial

29 Optimization of design with respect to process efficiency - energy and cost

30 Computer Aided Design - introduction - nomenclature

31 Computer Aided Design - creating shapes

32 Computer Aided Design of process equipment

Practical

1 Design of pressure vessels

2 Design of cleaners

3 Visit to food industry

4 Design of milling equipment for cereals

5 Design of milling equipment for pulses

6 Visit to sugar industry

7	Design of tubular heat exchangers
8	Design of shell and tube type heat exchangers
9	Design of plate heat exchangers
10	Visit to refined oil processing plant
11	Design of dryers
12	Design of belt conveyors
13	Design of bucket elevator
14	Design of screw conveyors
15	Design of screw conveyors
16	Practical exam

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RNEE 441 **3 (2+1)**

PHOTOVOLTAIC TECHNOLOGY AND SYSTEMS

Objective This course enables the students to acquire knowledge on solar photovoltaic system, types of solar cells, solar photovoltaic module, battery classification, types of charge controller, converters and applications of solar photovoltaic system.

Lecture	**Topic**
Theory	
1	Solar photovoltaic technology - introduction to solar photovoltaic technology, its advantages and limitations, current status of PV technology
2	SWOT analysis - Strengths, Weaknesses, Opportunities, Threats (SWOT) - analysis of PV technology
3	SWOT analysis - Strengths, Weaknesses, Opportunities, Threats (SWOT) - analysis of PV technology
4	Types of solar cells – introduction to different types of solar PV cells - advantages and disadvantages
5	Types of solar cells – wafer based silicon cell
6	Types of solar cells – thin film amorphous silicon cell
7	Types of solar cells – thin cadmium telluride (CdTe) cell
8	Types of solar cells – copper indium gallium selenide (CiGS) cell,
9	Types of solar cells - thin film crystalline silicon solar cell
10	Solar PV module - solar cell - types of solar modules - solar array, series connections of cell - mismatch in cell and fill factor
11	Solar PV module - solar cell - solar module - solar array - parallel connections of solar cell - mismatch in cell and fill factor
12	PV module performance - effect of solar radiation and temperature on power output of module
13	PV module performance - effect of solar radiation and temperature on I-V and power curve of module
14	PV module performance - effect of solar radiation and temperature on I-V and power curve of module

15	Balance of solar PV system - introduction to batteries - battery types and its characteristics
16	Balance of solar PV system- lead acid battery
17	Balance of solar PV system - nickel cadmium battery
18	Balance of solar PV system - comparison of batteries and battery performance
19	Balance of solar PV system - battery parameters - advantages and disadvantages
20	Charge controller - definition of charge controller, function of charge controller, types of charge controllers
21	Charge controller - methods of charge controllers, PWM type charge controller
22	Charge controller - MPPT type charge controller
23	Converters - DC to DC converter technologies
24	Converters - DC to AC type converter technologies
25	Application of solar PV system - solar home lighting system
26	Application of solar PV system - solar lantern
27	Application of solar PV system- solar fencing
28	Application of solar PV system - solar street light
29	Application of solar PV system - solar water pumping system
30	Application of solar PV system - roof top solar photovoltaic power plant
31	Classification of PV systems - stand alone system
32	Smart grid technology

Practical

1	Study of V-I characteristics of solar PV system - series connection
2	Study of V-I characteristics of solar PV system - parallel connection
3	Study of smart grid technology and application
4	Study of manufacturing technique of solar array

5	Study of different DC to DC converter
6	Study of different DC to AC converter
7	Study of domestic solar lighting system
8	Study of domestic solar pumping system
9	Study of various solar module technologies
10	Study of various solar module technologies
11	Safe measurement of PV modules electrical characteristics
12	Safe measurement of PV modules electrical characteristics
13	Commissioning of complete solar PV system
14	Visit to solar PV cell park center
15	Visit to solar smart grid technology center
16	Practical examination

References

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2	Rathore N.S., Kurchania A.K., Panwar N.L. 2006. Renewable Energy: Theory & Practice, Himanshu Publications,.
3	Solanki C.S. 2011. Solar Photovoltaic: Fundamentals, Technologies and Applications, PHI Learning Private Ltd.
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RNEE 442 **3 (2+1)**

WASTE AND BY-PRODUCTS UTILIZATION

Objective To impart the knowledge of technology of converting low-value by-products from agricultural and food processing industries to economically viable and value added products. Different technologies of waste treatment and environmentally safe disposal will also be the targeted.

