FACULTY OF
AGRICULTURAL ENGINEERING AND TECHNOLOGY
JUNAGADH AGRICULTURAL UNIVERSITY, JUNAGADH

COURSE CURRICULA FOR UNDERGRADUATE PROGRAMME
B.TECH. (AGRICULTURAL ENGINEERING)

(As per ICAR V Deans' Committee Recommendations)

To be implemented from 2017-18

॥ कृषिमूलम् जगत् सर्वम् ॥

COLLEGE OF AGRICULTURAL ENGINEERING & TECHNOLOGY
JUNAGADH AGRICULTURAL UNIVERSITY,
JUNAGADH

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COLLEGE OF AGRICULTURAL ENGINEERING & TECHNOLOGY
JUNAGADH AGRICULTURAL UNIVERSITY,
JUNAGADH

JUNE-2017

Implementation of V Deans' Committee recommendation from 2017-18 in the faculty of Agriculture, Horticulture, Agril. Engineering & Technology and Fisheries Science.

જૂનાગઢ કૃષિ યુનિવર્સિટી

જૂનાગઢ

જાહેરનામુ

આથી સબંધ કર્તા સર્વેને જણાવવામાં આવે છે કે, તા.૦૧.૦૫.૨૦૧૭ના રોજ જૂનાગઢ ખાતે મળેલ જૂનાગઢ કૃષિ યુનિવર્સિટીના નિયામક મંડળની ૪૫ મી બેઠકની કાર્યનોંધના **મુદ્દા નં. ૪૫.૧૨ થી Implementation of V Deans' Committee recommendation from 2017-18 in the faculty of Agriculture, Horticulture, Agril. Engineering & Technology and Fisheries Science** બાબતે નીચે મુજબ ઠરાવેલ છે.

"It is resolved that the Course Curricula along with modification (as per local needs) and Evaluation System in line of recommendation of V Deans' committee, ICAR, New Delhi are approved and are to be implemented in Junagadh Agricultural University with effect from academic year 2017-18 as given below."

1	Agriculture	Annexure-A
2	Horticulture	Annexure-B
3	Agricultural Engineering & Technology	Annexure-C
4	Fisheries Science	Annexure-D

Additionally, it is also *post facto* approved the student READY programme which has already been implemented in the faculty of Agriculture, Horticulture, Agricultural Engineering & Technology and Fisheries Science from the academic year 2016-17.

It was also pointed out that a minimum copies of suggested reading as given in V Deans' committee report should be kept in the university / college library for each faculty.

(એ.એમ.પારખીયા)
કુલસચિવ

જા.નં.જૂકૃયુ/૨૭/એસીએ-૧/નિ.મં.૪૫/ ૮૯ ૨૧ - ૫૦ /૨૦૧૭ તા. ૫.૦૬.૨૦૧૭

નકલ સવિનય રવાનાઃ–

નિયામક મંડળના તમામ સભ્યશ્રીઓ તરફ.

નકલ રવાનાઃ–

૧. માન. કુલપતિશ્રીના રહસ્ય સચિવશ્રી, જૂનાગઢ કૃષિ યુનિવર્સિટી, જૂનાગઢ
૨. કુલસચિવશ્રીના રહસ્ય સચિવશ્રી, જૂનાગઢ કૃષિ યુનિવર્સિટી, જૂનાગઢ
૩. નિયામકશ્રી(આઇ.ટી.) તરફ આ યુનિવર્સિટીના તમામ યુનિટ / સબ યુનિટ અધિકારીશ્રીઓને ઉકત વિગતે E-Mail દ્વારા જાણ કરવા સારૂ.
૪. આ કચેરીની તમામ શાખાઓ તરફ.
૫. જાહેરનામાં ફાઇલ.

SEMESTER-WISE COURSE PROGRAMME FOR THE DEGREE OF B.Tech. (Agricultural Engineering)

- **Course numbers of SWE are change to SWCE in accordance to the name of the department**
- **Course numbers indicates following**

E.g.

Subject/department	Year	Semester	Course no of particular Semester in sequence
Math(E)	1.	1.	1.
SWCE	2.	4.	6.

No.	Course No.	Title of the Course	Credit Hour	Remarks
Semester I				
1.	**Math(E)-1.1.1**	Engineering Mathematics-I	3(2+1)	
2.	**Phy(E)-1.1.2**	Engineering Physics	3(2+1)	
3.	**Chem(E)-1.1.3**	Engineering Chemistry	3(2+1)	
4.	**Ag(E)-1.1.4**	Principles of Soil Science	3(2+1)	
5.	**CE-1.1.5**	Surveying and Levelling	3(1+2)	
6.	**CE-1.1.6**	Engineering Mechanics	3(2+1)	
7.	**ME-1.1.7**	Engineering Drawing	2(0+2)	
8.	**ME-1.1.8**	Heat and Mass Transfer	2(2+0)	
9.	**Phy. Edu.-1.1.9**	NSS/NCC/Physical Education	0(0+1*)	
Total			**22(13+9)**	
Semester II				
1.	**Math(E)-1.2.1**	Engineering Mathematics-II	3(2+1)	
2.	**AS(E)-1.2.2**	Environmental Science and Disaster Management	3(2+1)	
3.	**AS(E)-1.2.3**	Entrepreneurship Development and Business Management	3(2+1)	
4.	**CE-1.2.4**	Fluid Mechanics and Open Channel Hydraulics	3(2+1)	
5.	**CE-1.2.5**	Strength of Materials	2(1+1)	
6.	**ME-1.2.6**	Workshop Technology and Practices	3(1+2)	
7.	**ME-1.2.7**	Theory of Machines	2(2+0)	
8.	**CSE-1.2.8**	Web Designing and Internet Applications	2(1+1)	
9.	**Phy. Edu.-1.2.9**	NSS/NCC/Physical Education	0(0+1*)	
		Total	**21(13+8)**	

Semester III				
1.	**Ag(E)-2.3.1**	Principles of Horticultural Crops and Plant Protection	2(1+1)	
2.	**Ag(E)-2.3.2**	Principles of Agronomy	3(2+1)	
3.	**AS(E)-2.3.3**	Communication Skills and Personality Development	2(1+1)	
4.	**Math(E)-2.3.4**	Engineering Mathematics-III	3(2+1)	
5.	**CE-2.3.5**	Soil Mechanics	2(1+1)	
6.	**CE-2.3.6**	Design of Structures	2(1+1)	
7.	**ME-2.3.7**	Machine Design	2(2+0)	
8.	**ME-2.3.8**	Thermodynamics, Refrigeration and Air Conditioning	3(2+1)	
9.	**EE-2.3.9**	Electrical Machines and Power Utilization	3(2+1)	
10.	**Phy.Edu.-2.3.10**	NSS/NCC/Physical Education	0(0+1*)	
		Total	**22(14+8)**	
Semester IV				
1.	**CE-2.4.1**	Building Construction and Cost Estimation	2(2+0)	
2.	**ME-2.4.2**	Auto CAD Applications	2(0+2)	
3.	**EE-2.4.3**	Applied Electronics and Instrumentation	3(2+1)	
4.	**FMPE-2.4.4**	Tractor and Automotive Engines	3(2+1)	
5.	**PFE-2.4.5**	Engineering Properties of Agricultural Produce	2(1+1)	
6.	**SWCE-2.4.6**	Watershed Hydrology	2(1+1)	
7.	**IDE-2.4.7**	Irrigation Engineering	3(2+1)	
8.	**IDE-2.4.8**	Sprinkler and Micro Irrigation Systems	2(1+1)	
9.	**REE-2.4.9**	Fundamentals of Renewable Energy Sources	3(2+1)	
10	**Phy.Edu.-2.4.10**	NSS/NCC/Physical Education	0(0+1*)	
		Total	**22(13+9)**	
V Semester				
1.	**FMPE-3.5.1**	Farm Machinery and Equipment-I	3(2+1)	
2.	**FMPE-3.5.2**	Tractor Systems and Controls	3(2+1)	
3.	**PFE-3.5.3**	Agricultural Structures and Environmental Control	3(2+1)	
4.	**PFE-3.5.4**	Post Harvest Engineering of Cereals, Pulses and Oil Seeds	3(2+1)	
5.	**SWCE-3.5.5**	Soil and Water Conservation Engineering	3(2+1)	
6.	**SWCE-3.5.6**	Watershed Planning and Management	2(1+1)	
7.	**IDE-3.5.7**	Drainage Engineering	2(1+1)	
8.	**REE-3.5.8**	Renewable Power Sources	3(2+1)	
9.	**CAE-3.5.9**	Skill Development Training-I (Student READY) Registration only	5(0+5)	
		Total	**27(14+13)**	

VI Semester				
1.	**CSE-3.6.1**	Computer Programming and Data Structures	3(1+2)	
2.	**FMPE-3.6.2**	Farm Machinery and Equipment-II	3(2+1)	
3.	**PFE-3.6.3**	Post Harvest Engineering of Horticultural Crops	2(1+1)	
4.	**SWCE-3.6.4**	Water Harvesting and Soil Conservation Structures	3(2+1)	
5.	**IDE-3.6.5**	Groundwater, Wells and Pumps	3(2+1)	
6.	**FMPE-3.6.6**	Tractor and Farm Machinery Operation and Maintenance	2(0+2)	
7.	**PFE-3.6.7**	Dairy and Food Engineering	3(2+1)	
8.	**REE-3.6.8**	Bio-energy Systems: Design and Applications	3(2+1)	
		Total	**22(12+10)**	
VII Semester				
VII Semester Student READY (Rural and Entrepreneurship Awareness Development Yojana)				
1.	**CAE-4.7.1**	10- weeks Industrial Attachment /Internship (Student READY)	10(0+10)	
2.	**CAE-4.7.2**	10- weeks Experiential Learning On campus (Student READY)	10(0+10)	
3.	**CAE-4.7.3**	Skill Development Training-II (Student READY) Registration only	5(0+5)	
4.	**CAE-4.7.4**	Educational Tour (Registration only)	2 (0+2)	
		Total	**27(0+27)**	
VIII Semester				
VIII Semester Student READY (Rural and Entrepreneurship Awareness Development Yojana)				
1.		Elective course	3(2+1)	
2.		Elective course	3(2+1)	
3.		Elective course	3(2+1)	
4.	**CAE-4.8.4**	Project Planning and Report Writing (Student READY)	10(0+10)	
		Total	**19(6+13)**	
		Grand Total I to VIII semesters	**182(85+97)**	
Elective Courses (Any 3 courses) 9 (6+3)				
1	**SWCE-4.8.1**	Floods and Control Measures	3(2+1)	
2	**SWCE-4.8.2**	Wasteland Development	3(2+1)	
3	**SWCE-4.8.3**	Information Technology for Land and Water Management	3(2+1)	
4	**SWCE-4.8.4**	Remote Sensing and GIS Applications	3(2+1)	
5	**IDE-4.8.5**	Management of Canal Irrigation System	3(2+1)	
6	**IDE-4.8.6**	Minor Irrigation and Command Area Development	3(2+1)	

7	**IDE-4.8.7**	Precision Farming Techniques for Protected Cultivation	3(2+1)	
8	**IDE-4.8.8**	Water Quality and Management Measures	3(2+1)	
9	**IDE-4.8.9**	Landscape Irrigation Design and Management	3(2+1)	
10	**REE-4.8.10**	Plastic Applications in Agriculture	3(2+1)	
11	**FMPE-4.8.11**	Mechanics of Tillage and Traction	3(2+1)	
12	**FMPE-4.8.12**	Farm Machinery Design and Production	3(2+1)	
13	**FMPE-4.8.13**	Human Engineering and Safety	3(2+1)	
14	**FMPE-4.8.14**	Tractor Design and Testing	3(2+1)	
15	**FMPE-4.8.15**	Hydraulic Drives and Controls	3(2+1)	
16	**FMPE-4.8.16**	Precision Agriculture and System Management	3(2+1)	
17	**PFE-4.8.17**	Food Quality and Control	3(2+1)	
18	**PFE-4.8.18**	Food Plant Design and Management	3(2+1)	
19	**PFE-4.8.19**	Food Packaging Technology	3(2+1)	
20	**PFE-4.8.20**	Development of Processed Products	3(2+1)	
21	**PFE-4.8.21**	Process Equipment Design	3(2+1)	
22	**REE-4.8.22**	Photovoltaic Technology and Systems	3(2+1)	
23	**REE-4.8.23**	Waste and By-products Utilization	3(2+1)	
24	**CSE-4.8.24**	Artificial Intelligence	3(3+0)	
25	**ME-4.8.25**	Mechatronics	3(2+1)	
26	**REE-4.8.26**	Energy Conservation and Audit in Agricultural Industry	3(2+1)	
			143 (87+56)	

DISCIPLINE WISE COURSES FOR THE DEGREE OF

B.Tech. (Agricultural Engineering)

Sr. No.	Course Name	Course No.	Credit
(A)	**Applied Sciences**		
1	Engineering Mathematics-I	Math(E)-1.1.1	3(2+1)
2	Engineering Physics	Phy(E)-1.1.2	3(2+1)
3	Engineering Chemistry	Chem(E)-1.1.3	3(2+1)
4	Engineering Mathematics-II	Math(E)-1.2.1	3(2+1)
5	Engineering Mathematics-III	Math(E)-2.3.4	3(2+1)
	Total		**15(10+5)**
(B)	**Social Sciences**		
1	Environmental Science and Disaster Management	AS(E)-1.2.2	3(2+1)
2	Entrepreneurship Development and Business Management	AS(E)-1.2.3	3(2+1)
3	Communication Skills and Personality Development	AS(E)-2.3.3	2(1+1)
	Total		**8(5+3)**
(C)	**Agricultural Sciences**		
1	Principles of Soil Science	Ag(E)-1.1.4	3(2+1)
2	Principles of Horticultural Crops and Plant Protection	Ag(E)-2.3.1	2(1+1)
3	Principles of Agronomy	Ag(E)-2.3.2	3(2+1)
	Total		**8(5+3)**
	(D) Basic Engineering		
(D.1)	**Civil Engineering**		
1	Surveying and Levelling	CE-1.1.5	3(1+2)
2	Engineering Mechanics	CE-1.1.6	3(2+1)
3	Fluid Mechanics and Open Channel Hydraulics	CE-1.2.4	3(2+1)
4	Strength of Materials	CE-1.2.5	2(1+1)
5	Soil Mechanics	CE-2.3.5	2(1+1)
6	Design of Structures	CE-2.3.6	2(1+1)
7	Building Construction and Cost Estimation	CE-2.4.1	2(2+0)
	Total		**17(10+7)**
(D.2)	**Computer Science Engineering**		
1	Web Designing and Internet Applications	CSE-1.2.8	2(1+1)
2	Computer Programming and Data Structures	CSE-3.6.1	3(1+2)
3	Artificial Intelligence	CSE-4.8.24	3(3+0)
	Total		**8(5+3)**
(D.3)	**Electrical Engineering**		
1	Electrical Machines and Power Utilization	EE-2.3.9	3(2+1)
2	Applied Electronics and Instrumentation	EE-2.4.3	3(2+1)
	Total		**6(4+2)**
(D.4)	**Mechanical Engineering**		
1	Engineering Drawing	ME-1.1.7	2(0+2)
2	Heat and Mass Transfer	ME-1.1.8	2(2+0)
3	Workshop Technology and Practices	ME-1.2.6	3(1+2)