Lecture	Topic
Theory	
1	Definition of by-products waste - types and formation of by-products and waste
2	Magnitude of waste generation in different food processing industries
3	Uses of different agricultural by-products - rice mill, oil mill waste, and sugarcane industry waste
4	Uses of different agricultural by-products - fruits and vegetables industries waste - paper industries waste
5	Concept, scope and maintenance of waste management and effluent treatment
6	Waste water parameters - temperature, pH, biological oxygen demand (BOD), chemical oxygen demand (COD) in waste water
7	Waste water parameters - fat, oil, grease content, metal content, forms of phosphorous and sulphur in waste water
8	Waste water parameters - microbiology of waste, other ingredients like insecticide, pesticide and fungicide residues in waste waters
9	Waste water disposal - waste water treatment and its disposal techniques
10	BOD analysis of industrial waste water - determination of BOD with seed material - related problems on BOD
11	COD analysis of industrial waste water - determination of COD with seed material - related problems on COD
12	Agro-waste utilization in various industries - furnaces and boilers run on agricultural wastes and by-products
13	Agro-waste utilization - briquetting of biomass as fuel - production of charcoal briquette

14 Agro-waste utilization - generation of electricity using surplus biomass

15 Agro-waste utilization - producer gas generation and utilization,

16 Agro-waste utilization - design, construction, operation and management of institutional, community size biogas plants

17 Agro-waste utilization - design, construction, operation and management of family size biogas plant

18 Agro-waste utilization - concept of vermin-composting

19 Waste treatments - collection - components of waste collection systems - storage of manures and slurries - factors affecting choice of storage facility

20 Waste handling and transport - pumping liquid manures, dumps, mixing and agitation

21 Waste treatments - pre-treatment of waste by sedimentation and coagulation method

22 Waste treatments - pre-treatment of waste by flocculation and floatation method

23 Secondary treatments - biological and chemical oxygen demand for different food plant waste – trickling filters

24 Secondary treatments - biological and chemical oxygen demand for different food plant waste – oxidation ditches

25 Secondary treatments - biological and chemical oxygen demand for different food plant waste –activated sludge process

26 Secondary treatments - biological and chemical oxygen demand for different food plant waste – rotating biological contractors

27 Secondary treatments - biological and chemical oxygen demand for different food plant waste – anaerobic and aerobic lagoons

28 Tertiary treatments - advanced waste water treatment process - sand, coal and activated carbon filters

29 Tertiary treatments - advanced waste water treatment process - phosphorous, sulphur, nitrogen and heavy metals removal

30 Assessment, treatment and disposal of solid waste - biogas generation

31 Assessment, treatment and disposal of solid waste - effluent treatment plants

32 Environmental performance of food industry to comply with ISO-14001 standards

Practical

1 Determination of temperature of waste water

2 Determination of pH of waste water

3 Determination of turbidity, solids content of waste water

4 Determination of BOD of waste water

5 Determination of COD of waste water

6 Determination of ash content of agricultural wastes

7 Determination of un-burnt carbon in ash

8 Study about briquetting of agricultural residues

9 Estimation of excess air for better combustion of briquettes

10 Study of extraction of oil from rice bran

11 Study on bioconversion of agricultural wastes

12 Recovery of germ and germ oil from by-products of cereals

13 Visit to rice mill by-products industry

14 Visit to sugarcane by-products industry

15 Visit to fruits and vegetable processing by-products industry

16 Practical examination

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SWCE 451 **3 (2+1)**

FLOODS AND CONTROL MEASURES

Objective At the end of the course students shall learn methods to estimate floods, forecasting of floods, various flood control structures, design of earthen dams, check dams etc.

Lecture	Topic
Theory	
1	Floods - causes of flood and its occurrence
2	Flood classification - probable maximum flood, standard project flood, design flood, observed maximum flood, peak flood, annual flood, ordinary flood, foundation design flood
3	Flood estimation - methods of estimation - estimation of flood peak - rational method, envelope curve method
4	Flood estimation - empirical methods - Rave's formula, Nawab Jang Bahadur formula, Creager's formula, Modified Myer's formuls, Bourge's formula
5	Flood estimation - unit hydrograph method - probability or statistical methods
6	Statistics in hydrology - flood frequency methods - log normal, Gumbel's extreme value
7	Statistics in hydrology - log-Pearson type-III distribution - depth-area-duration analysis.
8	Flood forecasting - flood routing - channel routing - Muskingum method.
9	Reservoir routing - modified Pul's method.
10	Flood control - history of flood control, structural and non-structural measures of flood control.
11	Storage and detention reservoirs, levees, channel improvement.
12	Gully erosion and its control structures - vegetative methods, construction of temporary structures
13	Permanent gully control structures - design of permanent structures and implementation.
14	Ravine - types - ravine control measures - spillways - classification

15 River training works – types – embankments - guide banks - spurs or groynes, impermeable groynes, permeable groynes, bed pitching and bank revetment

16 Dredging of river, types of dredgers - bucket or grab dredger, dipper dredger, ladder dredger, suction cutter, head dredger

17 Planning of flood control projects and their economics

18 Earthen embankments - functions, classification - hydraulic fill and rolled fill dams - homogeneous, zoned and diaphragm type

19 Pore water pressure and its significance in the design of earth dam - foundation requirements, grouting, seepage through dams

20 Flow net and its properties, seepage pressure, causes of failures of earthen dams

21 Seepage line in composite earth embankments - seepage discharge through isotropic and non-isotropic soils, drainage filters, piping and its causes.

22 Design and construction of earthen dam- free board, width, upstream and downstream slopes

23 Stability of earthen embankments against failure by tension, overturning, sliding etc.

24 Stability of earthen slopes – determination of pore pressure from flow net, friction circle.

25 Stability of earthen slopes – stability of downstream slope during steady seepage

26 Stability of earthen slopes – stability of upstream seepage during sudden drawdown

27 Analysis of failure by different methods – gravity method, elementary profile

28 Subsurface dams - site selection – preliminary investigations and constructional features.

29 Check dam - small earthen embankments – types - arch dam, gravity dams, arch-gravity dams, barrages**,** embankment dams, concrete-face rock-fill dams, earth-fill dams

30 Design criteria for check dams

31 Subsurface dams – sand dams - basic principle - advantages and

	disadvantages
32	Design and site selection, constructional features of sub surface dams

Practical

1	Determination of flood stage - discharge relationship in a watershed.
2	Determination of flood peak-area relationships.
3	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.
4	Determination of frequency distribution functions for extreme flood values using log-Pearson Type-III distribution
5	Determination of probable maximum flood, standard project flood and spillway design flood.
6	Design of levees and jetties for flood control.
7	Design of gully / ravine control structures (vegetative and structural measures for gully stabilization) and cost estimation.
8	Designing, planning and cost- benefit analysis of a flood control project.
9	Study of different types, materials and design considerations of earthen dams.
10	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.
11	Stability of slopes of earth dams by friction circle and other methods.
12	Construction of flow net for isotropic and anisotropic media.
13	Computation of seepage by different methods.
14	Determination of settlement of earth dam - input-output-storage relationships by reservoir routing.
15	Visit to sites of earthen dam and water harvesting structures.
16	Practical Examination

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SWCE 452 **3 (2+1)**

WASTELAND DEVELOPMENT

Objective At the end of the course, student shall be learning land degradation causes, assessment of degradation, stabilization of conservation structures, afforestation methods, development of different kinds of waste lands, preparation of proposals for developing waste lands.

Lecture	Topic
Theory	
1	Land degradation – concept, causes of land degradation - deforestation, agricultural practices, industrialization, urbanization, forest degradation, rangeland degradation
2	Classification of land degradation in arid, semiarid, humid and sub-humid regions
3	Denuded range land and marginal lands.
4	Natural degradation hazards - water erosion, wind erosion, water logging, salinization, decline in soil fertility
5	Land degradation assessment - land, population, poverty and degradation
6	Wastelands - factors causing - types of waste lands (NWDB) classification
7	Mapping of wastelands of different categories in India
8	Planning of wastelands development – on going waste land development schemes – criteria for site selection, constraints, agro-climatic conditions
9	Development options, estimation of financial requirements and contingency plans.
10	Conservation structures - gully stabilization, ravine rehabilitation
11	Sand dune stabilization
12	Water harvesting and recycling methods.
13	Afforestation – land preparation methods, agro-horti-forestry-silvipasture methods
14	Afforestation – forage and fuel crops - socioeconomic constraints.
15	Shifting cultivation, optimal land use options.