4	Theory of Machines	ME-1.2.7	2(2+0)
5	Machine Design	ME-2.3.7	2(2+0)
6	Thermodynamics, Refrigeration and Air Conditioning	ME-2.3.8	3(2+1)
7	Auto CAD Applications	ME-2.4.2	2(0+2)
8	Mechatronics	ME-4.8.25	3(2+1)
	Total		**19(11+8)**
	(E) Agricultural Engineering		
(E.1)	**Farm Machinery and Power Engineering**		
1	Tractor and Automotive Engines	FMPE-2.4.4	3(2+1)
2	Farm Machinery and Equipment-I	FMPE-3.5.1	3(2+1)
3	Tractor Systems and Controls	FMPE-3.5.2	3(2+1)
4	Farm Machinery and Equipment-II	FMPE-3.6.2	3(2+1)
5	Tractor and Farm Machinery Operation and Maintenance	FMPE-3.6.6	2(0+2)
6	Mechanics of Tillage and Traction	FMPE-4.8.11	3(2+1)
7	Farm Machinery Design and Production	FMPE-4.8.12	3(2+1)
8	Human Engineering and Safety	FMPE-4.8.13	3(2+1)
9	Tractor Design and Testing	FMPE-4.8.14	3(2+1)
10	Hydraulic Drives and Controls	FMPE-4.8.15	3(2+1)
11	Precision Agriculture and System Management	FMPE-4.8.16	3(2+1)
	Total		**32(20+12)**
(E.2)	**Processing and Food Engineering**		
1	Engineering Properties of Agricultural Produce	PFE-2.4.5	2(1+1)
2	Agricultural Structures and Environmental Control	PFE-3.5.3	3(2+1)
3	Post Harvest Engineering of Cereals, Pulses and Oil Seeds	PFE-3.5.4	3(2+1)
4	Post Harvest Engineering of Horticultural Crops	PFE-3.6.3	2(1+1)
5	Dairy and Food Engineering	PFE-3.6.7	3(2+1)
6	Food Quality and Control	PFE-4.8.17	3(2+1)
7	Food Plant Design and Management	PFE-4.8.18	3(2+1)
8	Food Packaging Technology	PFE-4.8.19	3(2+1)
9	Development of Processed Products	PFE-4.8.20	3(2+1)
10	Process Equipment Design	PFE-4.8.21	3(2+1)
	Total		**28(18+10)**
(E.3)	**Soil and Water Conservation Engineering**		
1	Watershed Hydrology	SWCE-2.4.6	2(1+1)
2	Soil and Water Conservation Engineering	SWCE-3.5.5	3(2+1)
3	Watershed Planning and Management	SWCE-3.5.6	2(1+1)
4	Water Harvesting and Soil Conservation Structures	SWCE-3.6.4	3(2+1)
5	Floods and Control Measures	SWCE-4.8.1	3(2+1)
6	Wasteland Development	SWCE-4.8.2	3(2+1)
7	Information Technology for Land and Water Management	SWCE-4.8.3	3(2+1)
8	Remote Sensing and GIS Applications	SWCE-4.8.4	3(2+1)
	Total		**22(14+8)**

(E.4)	**Irrigation and Drainage Engineering**		
1	Irrigation Engineering	IDE-2.4.7	3(2+1)
2	Sprinkler and Micro Irrigation Systems	IDE-2.4.8	2(1+1)
3	Drainage Engineering	IDE-3.5.7	2(1+1)
4	Groundwater, Wells and Pumps	IDE-3.6.5	3(2+1)
5	Management of Canal Irrigation System	IDE-4.8.5	3(2+1)
6	Minor Irrigation and Command Area Development	IDE-4.8.6	3(2+1)
7	Precision Farming Techniques for Protected Cultivation	IDE-4.8.7	3(2+1)
8	Water Quality and Management Measures	IDE-4.8.8	3(2+1)
9	Landscape Irrigation Design and Management	IDE-4.8.9	3(2+1)
	Total		**25(16+9)**
(E.5)	**Renewable Energy Engineering**		
1	Fundamentals of Renewable Energy Sources	REE-2.4.9	3(2+1)
2	Renewable Power Sources	REE-3.5.8	3(2+1)
3	Bio-energy Systems: Design and Applications	REE-3.6.8	3(2+1)
4	Plastic Applications in Agriculture	REE-4.8.10	3(2+1)
5	Photovoltaic Technology and Systems	REE-4.8.22	3(2+1)
6	Waste and By-products Utilization	REE-4.8.23	3(2+1)
7	Energy Conservation and Audit in Agricultural Industry	REE-4.8.26	3(2+1)
	Total		**21(14+7)**
(E.6)	**Student READY Programme**		
1	Skill Development Training-I (Student READY) Registration only	CAE-3.5.9	5(0+5)
2	Skill Development Training-II (Student READY) Registration only	CAE-4.7.3	5(0+5)
3	10- weeks Industrial Attachment /Internship (Student READY)	CAE-4.7.1	10(0+10)
4	10- weeks Experiential Learning On campus (Student READY)	CAE-4.7.2	10(0+10)
5	Project Planning and Report Writing (Student READY)	CAE-4.8.4	10(0+10)
6	Educational Tour (Registration only)	CAE-4.7.4	2 (0+2)
	Total		**42(0+42)**
(F)	**Physical Education**		
1	NSS/NCC/Physical Education	Phy.Edu.-1.1.9	0(0+1*)
2	NSS/NCC/Physical Education	Phy.Edu.-1.2.9	0(0+1*)
3	NSS/NCC/Physical Education	Phy.Edu.– 2.3.10	0(0+1*)
4	NSS/NCC/Physical Education	Phy.Edu.-2.4.10	0(0+1*)
	*** Non Credit Courses**		5(0+5*)

NEW COURSE CURRICULAM

Discipline-wise credit hours distribution

Sr. No.	Course Name	No. of Course	Credit
1	Applied Science	5	15
2	Social Science	3	8
3	Agricultural Science	3	8
4	Basic Engineering	20	50
5	Agricultural Engineering (Including Elective Courses)	51	170
6	NSS / NCC / Physical Education	4	4

Semester-wise credit hours distribution

Semester	Credit	Semester	Credit
I	22	V	27
II	21	VI	22
III	22	VII	27
IV	22	VIII	19
		Total	**182**

EXAMINATION AND EVALUATION SYSTEM

Fifth Deans' Committee deliberated on the examination and evaluation system being followed by different universities. The Committee recommends Uniform Grading system to be followed with uniform OGPA requirements for award of degrees at all levels and uniform conversion formulae to be followed for declaration of I, II and III divisions, distinctions etc. Declaration of division in the degree certificate to be made compulsory. by all universities:

1. **Examination**
   - External theory (50%)
   - Internal Theory + Practical (50%)

   Courses with Theory and Practical
   Mid-term Exam (30%) + Assignment (5%) in practical oriented courses + Practical (15%)
   Courses with only Theory
   Mid-term Exam (40%) + Assignment (10%)
   Courses with only Practical:
   (100%) Internal
   - Paper to be set by external: HOD shall ensure the coverage of syllabus. If needed moderation can be done.
   - Evaluation to be done **i**nternally by the faculty other than the Course Instructor. Syllabus of the concerned course shall be sent to the external examiner, who shall prepare the question papers. For practical, it is recommended that examination shall be conducted by course instructor(s) and one teacher nominated by HOD.

2. **Evaluation**

Degree	Percentage of Marks Obtained	Conversion into Points
All	100	10 Points
	90 to <100	9 to < 10
	80 to <90	8 to < 9
	70 to <80	7 to < 8
	60 to <70	6 to < 7
	50 to <60	5 to < 6
	<50 (Fail)	< 5
	Eg. 80.76	8.076
	43.60	4.360
	72.50 (but shortage in attendance)	Fail (1 point)

OGPA	Division
5.000 – 5.999	Pass
6.000 – 6.999	II division
7.000 – 7.999	I division
8.000 and above	I division with distinction

GPA = Total points scored / Total credits (for 1 semester)

CGPA = ∑ Total points scored / Course credits

OGPA = ∑ Total points scored (after excluding failure points)/ Course credits

% of Marks = OGPA x 100/10

SEMESTER - I

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	Engineering Mathematics-1	Math(E)-1.1.1	3(2 + 1)	2	1	0

Course content:

Theory:

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

Tutorial:

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Elementary transformations, rank of a matrix, reduction to normal form, Solution of linear equations	3
2	Gauss-Jordon method to find inverse of a matrix	1
3	Eigen values and Eigen vectors, Cayley-Hamilton theorem, using Cayley-Hamilton theorem to find inverse of A, nature of rank	3
4	Linear transformation, orthogonal transformations, diagonalisation of matrices, quadratic forms. PAQ form, Echelon form	3
5	Taylor's and Maclaurin's expansions, indeterminate form; curvature	4
6	Partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivatives, maxima and minima.	4
7	Volumes and surfaces of revolution of curves	2
8	Double and triple integrals, change of order of integration, application of double and triple integrals to find area and volume	4
9	vector differential operator Del, Gradient of a scalar point function, Divergence and Curl of a vector point function and their physical interpretations	4

10	Identities involving Del, second order differential operator; line, surface and volume integrals	3
11	Stoke's divergence and Green's Theorems	1
	Total	**32**

Tutorials		
S.No.	**Topic**	**No. of Tutorials**
1	Rank of a matrix, reduction to normal form, consistency and solution of linear equations	2
2	Eigen values and eigen vectors, Cayley-Hamilton theorem	2
3	Diagonalization of matrices, quadratic forms	2
4	Taylor's and Maclaurin's expansion, indeterminate form	2
5	Curvature, tracing of curves	1
6	Partial differentiation, maxima and minima	2
7	Volume and surface of revolution, multiple integrals, Beta and Gama functions	2
8	Differentiation of vectors, gradient, divergence and curl of a vector point function	2
9	Stoke's divergence and Green's Theorems	1
	Total	16

Suggested Readings

Narayan Shanti. 2004. Differential Calculus. S. Chand and Co. Ltd. New Delhi.

Narayan Shanti. 2004. Integral Calculus. S. Chand and Co. Ltd. New Delhi.

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

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	**Engineering Physics**	**Phy(E)-1.1.2**	**3(2 + 1)**	**2**	**1**	**0**

Course content:

Theory:

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

Practical:

To find the frequency of A.C. supply using an electrical vibrator; To find the low resistance using Carey Foster bridge without calibrating the bridge wire; To determine dielectric constant of material using De Sauty's bridge; To determine the value of specific charge (e/m) for electrons by helical method; To study the induced e.m.f. as a function of velocity of the magnet; To obtain hysteresis curve (B-H curve) on a C.R.O. and to determine related magnetic quantities; To study the variation of magnetic field with distance along the axis of a current carrying circular coil and to detuning the radius of the coil; To determine the energy band gap in a semiconductor using a p-n Junction diode; To determine the slit width from Fraunhofer diffraction pattern using laser beam; To find the numerical aperture of optical fiber: To set up the fiber optic analog and digital link; To study the phase relationships in L.R. circuit; To study LCR circuit; To study the variations of thermo emf of a copper-constantan thermo-couple with temperature; To find the wave length of light by prism.

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Dia, Para and ferromagnetism-classification. Langevin theory of dia and paramagnetism	2
2	Adiabatic demagnetization. Weiss molecular field theory and ferromagnetism	2
3	Curie-Weiss law. Wave particle quality, de-Broglie concept	2
4	Uncertainty principle. Wave function. Time dependent Schrodinger wave equation	3
5	Time independent Schrodinger wave equation	2
6	Qualitative explanation of Zeeman effect, Stark effect	3
7	Paschan Back effect, Raman spectroscopy.	2
8	Statement of Bloch's function. Bands iii solids, velocity of Bloch's electron and effective mass.	2
9	Distinction between metals. insulators and semiconductors.	2
10	Intrinsic and extrinsic semiconductors, law of mass action.	1
11	Determination of energy gap in semiconductors. Donors and acceptor levels.	1
12	Superconductivity, critical magnetic field. Meissner effect	1
13	Isotope effect. Type-I and II superconductors	1
14	Josephson's effect DC and AC, Squids.	1
15	Introduction to high Tc superconductors.	1
16	Spontaneous and stimulated emission, Einstein A and B coefficients.	1
17	Population inversion, He-Ne and Ruby lasers	1
18	Ammonia and Ruby masers, Holography-Note.	1
19	Optical fiber. Physical structure. basic theory.	1
20	Mode type, input output characteristics of optical fiber and applications.	1
21	Illumination: laws of illumination, luminous flux, luminous intensity, candle power, brightness	1
	Total	**32**

Practicals		
S.No.	**Topic**	**No. of Praticals**
1	To find the frequency of A.C. supply using an electrical vibrator	1
2	To find the low resistance using Carey Foster bridge without calibrating the bridge wire	1

3	To determine dielectric constant of material using De Sauty's bridge	1
4	To determine the value of specific charge (e/m) for electrons by helical method	1
5	To study the induced e.m.f. as a function of velocity of the magnet;	1
6	To obtain hysteresis curve (B-H curve) on a C.R.O. and to determine related magnetic quantities	1
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	1
8	To determine the energy band gap in a semiconductor using a p-n Junction diode	1
9	To determine the slit width from Fraunhofer diffraction pattern using laser beam	1
	Determination of ultrasonic wave velocity in a liquid medium	1
10	To find the numerical aperture of optical fiber	1
11	To set up the fiber optic analog and digital link	1
12	To study the phase relationships in L.R. circuit	1
13	To study LCR circuit	1
14	To study the variations of thermo emf of a copper-constantan thermo-couple with temperature	1
15	To find the wave length of light by prism	1
16	To study the phase relationships in L.R. circuit	1
	Total	**16**

Suggested Readings

Brijlal and Subrahmanyam. Text Book of optics. S. Chand and Co., New Delhi.

Sarkar Subir Kumar. Optical State Physics and Fiber Optics. S. Chand and Co., New Delhi.

Gupta S L, Kumar V Sharma R C. Elements of Spectroscopy. Pragati Prakasam, Meeruth.

Saxena B S and Gupta R C. Solid State Physics. Pragati Prakasam, Meeruth.

Srivastava B N. Essentials of Quantum Mechanics. Pragati Prakasam, Meeruth.

Vasudeva D N. Fundamentals of Magnetism and Electricity. S. Chand and Co., New Delhi.

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	Engineering Chemistry	Chem(E)-1.1.3	3(2 + 1)	2	1	0

Course content:

Theory:

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

Practical:

Determination of temporary and permanent hardness of water by EDTA method: Estimation of chloride in water: Estimation of dissolved oxygen in water: Determination of BOD in water sample:

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Phase rule its application to one and two component systems	2
2	Fuels Classification, Calorific value	2
3	Colloids Classification, properties	2
4	Corrosion: Causes, type and methods of prevention	2
5	Water: Temporary and permanent hardness, disadvantages of hard water	2
6	Scale and sludge formation in boilers, boiler corrosion	2
7	Analytical methods like thermo-gravimetric. polarographic analysis	2
8	nuclear radiation. detectors and analytical applications of radioactive materials	3
9	Enzymes and their use in the manufacturing of ethanol and acetic acid by fermentation methods	3
10	Principles of food chemistry. Introduction to lipids, proteins, carbohydrates, vitamins, food preseltators, colorings and flavoring reagents of food	6
11	Lubricants: properties. mechanism. classification and tests	2
12	Polymers. types of polymerization. properties. uses and methods for the determination of molecular weight of polymers.	3
13	Introduction to IR spectroscopy.	1
	Total	**32**

Practicals		
S.No.	**Topic**	**No. of Praticals**
1	Determination of temporary and permanent hardness of water by EDTA method	1
2	Estimation of chloride in water	1
3	Estimation of dissolved oxygen in water	1
4	Determination of BOD in water sample	1
5	Determination of COD in water sample	1
6	Estimation of available chlorine in bleaching powder	1
7	Determination of viscosity of oil	1
8	Estimation of activity and alkalinity of water sample	1
9	Determination of carbonate and non- carbonate hardness by soda reagent	1
10	Determination of coagulation of water and chloride ion content	1
11	Determination of specific rotation of an optically active compound	1
12	Determination of max and verification of Beer Lambert Law	1
13	Determination of calorific value of fuel	1
14	Identification of functional groups (alcohol, aldelyde, ketones, carboxylic acid and amide) by IR	1

15	Chromatographic analysis	1
16	Determination of molar refraction of organic compounds	1
	Total	**16**

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

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	Principles of Soil Science	Ag(E)-1.1.4	3(2 +1)	2	1	0

Course content:

Theory:

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

Practical:

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Nature and origin of soil	3
2	soil forming rocks and minerals, their classification and composition, soil forming processes	3
3	classification of soils – soil taxonomy orders; important soil physical properties; and their importance	3
4	soil particle distribution; soil inorganic colloids – their composition, properties and origin of charge	3
5	ion exchange in soil and nutrient availability; soil organic matter – its composition and decomposition, effect on soil fertility	3
6	soil reaction – acidic, saline and sodic soils; quality or irrigation water	3
7	essential plants nutrients – their functions and deficiency symptoms in plants	3
8	important inorganic fertilizers and their reactions in soils	3
9	Use of saline and sodic water for crop production	2
10	Gypsum requirement for reclamation of sodic soils and neutralising RSC	3
11	Liquid fertilisers and their solubility and compatibility	3
	Total	**32**

Practicals		
S.No.	**Topic**	**No. of Praticals**
1	Identification of rocks and minerals	2
2	Examination of soil profile in the field	1
3	Collection of Soil Sample	1
4	Determination of bulk density, particle density and porosity of soil	3
5	Determination of organic carbon of soil	1
6	Determination of Nitrogen	1
7	Determination of Phosphorus	1
8	Determination of Potassium	1
9	Identification of nutrient deficiency symptoms of crops in the field	2
10	Determination of gypsum requirement of sodic soils	1
11	Determination of water quality parameters	2
	Total	**16**

Suggested Readings

Brady Nyle C and Ray R Well. 2002. Nature and properties of soils. Pearson Education Inc., New Delhi.

Indian Society of Soil Science. 1998. Fundamentals of Soil Science. IARI, New Delhi.

Sehgal J.. A. Textbook of Pedology Concepts and Applications. Kalyani Publishers, New Delhi.

Hillel D. 1982. Introduction to Soil Physics. Academic Press, London.

Sr. No.	Course Name	Course No.	Credit	L	P	T
5	Surveying and Levelling	CE-1.1.5	3(1 + 2)	1	2	0

Course content:

Theory:

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

Practical:

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Surveying Introduction	1
2	classification and basic principles Linear measurements	1
3	Chain Surveying. Compass survey	2
4	Errors in measurements, their elimination and correction	1

5	Plane table surveying.	2
6	Levelling, Leveling difficulties and error in leveling	2
7	Contouring	3
8	Computation of area and volume	1
9	Theodolite traversing..	2
10	Introduction to setting of curves	1
	Total	**16**

Practicals		
S.No.	**Topic**	**No. of Praticals**
1	Measurement of distance by ranging and chaining.	**2**
2	Locating various objects by chain & cross staff surveying.	**1**
3	Determination of area of polygon by chain and cross staff survey.	**1**
4	Measurement of bearings of sides of traverse with prismatic compass and computation of correct included angle.	**1**
5	Locating given building by chain and compass traversing,	**2**
6	Determination of elevation of various points with dumpy level by collimation plane method and rise & fall method.	**1**
7	Fixing bench mark with respect to temporary bench mark with dumpy level by fly leveling and check levelling.	**1**
8	L-Section and cross section of road.	**1**
9	Measurement of horizontal angles theodolite by simple method.	**1**
10	Measurement of horizontal angles theodolite by repetition method	**1**
11	Measurement of horizontal angles theodolite by Reiteration method	**1**
12	Measurement of vertical angles with theodolite.	**1**
13	Determination of horizontal distance between two inaccessible points with thedolite.	**1**
14	Locating given building by thedolite traversing.	**2**
15	Plane table survey- Radiation method.	**1**
16	Plane table survey- Intersection method.	**1**
17	Plane table survey- Traversing method.	**1**
18	Locating given building by plain table traversing.	**2**
19	Three point problem in plane table traversing.	**1**
20	Determination of elevation of point by trigonometric levelling.	**1**
21	Contour survy of given area.	**2**
22	Determination of horizontal distance between two inaccessible points with theodolite.	**1**
23	To prepare Gale's traverse table of a closed traverse	**2**
24	To measure elevation and depression angles	**1**
25	To find the reduced level of base inaccessible point	**1**
26	Carry out survey with with minor instruments	**1**
	Total	**32**

Suggested Readings

Punmia,B C 1987. Surveying (Vol.I). Laxmi Publications, New Delhi.

Arora K R 1990. Surveying(Vol.I), Standard Book House, Delhi.

Kanetkar T P 1993. Surveying and Levelling. Pune Vidyarthi Griha, Prakashan, Pune.

Sr. No.	Course Name	Course No.	Credit	L	P	T
6	Engineering Mechanics	CE-1.1.6	3(2 + 1)	2	1	0

Course content:

Theory:

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

Practical:

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Basic concepts of Engineering Mechanics.	2
2	Force systems,	2
3	Free body diagram and equilibrium of forces	3
4	Centroid,	4
5	Moment of inertia	4
6	Frictional forces	4
7	Analysis of simple framed structures using methods of joints, methods of sections and graphical method.	4
8	Simple stresses. Shear force and bending moment diagrams.	3
9	Stresses in beams	3
10	Torsion. Analysis of plane and complex stresses.	3
	Total	**32**

Practicals		
S.No.	**Topic**	**No. of Praticals**
1	Problems on composition and resolution of forces, moments of a force, couples, transmission of a couple, resolution of a force into a force & a couple.	2
2	Problems relating to resultant of; Co-planer force system, collinear force system, concurrent force system, co-planer concurrent force system, co-planer non-concurrent force system, Non-coplaner concurrent force system, Non-coplaner non-concurrent force system, system of couples in space.	2

3	Problems relating to centroids of composite areas.	1
4	Problems on moment of inertia, polar moment of inertia, radius of gyration, polar radius of gyration of composite areas.	2
5	Equilibrium of concurrent – co-planer and non concurrent – co-planer force systems.	1
6	Problems involving frictional forces.	1
7	Analysis of simple trusses by graphical method.	2
8	Problems relating to simple stresses and strains.	1
9	Problems on shear force and bending moment diagrams.	1
10	Problems relating to stresses in beams.	1
11	Problems on torsion of shafts.	1
12	Analysis of plane and complex stresses.	1
	Total	16

Suggested Readings

Sundarajan V 2002. Engineering Mechanics and Dynamics. Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Timoshenko S and Young D H 2003. Engineering Mechanics. McGraw Hill Book Co., New Delhi.

Prasad I B 2004. Applied Mechanics. Khanna Publishers, New Delhi.

Prasad I B 2004. Applied Mechanics and Strength of Materials. Khanna Publishers, New Delhi.

Bansal R K 2005. A Text Book of Engineering Mechanics. Laxmi Publishers, New Delhi.

Sr. No.	Course Name	Course No.	Credit	L	P	T
7	Engineering Drawing	ME-1.1.7	2(0 + 2)	0	2	0

Course content:

Practical:

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

Practicals		
S.No.	**Topic**	**No. of Praticals**
1	Introduction of drawing scales; Different methods of dimensioning	2
2	First and third angle methods of projection. Principles of orthographic projections; References planes;	2

3	Projection of Points, Projection of Lines traces of lines and planes;	2
4	True length and inclination of lines	2
5	Projection of Planes	2
6	Traces Auxiliary planes and true shapes of oblique plain surface	2
7	Projections of solids (Change of position method, alteration of ground lines	2
8	Section of solids and Interpenetration of solid surfaces	2
9	Development of surfaces of geometrical solids	2
10	Isometric projection of geometrical solids, Preparation of working drawing from models and isometric views, Drawing of missing views	2
11	Concept of sectioning. Revolved and oblique sections. Sectional drawing of simple machine parts	2
12	Types of rivet heads and riveted joints. Processes for producing leak proof joints. Symbols for different types of welded joints. Nomenclature, thread profiles, multi start threads, left and right hand threads	2
13	Square headed and hexagonal nuts and bolts	1
14	Conventional representation of threads	1
15	Different types of lock nuts, studs, machine screws, cap screws and wood screws. Foundation bolts	2
16	Forms of screw threads, representation of threads, Bolts- headed centre, stud screws, set screws, butt, hexagonal and square	2
17	keys-types, taper, rank taper, hollow saddle etc.	2
	Total	**32**

Suggested Readings

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

Bhatt N D and Panchal V M. 2013. Machine Drawing. Charotar Publishing House Pvt. Ltd., Anand.

Narayana K L and Kannaiah P. 2010. Machine Drawing. Scitech Publications (India) Pvt. Ltd., Chennai.

Sr. No.	Course Name	Course No.	Credit	L	P	T
8	Heat and Mass Transfer	ME-1.1.8	2(2 + 0)	2	0	0

Course content:

Theory:

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Introductory concepts, modes of heat transfer.	2
2	thermal conductivity of materials, measurement General differential equation of conduction. One dimensional steady state conduction through plane and composite walls, tubes and spheres with and without heat generation. Electrical analogy	3
3	Insulation materials	2
4	Fins	2
5	Free and forced convection. Newton' s law of cooling, heat transfer coefficient in convection	3
6	Dimensional analysis of free and forced convection	2
7	Useful non dimensional numbers and empirical relationships for free and forced convection	2
8	Equation of laminar boundary layer on flat plate and in a tube	2
9	Laminar forced convection on a flat plate and in a tube	1
10	Combined free and forced convection	1
11	Introduction. Absorptivity, reflectivity and transmissivity of radiation. Black body and monochromatic radiation, Planck's law, Stefan-Boltzman law, Kirchoff's law, grey bodies and emissive power, solid angle, intensity of radiation	2
12	Radiation exchange between black surfaces, geometric configuration factor	1
13	Heat transfer analysis involving conduction, convection and radiation by networks	2
14	Types of heat exchangers, fouling factor, log mean temperature difference, heat exchanger performance, transfer units	2
15	Heat exchanger analysis restricted to parallel and counter flow heat Exchangers	2
16	Steady state molecular diffusion in fluids at rest and in laminar flow, Flick's law, mass transfer coefficients. Reynold's analogy	3
	Total	**32**

Suggested Readings

Geankoplis C.J. 1978. Transport Port Processes and Unit Operations. Allyn and Bacon Inc., Newton, Massachusetts.

Holman J P. 1989. Heat Transfer. McGraw Hill Book Co., New Delhi.

Incropera F P and De Witt D P. 1980. Fundamentals of Heat and Mass Transfer. John Wiley and Sons, New York.

Gupta C P and Prakash R. 1994. Engineering Heat Transfer. Nem Chand and Bros., Roorkee.