16 Wasteland development – hills

17 Wasteland development – semi-arid areas - in-situ conservation measures

18 Wasteland development – coastal areas

19 Wasteland development – water scarce areas

20 Wasteland development – reclamation of waterlogged and salt-affected lands

21 Mine spoils - impact, land degradation, impact on environment

22 Reclamation and rehabilitation, slope stabilization of mine spoils

23 Management of mine environment

24 Micro-irrigation in wastelands development.

25 Sustainable wasteland development - drought situations, tree based farming, horticulture, cash crops, use of bio-fertilisers, etc.

26 Development of pasture on village common lands and improved livestock management

27 Socio-economic perspectives of sustainable wasteland development

28 Government policies in wasteland development

29 Participatory approach for wasteland development

30 Impact assessment of wasteland development

31 Preparation of proposal for wasteland development

32 Analysis of benefit-cost of wasteland development

Practical

1 Mapping of wastelands using RS and GIS techniques

2 Classification of wastelands

3 Identification of factors causing wastelands.

4 Estimation of vegetation density and classification

5 Planning and design of engineering measures for reclamation of wastelands in hills.

6 Planning and design of engineering measures for reclamation of wastelands

in semi arid areas & water scarce areas.

7 Planning and design of engineering measures for reclamation of wastelands in coastal areas.

8 Planning and design of engineering measures for reclamation of wastelands in water logged areas

9 Planning and design of engineering measures for reclamation of wastelands in salt affected areas.

10 Design and estimation of different soil and water conservation structures under arid conditions.

11 Design and estimation of different soil and water conservation structures under semiarid conditions

12 Design and estimation of different soil and water conservation structures under humid conditions

13 Planning and design of micro-irrigation in wasteland development.

14 Cost estimation of the above measures / structures.

15 Visit to wasteland development project sites.

16 Practical examination

References

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SWCE 453 **3 (2+1)**

INFORMATION TECHNOLOGY FOR LAND AND WATER MANAGEMENT

Objective In the present scenario, modern land and water management systems needs to know precise database of weather parameters, water availability & water demand, gross command area, crop water requirements, crop production for different amount of water supply, to prepare water supplying scheduled, water billing etc. Scientific researches in irrigation in different countries can be easily accessible by internet than any other publication source. This course is mainly aimed the students to get knowledge about information technology, database, multimedia technologies, networking system and communication technology etc.

Lecture	Topic
Theory	
1	Information technology (IT) introduction - users' needs in terms of land and water information systems and decision-support systems
2	Information technology concepts and its application potential.
3	Role of IT in natural resources management in modern irrigation sector
4	Existing system of information generation in land water management and organizations involved in the field of land and water management.
5	Multimedia technologies – introduction - applications
6	Role of multi-media in the development of natural resources
7	Internet application tools in water management planning
8	Web technology - introduction – study of websites available for information on land and water resources
9	Networking system of information – introduction - types – study of water supply networks - global network on water and development information for arid lands (G-WADI)
10	Communication technology - the role of communication technology in land and water information systems - problems and prospects of new information and communication technology
11	Multiple criteria decision analysis for integrated land resources planning and

management

12 Database – introduction - types of database management systems

13 Different data base systems in land and water management

14 Development of database concept for effective natural resources management.

15 Application of remote sensing, geographic information system (GIS) and GPS in thematic mapping like soil, water, ground water, resource, drainage etc.