Sr. No.	Course Name	Course No.	Credit	L	P	T
9	NSS/NCC/Physical Education	Phy. Edu.-1.1.9	0(0 +1)	0	0	0

SEMESTER – II

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	Engineering Mathematics-II	Math(E)-1.2.1	3(2 + 1)	2	1	0

Course content:

Theory:

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

Tutorial:

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Exact and Bernoulli's differential equations, equations reducible to exact form by integrating factors, equations of first order and higher degree, Clairaut's equation	3
2	Differential equations of higher orders, methods of finding complementary functions and particular integrals, method of variation of parameters	4
3	Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients, Bessel's and Legendre's differential equations	3
4	Series solution techniques	3
5	Functions of a Complex variable: Limit, continuity and analytic function	2
6	Cauchy-Riemann equations, Harmonic functions	3
7	Fourier series, Euler's formulae, Dirichlet's conditions, functions having arbitrary period, even and odd functions, half range series, Harmonic analysis. Fourier Sine and Cosine Series, Fourier series for function having period 2L, periodic functions	5
8	Partial differential equations: Formation of partial differential equations, Elimination of one and two arbitrary functions, Higher order linear partial differential equations with constant coefficients	5

9	Solution of non-linear partial differential equations, Charpit's method	2
10	Application of partial differential equations (one dimensional wave and heat flow equations, Laplace Equation)	2
	Total	**32**
	Tutorials	
S.No.	**Topic**	**No. of Praticals**
1	Solution of ordinary differential equations of first and higher orders	2
2	Series solutions of differential equations	3
3	Bessel's and Legendre's differential equations	1
4	Convergence of infinite series	1
5	Fourier series, harmonic analysis	3
6	Analytical functions, Cauchey-Riemann equations, harmonic functions	3
7	Solution of partial differential equations, Application of partial differential equations.	3
	Total	16

Suggested Readings

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

Grewal B S. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi. Ramana B V. 2008. Engineering Mathematics. Tata McGraw-Hill. New Delhi

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	**Environmental Science and Disaster Management**	**AS(E)-1.2.2**	**3(2 + 1)**	**2**	**1**	**0**

Course content:

Theory: ***Environmental Studies :*** Scope and importance. Natural Resources: Renewable and non-renewable resources Natural resources and associated problems. a) Forest resources: Use and over- exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer- pesticide problems, water logging, salinity, case studies. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles. Ecosystems: Concept, Structure, function, Producers, consumers, decomposers, Energy flow, ecological succession, food chains, food webs, ecological pyramids. Introduction, types, characteristic features, structure and function of the forest, grassland, desert and aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity and its conservation:- Introduction, definition, genetic, species & ecosystem diversity and bio-geographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and

endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Environmental Pollution: definition, cause, effects and control measures of a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Social Issues and the Environment from Unsustainable to Sustainable development, Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. dies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster Management:

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

Practicals

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Scope and importance	1
2	Natural Resources: Renewable and non-renewable resources	1
3	Natural resources and associated problems	1
4	a) Forest resources	1
5	b) Water resources	1
6	c) Mineral resources	1
7	d) Food resources	1

8	e) Energy resources	1
9	f) Land resources	1
10	Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles	1
11	Equitable use of resources for sustainable lifestyles	1
12	Ecosystems	1
13	Function of the forest, grassland, desert and aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	1
14	Biodiversity and its conservation	1
15	Value of biodiversity	1
16	Hot-sports of biodiversity. Threats to biodiversity	1
17	Conservation of biodiversity	1
18	Environmental Pollution	1
19	Solid Waste Management	1
20	Role of an individual in prevention of pollution. Pollution case studies Social Issues and the Environment from Unsustainable to Sustainable development, Urban problems related to energy	1
21	Water conservation, rain water harvesting, watershed management	1
22	Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. dies	1
23	Wasteland reclamation. Consumerism and waste products	1
24	Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act.	1
25	Issues involved in enforcement of environmental legislation. Public awareness	1
26	Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme	1
27	Environment and human health: Human Rights, Value Education, HIV/AIDS., Women and Child Welfare	1
28	Role of Information Technology in Environment and human health.	1
29	Natural Disasters and nature of natural disasters, their types and effects ,Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion	1
30	Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents	1
31	Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction.	1
32	Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media. Central, state, district and local administration Armed forces in disaster response; Disaster response; Police and other organizations	1
	Total	**32**

Practicals		
S.No.	**Topic**	**No. of Praticals**
1	Case Studies and Field work. Visit to a local area to document environmental assets river/forest/grassland/hill/mountain,	3
2	Visit to a local polluted site-Urban/ Rural/ Industrial/ Agricultural,	3

3	Study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc.	2
4	Expected impact of climate change on agricultural production and water resources, Mitigation Strategies	2
5	Economics of climate change.	1
6	Disaster Management introduction,	1
7	Natural and Manmade Disaster Studies	1
8	Informatics for Disaster Management,	1
9	Quantitative Techniques for Disaster Management Environmental Impact Assessment (EIA)	1
10	Disaster Management Disaster Management Policy Environmental Modelling.	1
	Total	**16**

Suggested Readings

Bharucha Erach. 2005. Text Book of Environmental Studies for Undergraduate Courses. University Grants

Commission, University Press, Hyderabad.

Sharma J P. 2003. Introduction to Environment Science. Lakshmi Publications.

Chary Manohar and Jaya Ram Reddy. 2004. Principles of Environmental Studies. BS Publishers, Hyderabad.

Kaul S N, Ashuthosh Gautam. 2002. Water and Waste Water Analysis. Days Publishing House, Delhi.

Gupta P K. 2004. Methods in Environmental Analysis – Water. Soil and Air. Agro bios, Jodhpur. Climate change.1995: Adaptation and mitigation of climate change-Scientific Technical Analysis

Cambridge University Press, Cambridge.

Sharma, R.K. & Sharma, G. 2005. Natural Disaster. APH Publishing Corporation, New Delhi.

Husain Majid. 2013. Environment and Ecology: Biodiversity, Climate Change and Disaster Management. online book

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	**Entrepreneurship Development and Business Management**	**AS(E)-1.2.3**	**3 (2 + 1)**	**2**	**1**	**0**

Course content :

Theory

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

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

Practical

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

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Introduction to entrepreneurship and management	1
2	Management functions – planning- Organizing Directing – motivation – ordering – leading – supervision	1
3	Communication and control– Capital	1
4	Financial management – importance of financial statements – balance sheet – profit and loss statement	1
5	Analysis of financial statements – liquidity ratios – leverage ratios	1
6	Analysis of financial statements – Coverage ratios – turnover ratios – profitability ratios	1
7	Agro-based industries – Project	2
8	Project cycle – Project appraisal and evaluation techniques –	1
9	undiscounted measures – payback period – proceeds per rupee of outlay,	1
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	2
11	Importance of agribusiness in Indian economy International trade-WTO agreements – Provisions related to agreements in agricultural and food commodities.	1
12	Agreements on agriculture (AOA) – Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS).	2

13	Development (ED): Concept of entrepreneur and entrepreneurship	1
14	Assessing overall business environment in Indian economy	1
15	Entrepreneurial and managerial characteristics	1
16	Entrepreneurship development Programmes (EDP)	1
17	Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development	1
18	Globalization and the emerging business entrepreneurial environment	1
19	Managing an enterprise: Importance of planning, budgeting, monitoring evaluation and follow-up managing competition	1
20	Role of ED in economic development of a country- Overview of Indian social, political systems and their implications for decision making by individual entrepreneurs	1
21	Economic system and its implications for decision making by individual entrepreneurs	1
22	Social responsibility of business. Morals and ethics in enterprise management	1
23	SWOT analysis- Government schemes and incentives for promotion of entrepreneurship	1
24	Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors	1
25	Venture capital (VC) contract farming (CF) and joint ventures (JV)	1
26	public-private partnerships (PPP)	1
27	Overview of agricultural engineering industry	1
28	Characteristics of Indian farm machinery industry	2
	Total	**32**

Practical

S.No.	Topic	No. of Practicals
1	Planning, analysis and preparation of business proposal	1
2	A study on Strengths Weaknesses Opportunities and Threats (SWOT) analysis	1
3	A study on analysis of financial statements (Balance Sheet, Profit loss statement)	1
4	A study on Compounding and discounting	1
5	A study on Break-even analysis	1
6	Visit to agro-based industries – I	1
7	Visit to agro-based industries – II	1
8	A study of Agro-industries Development Corporation	1
9	A study on Ratio analysis – I	1
10	A study on Ratio analysis – II	1
11	Application of project appraisal technique – I(Undiscounted measures)	1
12	Application of project appraisal technique – II(Discounted Measures)	1
13	Formulation of project feasibility reports– Project proposals regarding Agribusiness/ Agricultural Engineering as entrepreneur – individual / group	2
14	Presentation of project proposals in the class	2
	Total	**16**

Suggested Readings

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

Joseph, L. Massie. 1995. Essentials of Management. Prentice Hall of India Pvt. Ltd., New Delhi. Omri Rawlins, N. 1980. Introduction to Agribusiness. Prentice Hall Inc., New Jersey

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

London.

Thomas W Zimmer and Norman M Scarborough. 1996. Entrepreneurship. Prentice-Hall, New Jersey. Mark J Dollinger. 1999. Entrepreneurship Strategies and Resources. Prentice-Hall, Upper Saddal Rover,

New Jersey.

Khanka S S. 1999. Entrepreneurial Development. S. Chand and Co. New Delhi.

Mohanty S K. 2007. Fundamentals of Entrepreneurship. Prentice Hall India Ltd., New Delhi.

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	Fluid Mechanics and Open Channel Hydraulics	CE-1.2.4	3(2 + 1)	2	1	0

Course content:

Theory:

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

Practical

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Properties of fluids: Ideal and real fluid.	2
2	Pressure and its measurement, Pascal's law, pressure forces on plane and curved surfaces, centre of pressure, buoyancy, meta centre and meta centric height, condition of floatation and stability of submerged and floating bodies	4
3	Kinematics of fluid flow	2
4	Dynamics of fluid flow	2
5	Bernoulli's theorem	1
6	Venturimeter, orifice meter and nozzle, siphon;	1
7	Laminar flow: Stress strain relationships, flow between infinite parallel plates both plates fixed, one plate moving, discharge, average velocity;	4
8	Laminar and turbulent flow in pipes, general equation for head loss Darcy, Equation	3
9	Moody's diagram, Minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic gradient and energy gradient	4
10	Flow through orifices,Flow through Mouthpieces, Flow over Notches , Flow over weirs, Chezy's formula for loss of head in pipes, Flow through simple and compound pipes	3
11	Open channel design and hydraulics.	1
12	Velocity and Pressure profiles in open channels, Hydraulic jump;	1
13	Dimensional analysis and similitude: Rayleigh's method and Buckingham's `Pi' theorem, types of similarities, dimensional analysis, dimensionless numbers	3
14	Introduction to fluid machinery.	1
	Total	**32**

Practicals		
S.No.	**Topic**	**No. of Praticals**
1	Study of manometers and pressure gauges;	1
2	Verification of Bernoulli's theorem;	1
3	Determination of coefficient of discharge of venturi-meter and orifice meter;	1
4	Determination of coefficient of friction in pipeline	1
5	Determination of coefficient of discharge for rectangular and triangular notch	1
6	Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice;	2
7	Determination of coefficient of discharge for mouth piece;	1
8	Measurement of force exerted by water jets on flat and hemispherical vanes;	2
9	Determination of meta-centric height	1
10	Determination of efficiency of hydraulic ram	1
11	Performance evaluation of Pelton and Francis turbine;	1
12	Study of current meter;	1
13	Velocity distribution in open channels and determination of Manning's coefficient of rugosity	2
	Total	**16**

Suggested Readings

Sundarajan V 2002. Engineering Mechanics and Dynamics. Tata McGraw Hill Publishing Co. Ltd., New

Delhi.

enko S and Young D H 2003. Engineering Mechanics. McGraw Hill Book Co., New Delhi. Prasad I B 2004. Applied Mechanics. Khanna Publishers, New Delhi.

Prasad I B 2004. Applied Mechanics and Strength of Materials. Khanna Publishers, New Delhi.

Bansal R K 2005. A Text Book of Engineering Mechanics. Laxmi Publishers, New Delhi

Sr. No.	Course Name	Course No.	Credit	L	P	T
5	Strength of Materials	CE-1.2.5	2(1 + 1)	1	1	0

Course content:

Theory

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

Practical

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Slope and deflection of beams using integration techniques	2
2	Moment area theorems and conjugate beam method	2
3	Columns and Struts	1
4	Riveted and welded connections	2
5	Stability of masonry dams	2
6	Analysis of statically intermediate beams	2
7	Propped beams	2
8	Fixed and continuous beam analysis using superposition	1
9	Three moment equation and moment distribution methods	2
	Total	**16**

Practicals		
S.No.	**Topic**	**No. of Praticals**
1	To perform the tension test on metal specimen (M.S., C.I.), to observe the behaviour of materials under load, to calculate the value of E, ultimate stress, permissible stress, percentage elongation etc. and to study its fracture.	1
2	To perform the compression test on; Concrete cylinders &cubes, C.I., M.S. & Wood specimens and to determine various physical and mechanical properties	1
3	To perform the bending test on the specimens; M.S. Girder, Wooden beam, Plain concrete beams &R.C.C. Beam, and to determine the various physical and mechanical properties	1
4	To determine Young's modulus of elasticity of beam with the help of deflection produced at centre due to loads placed at centre & quarter points	1
5	To study the behaviour of materials (G.I. pipes, M.S., C.I.) under torsion and to evaluate various elastic constants	1
6	To study load deflection and other physical properties of closely coiled helical spring in tension and compression	1
7	To perform the Rockwell, Vicker's and Brinell's Hardness tests on the given specimens	1
8	To perform the Drop Hammer Test, Izod Test and Charpay's impact tests on the given specimens	1
9	To determine compressive & tensile strength of cement after making cubes and briquettes	3
10	To measure workability of concrete (slump test, compaction factor test)	2
11	To determine voids ratio & bulk density of cement, fine aggregates and coarse aggregates	1
12	To determine fatigue strength of a given specimen.	1
13	To write detail report emphasizing engineering importance of performing tension, compression, bending, torsion, impact and hardness tests on the materials	1
	Total	**16**

Suggested Readings

Khurmi R.S. 2001. Strength of Materials S. Chand & Co., Ltd., New Delhi.

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
6	Work shop Technology and Practices	ME-1.2.6	3(1 +2)	1	2	0

Course content:

Theory:

Introduction to various carpentry tools, materials, types of wood and their characteristics and Processes or operations in wood working; Introduction to Smithy tools and operations; Introduction to welding, types of welding, Oxyacetylene gas welding, types of flames, welding techniques and equipment. Principle of arc welding, equipment and tools. Casting processes; Classification, constructional details of center lathe, Main accessories and attachments. Main operations and tools

used on center lathes. Types of shapers, Constructional details of standard shaper. Work holding devices, shaper tools and main operations. Types of drilling machines. Constructional details of pillar types and radial drilling machines. Work holding and tool holding devices. Main operations. Twist drills, drill angles and sizes. Types and classification. Constructional details and principles of operation of column and knee type universal milling machines. Plain milling cutter. Main operations on milling machine.

Practical:

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Introduction to various carpentry tools, materials, types of wood and their characteristics, Processes or operations in wood working;	1
2	Introduction to Smithy tools and operations.	1
3	Introduction to welding, types of welding Oxyacetylene gas welding, types of flames, welding techniques and equipment. Principle of arc welding, equipment and tools.	2
4	Casting processes; Classification, constructional details of center lathe, Main accessories and attachments.	2
5	Main operations and tools used on center lathes.	2
6	Types of shapers, Constructional details of standard shaper.	1
7	Work holding devices, shaper tools and main operations.	1
8	Types of drilling machines.	1
9	Constructional details of pillar types and radial drilling machines.	1
10	Work holding and tool holding devices. Main operations. Twist drills, drill angles and sizes.	1
11	Types and classification. Constructional details of column and knee type universal milling machines	1
12	Principles of operation of column and knee type universal milling machines.	1
13	Plain milling cutter. Main operations on milling machine	1
	Total	**16**

Practicals		
S.No.	**Topic**	**No. of Practical**
1	To understand and prepare a layout of workshop	2
2	Introduction to tools and measuring instruments for carpentry	2
3	Preparation of simple jobs using carpentry tools	2
4	Introduction to tools and measuring instruments for fitting	2
5	Preparation of simple jobs using fitting tools	2
6	Introduction to tools and measuring instruments for sheet metal work	2
7	Preparation of simple jobs using sheet metal work with G.I. sheet	2
8	Introduction to different tools and equipments of welding machine	2
9	Demonstration of a job in arc welding	2
10	Introduction to metal casting equipment, tools and their use	2
11	Prepare a mould cavity by using different casting equipments.	4
12	Introduction to machine shop and different cutting tools	2
13	Demonstration of a job on lathe machine	2
14	Demonstration of a job on drilling machine	2
15	Demonstration of a job on shaper machine	2
	Total	**32**

Suggested Readings

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

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

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
7	**Theory of Machines**	**ME-1.2.7**	**2(2 + 0)**	**2**	**0**	**0**

Course content:

Theory:

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Introduction to elements, links, pairs, kinematic chain and mechanism. Classification of pairs, mechanism and their inversion	3
2	Determination of velocity and acceleration using graphical method and instantaneous centers	4
3	Types of gears and law of gearing, involutes and cycloidal profile for gear teeth, spur gear nomenclature, introduction to helical, spiral, bevel and worm gear, simple, compound, reverted and epicyclic	4
4	Determination of velocity ratio by tubular method, turning moment diagram, coefficient of fluctuation of speed and energy, fly wheel and its application	4
5	Types of belt drives, belt mechanism, belt materials, length of belts, power transmitted, velocity ratio, effect of centrifugal tension, creep and slip, chain drive	4
6	Types of friction, law of dry friction, friction of pivots and collars	2
7	Single disc, multiple disc and cone clutches, rolling friction and antifriction bearing	3
8	Types of governors, constructional details and analysis of watt, porter, proell governors	3
9	Effect of friction, controlling force curve, sensitiveness, stability, hunting, isochronisms, power and effect of governors	3
10	Static and dynamic balancing, balancing of rotating mass in one and different planes	2
	Total	**32**

Suggested Readings

Bevan Thomas. 1984. Theory of Machines. CBS Publishers and Distributors, Delhi.

Ballaney P L. 1985. Theory of Machines. Khanna Publishers, 2-B Nath Market, Nai Sarak, New Delhi. Rao J S and Dukkipatti R V. 1990. Mechanisms and Machine Theory. Wiley astern Ltd., New Delhi.

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

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

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
8	**Web Designing and Internet Applications**	**CSE-1.2.8**	**2 (1 + 1)**	**1**	**1**	**0**

Course content:

Theory:

Basic principles in developing a web designing, Planning process, Five Golden rules of web designing, Designing navigation bar, Page design, Home Page Layout , Design Concept. Basics

in Web Design, Brief History of Internet, World Wide Web , creation of a web site, Web Standards, Audience requirement. Introduction to JavaScript, variables & functions, Working with alert, confirm and prompt, Connectivity of Web pages with databases; Project

Practical:

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Brief History of Internet	1
2	Introduction of WWW, Website, Web server and Web client	1
3	Web design concepts, principals and standards	2
4	Basic of HTML & Dream viewer	3
5	Introduction to JavaScript, variables	1
6	Working with alert, confirm and prompt	1
7	JavaScript conditional statement and looping	3
8	JavaScript Events and Form Elements	3
9	Connectivity of Web pages with databases	1
Total		**16**
Practicals		
S.No.	**Topic**	**No. of Tutorials**
1	Introduction of DREAM WEAVER windows layouts & menu	1
2	DREAM WEAVER: Planning & Setting Web Site Structure	1
3	DREAM WEAVER: Text formatting, Listing & Table	2
4	DREAM WEAVER: Image properties & Linking	1
5	DREAM WEAVER: Frame and partition tags	1
6	FTP Uploading & Downloading	1
7	JavaScript: Introduction, variable and operators	2
8	JavaScript: alert, confirm and prompt dialog boxes	1
9	JavaScript: Concept of Form Elements & events	2
10	JavaScript: Creating rollover image	1
11	FLASH: Introduction and layouts	1
12	FLASH Animation: Motion and shape tween	1
13	GIF Image & Animated button	1
	Total	**16**

Suggested Readings

Jennifer Niederst Robbins. Developing web design latest edition. Frain and Ben. Responsive Web Design with HTML5..

Nicholas c.Zakas. Java Script for Web Developers.

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
9	NSS/NCC/Physical Education	Phy. Edu.-1.2.9	0(0 +1)	0	0	0

SEMESTER – III

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	**Principles of Horticultural Crops and Plant Protection**	**Ag(E)-2.3.1**	**2(1 + 1)**	**1**	**1**	**0**

Course content:

Theory:

Scope of horticultural. Soil and climatic requirements for fruits, vegetables and floriculture crops, improved varieties, Criteria for site selection, layout and planting methods, nursery raising, commercial varieties/hybrids, sowing and planting times and methods, seed rate and seed treatment for vegetable crops; macro and micro propagation methods, plant growing structures, pruning and training, crop coefficients, water requirements and critical stages, fertilizer application, fertigation, irrigation methods, harvesting, grading and packaging, post harvest practices, Garden tools, management of orchard, Extraction and storage of vegetables seeds. Major pests and diseases and their management in horticulture crops.

Practical

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Scope of horticultural.	1
2	Soil and climatic requirements for fruits, vegetables and floriculture crops, improved varieties	1
3	Criteria for site selection, layout and planting methods, nursery raising, commercial varieties/hybrids, sowing and planting times and methods	2
4	Seed rate and seed treatment for vegetable crops;	1
5	Macro and micro propagation methods,	1
6	Plant growing structures, pruning and training,	2
7	Crop coefficients, water requirements and critical stages, fertilizer application, fertigation, irrigation methods,	2
8	Harvesting, grading and packaging, post harvest practices,.	2
9	Garden tools, management of orchard,	1
10	Extraction and storage of vegetables seeds.	2
11	Major pests and diseases and their management in horticulture crops	1
	Total	**16**

Practicals		
S.No.	**Topic**	**No. of Praticals**
1	Judging maturity time for harvesting of crop;	1
2	Study of seed viability and germination test;	2
3	Identification and description of important fruits, flowers and vegetable crops;.	2
4	Study of different garden tools;	1
5	Preparation of nursery bed;	1
6	Practices of pruning and training in some important fruit crops,	2
7	Visit to commercial greenhouse/ polyhouse;	2
8	Cultural operations for vegetable crops (sowing, fertilizer application, mulching,	2
	irrigation and weed control);	
9	Seed extraction techniques;	2
1	Identification of important pests and diseases and their control	1
0	**Total**	**16**

Suggested Readings

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

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

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

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	**Principles of Agronomy**	**Ag(E)-2.3.2**	**3(2 + 1)**	**2**	**1**	**0**

Course content:

Theory:

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

Practical

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Introduction and scope of agronomy	2

2	Classification of crops	2
3	Effect of different weather parameters on crop growth and development	3
4	Principles of tillage, tilth and its characteristics	4
5	Crop seasons	4
6	Methods, time and depth of sowing of major field crops	4
7	Methods and time of application of manures and fertilizers	3
8	Organic farming-Sustainable agriculture	3
9	Soil water plant relationship, crop coefficients, water requirement of crops and critical stages for irrigation	3
10	Weeds and their control, crop rotation, cropping systems	4
11	Relay cropping and mixed cropping	
	Total	**32**

Practicals

Sr.No.	Topic	No. of Practicals
1	Identification of crops and their varieties, seeds, manures, fertilizers and weeds;.	4
2	Fertilizer application methods;	2
3	Different weed control methods;	4
4	Practice of ploughing,	2
5	Practice of Puddling,	2
6	Practice of sowing	2
	Total	**16**

Suggested Readings

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

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

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

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

Rao V S. 1992. Principles of Weed Science. Oxford and IBH Publishing Co. Ltd. New Delhi. Reddy Yellamanda T and Shankar Reddy G H. 1995. Principles of Agronomy. Kalyani Publishers

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	**Communication Skills and Personality Development**	**AS(E)-2.3.3**	**2(1 + 1)**	**1**	**1**	**0**

Course content:

Theory:

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

Practical

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Communication Skills: Structural and functional grammar	4
2	process of communication	1
3	verbal and non-verbal communication	2
4	listening and note taking	1
5	writing skills	1
6	oral presentation skills, individual and group presentations, impromptu presentation, public speaking	2
7	indexing, footnote and bibliographic procedures	1
8	Reading and comprehension of general and technical articles	1
9	precis writing, summarizing, abstracting	1
10	Group discussion	1
11	Organizing seminars and conferences	1
Total		**16**
Tutorials		
S.No.	**Topic**	**No. of Tutorials**
1	Listening and note taking	2
2	writing skills	2
3	oral presentation skills, individual and group presentations	6
4	Indexing, footnote and bibliographic procedures.	2
5	Reading and comprehension of general and technical articles	2
6	precis writing, summarizing, abstracting	2
	Total	**16**

Suggested Readings

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

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

Naterop, Jean, B. and Rod Revell. 1997. Telephoning in English. Cambridge University Press, Cambridge. Mohan Krishna and Meera Banerjee. 1990. Developing Communication Skills. Macmillan India Ltd. New Delhi.

Krishnaswamy,. N and Sriraman, T. 1995. Current English for Colleges. Macmillan India Ltd. Madras. Narayanaswamy V R. 1979. Strengthen your writing. Orient Longman, New Delhi.

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	Engineering Mathematics-III	Math(E)-2.3.4	3(2 + 1)	2	1	0

Course content:

Theory:

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

Tutorial:

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Finite difference, various difference operators and their relationships. factorial notation	3
2	Interpolation with equal integrals. Newton's forward and backward interpolation formula. Bessel's and Stirling's difference interpolation formulae	4
3	Interpolation with unequal intervals. Newton's divided difference formula. Lagrange's interpolation formula.	2
4	numerical differentiations, numerical integrations	2
5	difference equations and their solutions	2
6	Numerical solutions of ordinary differential equations by Picard's Taylor's series. Fuller's and modified Fuller's methods. Runga-Kutta method	3
7	Laplace transformation and its applications to the solutions of ordinary and simultaneous differential equations	4
8	Testing of Hypothesis-Level of Significance-Degrees of freedom-Statistical errors	4
9	Large sample test (Z-test), Small sample test t-test (One tailed, two tailed and Paired tests)	4
10	Testing of Significance through variance (F-test), Chi -Square test, contingency table, Correlation, Regression	4
	Total	**32**

Tutorials		
S.No.	**Topic**	**No. of Tutorials**
1	Interpolation	2
2	Numerical differentiation and integration	1
3	solutions of difference equations	1
4	numerical solution of ordinary differential equations of first order and first degree	2
5	Laplace and inverse Laplace transformations and their application to solution of ordinary and simultaneous differential equations.	3
6	Problems on One Sample, Two sample Z-tests when Population S.D. is known and unknown	2
7	Problems on one sample, Two sample and paired t-test Chi-Square test – 2x2 and m x n	2
8	Calculation of Correlation coefficient and its testing	2
9	Contingency Table and F-test.	1
	Total	**16**

Suggested Readings

Chandel SRS. A Hand book of Agricultural Statistics. Achal Praskasam Masndir, Kanpur. Agrawal B L. Basic Statistics. Wiley Eastern Ltd. New Age International Ltd.

Nageswara Rao G. Statistics for Agricultural Sciences. BS Publications.