16 Application of remote sensing, geographic information system (GIS) and GPS in natural resource inventory

17 Application of remote sensing, geographic information system (GIS) and GPS in watershed characterization, watershed prioritization, inventory & assessment of natural resources, wasteland mapping,

18 Application of remote sensing, geographic information system (GIS) and GPS in ground water potential zones, run off estimation, water resources action plan, land resources action plan, site selection for implementation, land resource and evaluation

19 Use of satellite data for monitoring the changes in land and water

20 Relational data base management system (RDBMS) - definition- special application in land and water management (FAO)

21 Object oriented approach – principle - OO approaches in water resource planning, flood planning, water quality monitoring etc

22 Information system – overview - types of information systems - development – integrated land and water information systems

23 Decision support systems – elements - support elements, water availability elements, water demand elements, integrated water management elements.

24 Expert systems in relation to water management

25 Agricultural information management systems – models – types of models

26 Mathematical models in irrigation, optimization and water resource management

27 Mathematical models in soil and water conservation

28 Application of decision support systems - multi sensor data loggers

29 Overview of software packages in natural resource management.

30 Video-conferencing of scientific information

31 Information technology (IT) – introduction - users' needs in terms of land and water information systems and decision-support systems

32 Information technology concepts and its application potential.

Practical

1 Study of role of IT in natural resources management

2 Study of internet applications - e-mail, voice mail, web tools and technologies.

3 Study of multimedia production using different softwares.

4 Study of handling and maintenance of new information technologies and exploiting their potential.

5 Exercises on database management using database programmes

6 Exercises on database management using spreadsheet programmes

7 Study of RS satellites for land and water information generation

8 Study of GIS tools for image processing

9 GPS survey and processing.

10 Exercise on computer software packages dealing with water balance

11 Exercise on crop production,

12 Exercise on land development, land and water allocation

13 Exercise on watershed analysis

14 Exercises on simple decision support and expert systems for management of natural resources.

15 Exercises on development of information system on selected theme(s).

16 Video-conferencing of scientific information

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SWCE 454 **3 (2+1)**

REMOTE SENSING AND GIS APPLICATIONS

Objective The students will have acquired knowledge on the concepts of remote sensing (RS) and GIS tools & techniques like scanning, working with photo images, editing etc., reading maps, knowledge on spatial data for applications in land and water resources.

Lecture	Topic
Theory	
1	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
2	Electromagnetic spectrum - different bands – resolution
3	Energy interactions in the atmosphere and with the Earth's surface
4	Major atmospheric windows - principal applications of different wavelength regions
5	Typical spectral reflectance curve for vegetation, soil and water - spectral signatures
6	Different types of sensors and platforms
7	Important features of Indian remote sensing satellites
8	Contrast ratio and possible causes of low contrast
9	Aerial photography - types of aerial photographs
10	Scale of aerial photographs - planning aerial photography - end lap and side lap
11	Stereoscopic vision - requirements of stereoscopic photographs
12	Air-photo interpretation - interpretation elements
13	Photogrammetry - measurements on a single vertical aerial photograph
14	Measurements on a stereo-pair - vertical measurements by the parallax method
15	Ground control for aerial photography - satellite remote sensing

16 Multispectral scanner - Whiskbroom and push-broom scanner - different types of resolutions

17 Analysis of digital data - image restoration

18 Image enhancement

19 Information extraction, image classification

20 Unsupervised classification, supervised classification

21 Important consideration in the identification of training areas, vegetation indices - microwave remote sensing

22 GIS and basic components

23 Different sources of spatial data, basic spatial entities

24 Major components of spatial data

25 Basic classes of map projections and their properties

26 Methods of data input into GIS

27 Data editing, spatial data models and structures

28 Attribute data management

29 Integrating data (map overlay) in GIS

30 Application of remote sensing and GIS for the management of land and water resources

31 Application of remote sensing and GIS in water resources development

32 Application of remote sensing and GIS in soil conservation

Practical

1 Familiarization with remote sensing and GIS hardware

2 Use of software for image interpretation

3 Interpretation of aerial photographs and satellite imagery

4 Basic GIS operations such as image display

5 Study of various features of GIS software package

6 Scanning

7	Digitization of maps and data editing
8	Digitization of maps and data editing
9	Data base query and map algebra
10	Data base query and map algebra
11	Application of remote sensing and GIS in water resources development
12	Application of remote sensing and GIS in soil conservation
13	Application of remote sensing and GIS in yield assessment
14	Application of remote sensing and GIS in geology and soil mapping
15	Application of remote sensing and GIS in watershed management
16	Practical examination

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