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
5	**Soil Mechanics**	**CE-2.3.5**	**2(1 + 1)**	**1**	**1**	**0**

Course content:

Theory

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

Practical

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Introduction of soil mechanics, field of soil mechanics.	1
2	Phase diagram physical and index properties of soil.	1
3	Classification of soils, general classification based on particles size, textural classification and I. S. Soil classification system.	1
4	Stress condition in soils, effective and neutral stress	1
5	Elementary concept of Bousinesque and Wester guards analysis, Newmark influence chart.	1
6	Shear strength Mohr stress circle, theoretical relationship between principle stress circle, theoretical relationship between principal stress	2
7	Mohr-coulomb failure theory, effective stress principle.	1
8	Determination of shear parameters by direct shear to the circle, theoretical test, numerical exercise based on various types of tests	1
9	Compaction composition of soils standard and modified protector test Abbot Compaction and Jodhpur mini compaction text field compaction method and control	2
10	Consolidation of soil Consolidation of soils, one dimensional consolidation spring analogy	1
11	Terzaghi's theory Laboratory consolidation test, calculation of void ratio and coefficient of volume change	1
12	Taylor's and Casagrande's method, determination of coefficient of consolidation	1
13	Earth pressure Plastic equilibrium in soils, active and passive states, Rankine's theory of earth pressure active and passive earth pressure for cohesive soils, simple numerical exercise	1
14	Stability of slopes Introduction to stability analysis of infinite and finite slopes friction circles method Taylor's stability number	1
	Total	**16**

Practicals		
S.No.	**Topic**	**No. of Praticals**
1	Determination of water content of soil. (Various methods)	1
2	Determination of specific gravity of soil	1
3	Determination of field density of soil by core cutter method	1
4	Determination of field density by sand replacement method	1

5	Grain size analysis by sieving (Dry sieve analysis)	1
6	Grain size analysis by hydrometer method	1
7	Determination of liquid limit by Casagrande's method	1
8	Determination of liquid limit by cone penetrometer and plastic limit	1
9	Determination of shrinkage limit.	1
10	Determination of permeability by constant head method	1
11	Determination of permeability by variable head method	1
12	Determination of compaction properties by standard proctor test	1
13	Determination of shear parameters by direct shear test	1
14	Determination of unconfined compressive strength of soil	1
15	Determination of shear parameters by Tri-axial test	1
16	Determination of consolidation properties of soils	1
	Total	**16**

Suggested Readings

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

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

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
6	Design of Structures	CE-2.3.6	2(1 + 1)	1	1	0

Course content:

Theory

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

Practical

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Loads and use of BIS Codes.	1
2	Design of connections.	2
3	Design of structural steel members in tension, compression and bending.	3
4	Design of steel roof truss.	2
5	Analysis and design of singly and doubly reinforced sections, Shear, Bond and Torsion.	3

6	Design of Flanged Beams, Slabs, Columns, Foundations, Retaining walls and Silos	3
7	Cattle shed, Poultry House, Rural Water Supply, Farm fencing	2
	Total	**16**

Practicals

S.No.	Topic	No. of Praticals
1	Design and drawing of single reinforced beam, double reinforced beam,	4
2	Design and drawing of steel roof truss;	4
3	Design and drawing of one way, two way slabs,	3
4	Design and drawing of RCC building;	2
5	Design and drawing of Retaining wall.	2
6	To measure workability of cement by slump test	1
	Total	**16**

Suggested Readings

Junarkar, S.B. 2001. Mechanics of Structures Vol. I Charotar Publishing Home, Anand.

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

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
7	**Machine Design**	**ME-2.3.7**	**2(2 +0)**	**1**	**1**	**0**

Course content:

Theory

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

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Meaning of design, Phases of design, design considerations.	2
2	Common engineering materials and their mechanical properties.	2
3	Types of loads and stresses, theories of failure, factor of safety, selection of allowable stress.	2
4	Stress concentration. Elementary fatigue and creep aspects.	2
5	Cotter joints, knuckle joint and pinned joints, turnbuckle.	3

6	Design of welded subjected to static loads.	2
7	Design of threaded fasteners subjected to direct static loads, bolted joints loaded in shear and bolted joints subjected to eccentric loading.	4
8	Design of shafts under torsion and combined bending and torsion.	3
9	Design of keys. Design of muff, sleeve, and rigid flange couplings.	3
10	Design of helical and leaf springs.	2
11	Design of flat belt and V-belt drives and pulleys.	3
12	Design of gears. Design of screw motion mechanisms like screw jack, lead screw, etc. Selection of anti-friction bearings.	4
	Total	**32**

Suggested Readings

Jain R K. 2013. Machine Design. Khanna Publishers, 2-B Nath Market, Nai Sarak, New Delhi.

Khurmi R S and Gupta J K. 2014. A Text Book of Machine Design. S. Chand & Company Ltd., New Delhi.

Sr. No.	Course Name	Course No.	Credit	L	P	T
8	**Thermodynamics, Refrigeration and Air Conditioning**	**ME-2.3.8**	**3(2 +1)**	**2**	**0**	**1**

Course content:

Theory

Thermodynamics properties, closed and open system, flow and non-flow processes, gas laws, laws of thermodynamics, internal energy. Application of first law in heating and expansion of gases in non-flow processes. First law applied to steady flow processes. Carnot cycle, Carnot theorem. Entropy, physical concept of entropy, change of entropy of gases in thermodynamics process. Otto, diesel and dual cycles. Principles of refrigeration, - units, terminology, production of low temperatures, air refrigerators working on reverse Carnot cycle and Bell Coleman cycle. Vapour refrigeration-mechanism, P-V,P-S,P-H diagrams, vapor compression cycles, dry and wet compression, super cooling and sub cooling. Vapour absorption refrigeration system. Common refrigerants and their properties. Design calculations for refrigeration system. Cold storage plants. Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychometric chart and its use, elementary psychometric process. Air conditioning – principles –Type and functions of air conditioning, physiological principles in air conditioning, air distribution and duct design methods, fundamentals of design of complete air conditioning systems – humidifiers and dehumidifiers – cooling load calculations, types of air conditioners – applications.

Practical

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Thermodynamics properties, closed and open system	2
2	flow and non-flow processes, gas laws, laws of thermodynamics, internal energy	2
3	Application of first law in heating and expansion of gases in non-flow processes.	2
4	First law applied to steady flow processes.	2
5	Carnot cycle, Carnot theorem.	2
6	Entropy, physical concept of entropy, change of entropy of gases in thermodynamics process.	2
7	Otto, diesel and dual cycles.	2
8	Principles of refrigeration, - units, terminology, production of low temperatures, air refrigerators working on reverse Carnot cycle and Bell Coleman cycle.	2
9	Vapour refrigeration-mechanism, P-V,P-S,P-H diagrams, vapor compression cycles, dry and wet compression, super cooling and sub cooling.	2
10	Vapour absorption refrigeration system.	2
11	Common refrigerants and their properties. Design calculations for refrigeration system. Cold storage plants	2
12	Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychometric chart and its use, elementary psychometric process.	3
13	Air conditioning – principles –Type and functions of air conditioning,	2
14	physiological principles in air conditioning, air distribution and duct design methods	
15	fundamentals of design of complete air conditioning systems –	1
16	humidifiers and dehumidifiers –	1
17	cooling load calculations,	2
18	types of air conditioners – applications	1
	Total	**32**

Practicals		
S.No	**Topic**	**No. of Practical's**
1	Tutorials on thermodynamic air cycles	**1**
2	Study and application of P V and T S chart in refrigeration, P H chart (or) Mollier diagram in refrigeration	**1**
3	Numerical on air refrigeration cycle systems	**1**
4	Numerical on vapour compression cycle refrigeration system	**1**
5	Study of domestic water cooler	**1**
6	Study of domestic household refrigerator	**1**
7	Study of absorption type solar refrigeration system	**1**
8	Study cold storage for fruit and vegetables, Freezing load and time calculations for food materials	**2**
9	Determination of refrigeration parameters using refrigeration tutor – II	**1**
10	Numerical on design of air conditioning systems	**1**
11	Study of window air conditioner	**1**
12	Study on repair and maintenance of refrigeration and air-conditioning systems	**2**
13	Visit to chilling or ice making and cold storage plants	**2**
	Total	**16**

Suggested Readings

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

Khurmi R S. 1992. Engineering Thermodynamics. S Chand and Co. Ltd., Ram Nagar, New Delhi.

Mathur M L and Mehta F S. 1992. Thermodynamics and Heat Power Engineering. Dhanpat Rai and Sons 1682 Nai Sarak, New Delhi.

Ballney P. L. 1994. Thermal Engineering. Khanna Publishers, New Delhi.

Nag P K.1995. Engineering Thermodynamics. Tata McGraw Hill Publishing Co.Ltd., 12/4 Asaf Ali Raod, New Delhi.

Sr. No.	Course Name	Course No.	Credit	L	P	T
9	Electrical Machines and Power Utilization	EE-2.3.9	3(2 +1)	2	1	0

Course content:

Theory

BASIC CONCEPTS: Basic electrical quantities – specific resistance – temperature coefficient.

DC CIRCUITS: Kirchhoff's laws – Thevenin, Superposition theorem – star delta transformation.

MAGNETIC CIRCUITS: **Electro** motive force, reluctance, laws of magnetic circuits, determination of ampere-turns for series and parallel magnetic circuits, hysteresis and eddy current losses. DC MACHINES:DC Generators: Principles, operation and performance of DC machine (generator and motor), EMF and torque equations, armature reaction, commutation, excitation of DC generator and their characteristics; DC Motors: DC motor characteristics, starting of shunt and series motor, starters, speed control methods-field and armature control. AC CIRCUITS: Single phase AC circuits: Basics – RMS and average quantities.Three phase AC circuits:Reasons for use of three phase systems – star and delta for generation and load - power factor - power and energy measurement various methods of three phase power measurement; power factor, reactive and apparent power, Concept and analysis of balanced poly-phase circuits; Series and parallel resonance;AC MACHINES:Transformer: Principle of working, construction of single phase transformer, EMF equation, phasor diagram on load, leakage reactance, voltage regulation, power and energy efficiency, open circuit and short circuit tests; Poly-phase induction motor: Construction, operation, phasor diagram, effect of rotor resistance, torque equation, starting and speed control methods. Single-phase induction motor: Double field revolving theory, equivalent circuit, characteristics, phase split, shaded pole motors

Practicals

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

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

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Basic electrical quantities, specific resistance, electrical units, Temperature coefficient	1
2	DC circuits, Kirchoff's first law	1
3	Kirchoff's second law , problem on this law	1
4	Thevenins theorem, superposition theorem, problem solving	2
5	Star delta transformation	1
6	Electro motive force, reluctance, laws of magnetic circuits,	1
7	Determination of ampere-turns for series and parallel magnetic circuits	1
8	Hysteresis and eddy current losses	1
9	Principles, operation and performance of DC generator	1
10	EMF, armature reaction, commutation	1
11	Excitation of DC generator and their characteristics	2
12	DC motor characteristics	1
13	Starting of shunt and series motor, starters	1
14	Speed control methods-field and armature control	1
15	Basics – RMS and average quantities	1
16	Three phase AC circuits – reasons for use of three phase systems – star and delta for generation and load	1
17	Power factor, reactive and apparent power	1
18	Power and energy measurement various methods of three phase power measurement	2
19	Concept and analysis of balanced poly-phase circuits	1
20	Series and parallel resonance	2
21	Principle of working, construction of single phase transformer	1
22	EMF equation, phasor diagram on load, leakage reactance	1
23	Voltage regulation, power and energy efficiency	1
24	Open circuit and short circuit tests	1
25	Construction, operation, phasor diagram	1
26	Effect of rotor resistance, torque equation, starting and speed control methods	1
27	Double field revolving theory, equivalent circuit	1
28	Characteristics, phase split, shaded pole motors	1
	Total	**32**

S.No	Topic	No. of Practicals
1	To obtain load characteristics of d.c. shunt/series /compound generator;	**3**
2	To study characteristics of DC shunt/ series motors	**2**
3	To study d.c. motor starters	**1**
4	To Perform load-test on 3 ph. induction motor & to plot torque V/S speed characteristics	**1**

5	To perform no-load & blocked –rotor tests on 3 ph. Induction motor to obtain equivalent ckt. parameters & to draw circle diagram	**1**
6	To study the speed control of 3 ph. induction motor by cascading of two induction motors, i.e. by feeding the slip power of one motor into the other motor	**1**
7	To study star- delta starters physically and (a) to draw electrical connection diagram (b) to start the 3 ph. induction motor using it. (c) to reverse the direction of 3 ph. I.M	**1**
8	To start a 3-phase slip –ring induction motor by inserting different levels of resistance in the rotor ckt. and to plot torque –speed characteristics	**1**
9	To perform no load & blocked –rotor test on 1 ph. induction motor & to determine the parameters of equivalent ckt. drawn on the basis of double revolving field theory	**1**
10	To perform load –test on 1 ph. induction motor & plot torque –speed characteristics	**1**
11	To study power consumed in a three-phase circuit	**1**
12	Two lights in series controlled by one switch	**1**
13	Two lights in parallel controlled by one switch.	**1**
	Total	**16**

Suggested Readings

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

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

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

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
10	**NSS/NCC/Physical Education**	**Phy. Edu. – 2.3.10**	**0(0 +1)**	**0**	**0**	**0**

SEMESTER – IV

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	**Building Construction and Cost Estimation**	**CE-2.4.1**	**2(2 + 0)**	**2**	**0**	**0**

Course content:

Theory:

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Building Materials: Rocks, Stones, Bricks	2
2	Properties and varieties of Tiles, Lime, Cement, Concrete, Sand. Glass, Rubber, Plastics, iron, Steel, Aluminium, Copper, Nickle. Timber.	3
3	Building components: Lintels, Arches, stair cases,	3
4	Different types of floors,	2
5	Finishing: Damp Proofing and water proofing, Plastering, pointing,	3
6	white washing and distempering – Painting,	2
7	Building design, Design procedures, Technology	2
8	building construction, Types of agricultural buildings and related needs,	2
9	application of design theory and practice to the conservation, sloped and flat roof buildings	3
10	construction economics: Preliminary estimates,	1
11	Detailed Estimates of Buildings source of cost information, use of cost analyses for controlling design,	3
12	Factors affecting building costs; cost evaluation of design and planning alternatives for building and estate development,	3
13	Measurement and pricing, Economic methods for evaluating investments in buildings and building systems: cost-in-use, benefit-to-costs and savings-to-investment ratios, rate of return, net benefits, payback	3
	Total	**32**

Suggested Readings

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

Duggal S K. Building material. New Age International Publishers. Sane Y.S. Planning and Designing of Buildings.

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

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	Auto CAD Applications	ME-2.4.2	2(0 + 2)	0	2	0

Course content:

Practical

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

Practical		
S.No.	Topic	No. of practical's
1	Introduction of CAD and use of computers for design	2
2	CAD- Overview of CAD window. Explanation of various options screen	2
3	Study of draw and dimension tool bar	2
4	Practice on draw and dimension tool bar	2
5	Study of OSNAP, 1ine thickness and format tool bar	2
6	Practice on OSNAP, line thickness and format tool bar	2
7	Practice on mirror, offset and array commands	2
8	Practice on trim, extend, chamfer and fillet commands	2
9	Practice on copy, move, scale and rotate commands	2
10	Drawing of 2 D- drawing using draw tool bar	2
11	Practice on creating boundary, region, hatch and gradient commands	2
12	Practice on Editing polyline- PEDIT and Explode commands	2
13	2D- drawing of machine parts with all dimensions and allowances	2
14	Drawing of hexagonal, nut and bolt and other machine parts	2
15	Practice on 3-D commands using Auto CAD, Pro-E and Bob CAD	2
16	Demonstration on CNC machine	2
	Total	**32**

Suggested Readings

Rao P.N.. 2002. CAD/CAM Principles and Applications. McGraw-Hill Education Pvt. Ltd., New Delhi.

Sareen Kuldeep and Chandan Deep Grewal. 2010. CAD/CAM Theory and Practice. S.Chand & Company Ltd., New Delhi.

Zeid Ibrahim. 2011. Mastering CAD/CAM with Engineering. McGraw-Hill Education Pvt. Ltd., New Delhi.

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	Applied Electronics and Instrumentation	EE-2.4.3	3(2 + 1)	2	1	0

Course content:

Theory

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

Practical

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

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Semiconductors, P-N junction, V-I characteristics of P-N junction	2
2	Diode as a circuit element, rectifier	2
3	Clipper, clamper	2
4	Voltage multiplier, Capacitive filter	2

5	Diode circuits for OR & AND gate	1
6	Bipolar junction Transistor; operating point	2
7	Classification of amplifier, various biasing methods	2
8	h-parameter model of a transistor, analysis of small signal	2
9	CE amplifier, phase shift oscillator	2
10	Analysis of different amplifier using transistor	2
11	Ideal OP-AMP characteristics	1
12	Linear and Non-linear application of OP-AMP	2
13	Zener diode Voltage Regulator, transistor series regulator	2
14	Current limiting, OP-AMP Voltage regulator	1
15	Basic theorem of Boolean algebra, Combinational logic circuits	1
16	Binary ladder D/A converter ,Successive approximation A/D converter	1
17	Generalized instrumentation, measurement of displacement, temperature using potentiometer	1
18	Velocity, force and pressure measurement using potentiometer	1
19	Resistance thermometer, thermocouple	1
20	Bourden tube, LVDT	1
21	Strain gauge and tacho generator	1
	Total	**32**

Practicals		
Sr.No.	**Topic**	**No. of Praticals**
1	To study V-I characteristics of p-n junction diode	1
2	To study half wave. full wave and bridge rectifier	1
3	To study a diode as clipper and clamper	2
4	To study transistor characteristics in CE configurations	1
5	To design and study fixed and self-bias transistor	1
6	To design and study potential divider bias transistor	1
7	To study a OP-AMP IC 741 as inverting and non- inverting amplifier	2
8	To study a OP-AMP IC 741 as differentiator and integrator to study a differential amplifier using two transistor	2
9	To study a OP-AMP IC 741 as differential amplifier	1
10	To study a zener regulator circuit	1
11	To study a OP-AMP IC 741 as a active rectifier	1
12	To study a OP-AMP IC 741 as a comparator	1
13	To familiarize with various types of transducers	1
	Total	**16**

Suggested Readings

Robert L Boyelsted, Electronic Devices and Circuit Theory

Mehta V K. Principles of Electronics. S. Chand and Co., New Delhi.

Shaney A K. Measurement of Electronics and Electronic Instrumentation. Khanna Publications. Roy Chowdary. Integrated Electronics. John Wiley International.

Kumar Anand. Digital Electronics. A. PHI.

Gupta Sanjeev, Sonthosh Gupta. Electronic Devices and Circuits. Danapath Rai Publications

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	Tractor and Automotive Engines	FMPE-2.4.4	3 (2 + 1)	2	1	0

Course content:

Theory

Study of sources of farm power –conventional & non-conventional energy sources. Classification of tractors and IC engines. Review of thermodynamic principles of IC (CI & SI) engines and deviation from ideal cycle. General energy equation and heat balance sheet. Study of mechanical, thermal and volumetric efficiencies. Study of engine components their construction, operating principles and functions. Study of engine strokes and comparison of 2-stroke and 4-stroke engine cycles and CI and SI engines. Study of Engine Valve systems, valve mechanism, Valve timing diagram, and valve clearance adjustment Study of Cam profile, valve lift and valve opening area. Study of importance of air cleaning system. Study of types of air cleaners and performance characteristics of various air cleaners. Study of fuel supply system. Study of fuels, properties of fuels, calculation of air-fuel ratio. Study of tests on fuel for SI and CI engines. Study of detonation and knocking in IC engines. Study of carburetion system, carburetors and their main functional components. Study of fuel injection system – Injection pump, their types, working principles. Fuel injector nozzles – their types and working principle. Engine governing – need of governors, governor types and governor characteristics. Study of lubrication system – need, types, functional components. Study of lubricants – physical properties, additives and their application. Engine cooling system – need, cooling methods and main functional components. Study of need and type of thermostat valves. Additives in the coolant. Study of radiator efficiency. Study of ignition system of SI engines. Study of electrical system including battery, starting motor, battery charging, cut-out, etc. Comparison of dynamo and alternator. Familiarization with the basics of engine testing

Practical

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1.	Study of sources of farm power –conventional & non-conventional energy	2
2.	Classification of tractors and IC engines.	2
3.	Review of thermodynamic principles of IC (CI & SI) engines and deviation	2
4.	General energy equation and heat balance sheet.	2
5.	Study of mechanical, thermal and volumetric efficiencies.	2
6.	Study of engine components their construction, operating principles and	2
7.	Study of engine strokes and comparison of 2-stroke and 4-stroke engine	2
8.	Study of Engine Valve systems, valve mechanism, Valve timing diagram,	2

9.	Study of importance of air cleaning system. Study of types of air cleaners	2
10.	Study of fuel supply system. Study of fuels, properties of fuels, calculation of air-fuel ratio.	2
11.	Study of tests on fuel for SI and CI engines. Study of detonation and	2
12.	Study of carburetion system, carburetors and their main functional	2
13.	Engine governing – need of governors, governor types and governor	2
14.	Study of lubrication system – need, types, functional components. Study of	2
15.	Engine cooling system – need, cooling methods and main functional	2
16.	Study of ignition system of SI engines. Study of electrical system including	2
17.	Familiarization with the basics of engine testing	2
	Total	**34**

Practicals

S.No.	Topic	No. of Praticals
1.	Introduction to different systems of CI engines; Engine parts and functions,	2
2.	Valve system – study, construction and adjustments	1
3.	Oil & Fuel – determination of physical properties	1
4.	Air cleaning system	1
5.	Fuel supply system of SI and CI engine	2
6.	Diesel injection system & timing	1
7.	Cooling system, and fan performance, thermostat and radiator performance	1
8.	Part load efficiencies & governing	1
9.	Lubricating system & adjustments	1
10.	Starting and electrical system	1
11.	Ignition system	1
12.	Tractor engine heat balance and engine performance curves	1
13.	Visit to engine manufacturer/ assembler/ spare parts agency	1
	Total	**15**

Suggested Readings

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

Rodichev V and G Rodicheva. Tractors and Automobiles.

Mathur ML and RP Sharma. A course in Internal Combustion Engines.

Singh Kirpal. Automobile Engineering – Vol II.

Heitner Joseph. Automotive Mechanics : Principles and Practices.

Sr. No.	Course Name	Course No.	Credit	L	P	T
5.	Engineering properties of Agricultural	PFE-2.4.5	2 (1 + 1)	1	1	0

Course content :

Theory

Classification and importance of engineering properties of Agricultural Produce, shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area of grains, fruits and vegetables, Thermal properties, Heat capacity, Specific heat, Thermal conductivity, Thermal diffusivity, Heat of respiration; Co-efficient of thermal expansion, Friction in agricultural materials; Static friction, Kinetic friction, rolling resistance, angle of internal friction, angle of repose, Flow of

bulk granular materials, Aero dynamics of agricultural products, drag coefficients, terminal velocity. Rheological properties; force, deformation, stress, strain, elastic, plastic and viscous behaviour, Newtonian and Non-Newtonian liquid, Visco-elasticity, Newtonian and Non-Newtonian fluid, Pseudo-plastic, Dilatant, Thixotropic, Rheopectic and Bingham Plastic Foods, Flow curves. Electrical properties; dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant, method of determination. Application of engineering properties in handling processing machines and storage structure

Practical

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

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Classification and importance of engineering properties of Agricultural Produce	1
2	Shape, size, roundness, sphericity, volume	1
3	Density, porosity, specific gravity, surface area of grains, fruits and vegetables	1
4	Thermal properties, Heat capacity, Specific heat, Thermal conductivity	1
5	Thermal diffusivity, Heat of respiration, Co-efficient of thermal expansion	1
6	Friction in agricultural materials; Static friction, Kinetic friction	1
7	Rolling resistance, angle of internal friction, angle of repose, Flow of bulk granular materials	2
8	Aero dynamics of agricultural products, drag coefficients, terminal velocity	1
9	Rheological properties; force, deformation, stress, strain, elastic, plastic and viscous behaviour	2
10	Newtonian and Non-Newtonian liquid, Visco-elasticity, Newtonian and Non-Newtonian fluid	1
11	Pseudo-plastic, Dilatant, Thixotropic, Rheopectic and Bingham Plastic Foods, Flow curves	1
12	Electrical properties; dielectric loss factor, loss tangent	1
13	A.C. conductivity and dielectric constant, method of determination	1
14	Application of engineering properties in handling processing machines and storage structures	1
	Total	**16**
	Practical	
S.No.	**Topic**	**No. of Practical**
1	Determination of shape and size grains using micrometer.	1
2	Determination of shape and size of fruits and vegetables using vernier caliper	1
3	Determination of sphericity, roundness and roundness ratio of grains	1
4	Determination of sphericity, roundness and roundness ratio of fruits and vegetables	1
5	Determination of bulk density of grains	1
6	Determination of particle density/true density and porosity of solid grains.	1
7	Determination of porosity of solid grains.	1
8	Determination of angle of repose for grains	1

9	Determination co-efficient of external friction of grain	1
10	Determination co-efficient of internal friction of grain	1
11	Determination of hardness of food material.	1
12	Determination of thermal conductivity of grains	1
13	Determination of specific heat of grains	1
14	Preparation of a ready re-ckoner of change in unit weight of food grains as affected by change in its moisture content (w.b.) (5% - 25%).	1
15	Determination of viscosity of liquid foods	1
16	Finding out the terminal velocity of grain samples and study the separating behaviour in a vertical wind tunnel	1
	Total	**16**

Suggested Readings

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

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

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

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

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
6	Watershed Hydrology	SWCE-2.4.6	1 (1 + 1)	1	1	0

Course content :

Theory:

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

Practical:

Visit to meteorological observatory and study of different instruments. Design of rain gauge network. Exercise on intensity - frequency - duration curves. Exercise on depth - area - duration and double mass curves. Analysis of rainfall data and estimation of mean rainfall by different methods. Exercise on frequency analysis of hydrologic data and estimation of missing data, test for

consistency of rainfall records. Exercise on computation of infiltration indices. Computation of peak runoff and runoff volume by Cook's method and rational formula. Computation of runoff volume by SCS curve number method. Study of stream gauging instruments - current meter and stage level recorder. Exercise on geomorphic parameters of watersheds. Exercise on runoff hydrograph. Exercise on unit hydrograph. Exercise on synthetic hydrograph. Exercise on flood routing.

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1.	Hydrologic cycle, precipitation and its forms	1
2.	rainfall measurement and estimation of mean rainfall	1
3.	frequency analysis of point rainfall	1
4.	Mass curve, hyetograph, depth-area-duration curves and intensity-duration-frequency relationship	1
5.	Hydrologic processes-Interception, infiltration -factors influencing, measurement and indices	1
6.	Evaporation - Estimation and measurement	1
7.	Runoff - Factors affecting, measurement, stage - discharge rating curve,	1
8.	estimation of peak runoff rate and volume	1
9.	Rational method, Cook's method and SCS curve number method	1
10.	Geomorphology of watersheds – Linear, aerial and relief aspects of watersheds-stream order, drainage density and stream frequency	1
11.	Hydrograph - Components, base flow separation, unit hydrograph theory	1
12.	S-curve, synthetic hydrograph, applications and limitations	1
13.	Stream gauging - discharge rating curves, flood peak, design flood and computation of probable flood	1
14.	Flood routing – channel and reservoir routing	1
15.	Drought – classification, causes and impacts	1
16.	drought management strategy	1
Total		**16**
Practicals		
S.No.	**Topic**	**No. of Practicals**
1	Visit to meteorological observatory and study of different instruments.	1
2	Design of rain gauge network.	1
3	Exercise on intensity - frequency - duration curves.	1
4	Exercise on depth - area - duration and double mass curves.	2
5	Analysis of rainfall data and estimation of mean rainfall by different methods.	1
6	Exercise on frequency analysis of hydrologic data and estimation of missing data, test for consistency of rainfall records.	2
7	Exercise on computation of infiltration indices.	1
8	Computation of peak runoff and runoff volume by Cook's method and rational formula.	1
9	Computation of runoff volume by SCS curve number method.	1
10	Study of stream gauging instruments - current meter and stage level recorder.	1

11	Exercise on geomorphic parameters of watersheds.	1
12	Exercise on runoff hydrograph.	1
13	Exercise on unit hydrograph.	2
14	Exercise on synthetic hydrograph.	1
	Total	**16**

Suggested Readings

Chow, V.T., D.R. Maidment and L.W. Mays. 2010. Applied Hydrology, McGraw Hill Publishing Co., New York.

Jaya Rami Reddy, P. 2011. A Text Book of Hydrology. University Science Press, New Delhi.

Linsley, R.K., M.A. Kohler, and J.L.H. Paulhus. 1984. Hydrology for Engineers. McGraw-Hill Publishing Co., Japan.

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

Raghunath, H.M. 2006. Hydrology: Principles Analysis and Design. Revised 2nd Edition, New Age International (P) Limited Publishers, New Delhi.

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

Suresh, R. 2005. Watershed Hydrology. Standard Publishers Distributors, Delhi.

Varshney, R.S. 1986. Engineering Hydrology. Nem Chand and Brothers, Roorkee, U.P.

Sr. No	Course Name	Course No.	Credit	L	P	T
7	Irrigation Engineering	IDE-2.4.7	3(2+1)	2	1	0

Course Content:

Theory:

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

Practical:

Measurement of soil moisture by different soil moisture measuring instruments; measurement of irrigation water; measurement of infiltration characteristics; determination of bulk density, field capacity and wilting point; estimation of evapotranspiration; land grading methods; design of underground pipeline system; estimation of irrigation efficiency; study of advance, recession and

computation of infiltration opportunity time; infiltration by inflow-outflow method; evaluation of border irrigation method; evaluation of furrow irrigation method; evaluation of check basin irrigation method.

Planning of Lecture		
Sr. No	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1.	Major and medium irrigation schemes of India, purpose of irrigation, environmental impact of irrigation projects, source of irrigation water, present status of development and utilization of different water reso urces of the country	6
2.	Measurement of irrigation water: weir, flumes and orifices and other methods	4
3.	open channel water conveyance system : design and lining of irrigation field channels, on farm structures for water conveyance, control & distribution ; underground pipe conveyance system: components and design	6
4.	land grading: criteria for land levelling, land levelling design methods, estimation of earth work.	4
5.	soil water plant relationship: soil properties influencing irrigation management, soil w ater movement, infiltration, soil water potential, soil moisture characteristics, soil moisture constants, measurement of soil moisture, moisture stress and plant response; water requirement of crops: concept of evapotranspiration (ET), measurement and est imation of ET, water and irrigation requirement of crops, depth of irrigation, frequency of irrigation, irrigation efficiencies.	6
6.	surface methods of water application: border, check basin and furrow irrigation- adaptability, specification and design considerations	6
	Total	**32**

Practical		
S. No	**Topics**	**No. of Practical**
1.	Measurement of soil moisture by different soil moisture measuring instruments	2
2.	Measurement of irrigation water	2
3.	Measurement of infiltration characteristics	1
4.	Determination of bulk density, field capacity and wilting point	2
5.	Estimation of evapotranspiration	1
6.	Land grading methods	1
7.	Design of underground pipeline system	1
8.	Estimation of irrigation efficiency	1
9.	Study of advance, recession and computation of infiltration opportunity time	1
10.	Infiltration by inflow-outflow method	1
11.	Evaluation of border irrigation method	1
12.	Evaluation of furrow irrigation method	1
13.	Evaluation of check basin irrigation method.	1
	Total	**16**

Suggested Readings

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

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

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

Murthy VVN. 2013. Land and Water Management Engineering. Kalyani Publishers, New Delhi.

Israelsen O W. and Hansen V. E and Stringham G. E. 1980. Irrigation Principles and Practice, John Wiley & Sons, Inc. USA.

Sr. No	Course Name	Course No.	Credit	L	P	T
8	**Sprinkler and Micro irrigation Systems**	**IDE-2.4.8**	**2(1+1)**	**1**	**1**	**0**

Course Content:

Theory:

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

Practical:

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

Planning of Lecture		
Sr. No	**Topics to be covered in Lecture**	**Proposed No. of Lecture**
1.	Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems; design of sprinkler irrigation system: layout selection, hy draulic design of lateral, sub -main and main pipe line, design steps; selection of pump and power unit for sprinkler irrigation system; performance evaluation of sprinkler irrigation system: uniformity coefficient and pattern efficiency;	3
2.	Micro Irrigati on Systems: types -drip, spray, & bubbler systems, merits and demerits, different components;	3
3.	Design of drip irrigation system: general considerations, wetting patters, irrigation requirement, emitter selection, hydraulics of drip irrigation system, des ign steps;	4
4.	Necessary steps for proper operation of a drip irrigation system; maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment	3
5.	Fertigation: advantages and limitations of fertigation, fertili zers solubility and their compatibility, precautions for successful fertigation system, fertigation frequency, duration and injection rate, methods of fertigation.	3
	Total	**16**
Practical		
Sr. No	**Topics**	**No. of Practical**
1.	Study of different components of sprinkler irrigation system	1
2.	Design and installation of sprinkler irrigation system	2
3.	Determination of precipitation pattern, discharge and uniformity coefficient	2
4.	Cost economics of sprinkler irrigation system	1
5.	Study of different components of drip irrigation	2
6.	Design and installation of drip irrigation system	2
7.	Determination of pressure discharge relationship and emission uniformity for given emitter	1
8.	Study of different types of filters and determination of filtration efficiency	1
9.	Determination of rate of injection and calibration for chemigation/fertigation	1
10.	Design of irrigation and fertigation schedule for crops	1
11.	Field visit to micro irrigation system and evaluation of drip system	1
12.	Cost economics of drip irrigation system.	1
	Total	**16**

Suggested Readings

Keller Jack and Bliesner Ron D. 2001. Sprinkle and Trickle Irrigation. Springer Science+ business Media, New York .

Mane M.S. and Ayare B.L.2007. Principles of Sprinkler Irrigation systems, Jain Brothers, New Delhi.

Mane M.S and Ayare B.L. and MagarS.S.2006.Principles of Drip Irrigation systems, Jain Brothers, New Delhi.

Michael AM, Shrimohan and KR Swaminathan. Design and evaluation of irrigation methods, (IARI Monograph No.1). Water Technology Centre, IARI New Delhi.

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

Choudhary M.L and Kadam U.S 2006. Micro irrigation for cash crops Westville Publishing

Sr. No.	Course Name	Course No.	Credit	L	P	T
9	**Fundamentals of Renewable Energy Sources**	**REE-2.4.9**	**3 (2+1)**	**2**	**1**	**0**

Course Content:

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

Practical

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

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Concept and limitation of Renewable Energy Sources (RES), Criteria for assessing the potential of RES	2
2	Classification of RES, Solar, Wind, Geothermal, Biomass, Ocean energy sources, Comparison of renewable energy sources with non renewable sources	2
3	Solar Energy: Energy available from Sun, Solar radiation data, solar energy conversion into heat through,	2
4	Flat plate and Concentrating collectors, different solar thermal devices, Principle of natural and forced convection drying system	3
5	Solar Photo voltaics: p-n junctions. Solar cells, PV systems, Stand alone, Grid connected solar power station, Calculation of energy through photovoltaic power generation and cost economics	4

6	Wind Energy: Energy available from wind, General formula, Lift and drag. Basis of Wind energy conversion, Effect of density, Frequency variances, Angle of attack, Wind speed, Types of Windmill rotors, Determination of torque coefficient, Induction type generators, Working principle of wind power plant.	5
7	Bio-energy: Pyrolysis of Biomass to produce solid, liquid and gaseous fuels.	2
8	Biomass gasification, Types of gasifier, various types of biomass cook stoves for rural energy needs.	3
9	Biogas: types of biogas plants, biogas generation, factors affecting biogas generation and usages, design consideration, advantages and disadvantages of biogas spent slurry.	6
	Total	29

Planning of Practical

S. No.	Topics	Proposed No. of Lectures / Tutorials
1	Demonstration of different instruments used for Renewable Energy gadgets measurements	1
2	Demonstration of Box types of solar cookers	1
3	Demonstration of concentrating solar cookers	1
4	Demonstration of Solar water heating system	1
5	Demonstration of Natural convection solar dryer	1
6	Demonstration of Forced convection solar dryer	1
7	Demonstration of Solar desalination unit	1
8	Study of biogas process and different types of biogas plants	1
9	Demonstration of working of a Fixed Dome Type Biogas Plants	1
10	Demonstration of working of a Floating Dome Type Biogas Plants	1
11	Study of Biomass gasification technology and demonstration of updraft biomass gasifier for thermal utilization	1
12	Demonstration of down draft throat-less and throat type biomass gasifier	1
13	Study and Demonstration of Biomass improved cook-stoves	1
14	Demonstration of Solar photovoltaic system	1
15	Study and demonstration of biomass pyrolysis system	1
16	Demonstration and study of wind mill power generation system	1
	Total	**16**

Suggested Readings

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

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

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

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

Tiwari, G.N. and Ghoshal, M.K. 2005. Renewable Energy Resources: Basic Principles and Applications. Narosa Pub. House. Delhi.

Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Renewable Energy, Theory and Practice, Himanshu Publications.

Reed TB and Das A. Handbook of Biomass Downdraft Gasifier Engine System. The Biomass Energy Foundation Press, Colorado; 1984.

Sr. No.	Course Name	Course No.	Credit	L	P	T
10	NSS/NCC/Physical Education	Phy.Edu.-2.4.10	0(0 +1)	0	0	0

SEMESTER – V

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	**Farm Machinery and Equipment-I**	**FMPE-3.5.1**	**3 (2 + 1)**	**2**	**1**	**0**

Course content:

Theory

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

Practical

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1.	Introduction to farm mechanization. Classification of farm machines.	2
2.	Unit operations in crop production. Identification and selection of machines for various operations on the farm.	2
3.	Hitching systems and controls of farm machinery.	2
4.	Calculation of field capacities and field efficiency.	2
5.	Calculations for economics of machinery usage, comparison of ownership with hiring of machines.	2
6.	Introduction to seed-bed preparation and its classification.	2

7.	Familiarization with land reclamation and earth moving equipment.	2
8.	Introduction to machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage.	2
9.	Measurement of draft of tillage tools and calculations for power requirement for the tillage machines.	2
10.	Introduction to tillage machines like mould-board plough, disc plough, chisel plough, sub-soiler, harrows, cultivators etc.	2
11.	Identification of major functional components of tillage machinery. Attachments with tillage machinery. Adjustments during operation.	2
12.	Introduction to sowing, planting & transplanting equipment. Introduction to seed drills, no-till drills, and strip-till drills.	2
13.	Introduction to planters, bed-planters and other planting equipment. Calibration of seed-drills/ planters.	2
14.	Study of types of furrow openers and metering systems in drills and planters. Adjustments during operation.	2
15	Introduction to materials used in construction of farm machines. Heat treatment processes and their requirement in farm machines. Properties of materials used for critical and functional components of agricultural machines. Introduction to steels and alloys for agricultural application. Identification of heat treatment processes specially for the agricultural machinery components.	3
	Total	31

Practicals

S.No.	Topic	No. of Praticals
1.	Familiarization with different farm implements and tools.	1
2.	Study of hitching systems,	1
3.	Problems on machinery management.	2
4.	Study of primary and secondary tillage machinery – construction, operation, adjustments and calculations of power and draft requirements.	2
5.	Study of sowing and planting equipment – construction, types, calculation for calibration and adjustments.	2
6.	Study of transplanters – paddy, vegetable, etc.	2
7.	Identification of materials of construction in agricultural machinery and study of material properties. Study of heat treatment processes subjected to critical components of agricultural machinery.	3
	Total	**13**

Suggested Readings

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

Smith HP and LH Wilkey. Farm Machinery and Equipment.

Culpin Claude. Farm Machinery.

Srivastava AC. Elements of Farm Machinery.

Lal Radhey and AC Datta. Agricultural Engineering.

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	Tractor Systems and Controls	FMPE-3.5.2	3 (2 + 1)	2	1	3

Course content :

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

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Study of need for transmission system in a tractor. Transmission system –types, major functional systems. Study of clutch – need, types, functional requirements, construction and principle of operation.	2
2	Familiarization with single plate, multi -plate, centrifugal and dual clutch systems.	3
3	Study of Gear Box – Gearing theory, principle of operation, gear box types, functional requirements, and calculation for speed ratio.	3
4	Study of differential system – need, functional components, construction, calculation for speed reduction. Study of need for a final drive.	2
5	Study of Brake system – types, principle of operation, construction, calculation for braking torque.	2
6	Study of steering system – requirements, steering geometry characteristics, functional components, calculation for turning radius. Familiarization with Ackerman steering. Steering systems in track type tractors.	3
7	Study of Hydraulic system in a tractor – Principle of operation, types, main functional components, functional requirements. Familiarization with the Hydraulic system adjustments and ADDC.	3
8	Study of tractor power outlets – PTO. PTO standards, types and functional requirements.	1
9	Introduction to traction. Traction terminology. Theoretical calculation of shear force and rolling resistance on traction device.	2

10	Study of wheels and tyres – Solid tyres and pneumatic tyres, tyre construction and tyre specifications. Study of traction aids.	2
11	Study of tractor mechanics – forces acting on the tractor. Determination of CG of a tractor.	2
12	Determination and importance of moment of inertia of a tractor. Study of tractor static equilibrium, tractor stability especially at turns.	2
12	Determination of maximum drawbar pull. Familiarization with tractor as a spring-mass system.	2
13	Ergonomic considerations and operational safety.	2
14	Introduction to tractor testing. Deciphering the engine test codes.	1
	Total	**32**

Practicals

S. No.	Topic	No. of Practicals
1	Introduction to transmission systems and components	1
2	Study of clutch functioning, parts and design problem on clutch system	2
3	Study of different types of gear box, calculation of speed ratios, design problems on gear box	2
4	Study on differential and final drive and planetary gears	1
5	Study of brake systems and some design problems	1
6	Steering geometry and adjustments;	1
7	Study of hydraulic systems in a tractor hydraulic trainer and some design problems	2
8	Appraisal of various controls in different makes tractors in relation to anthropometric measurements	2
9	Determination of location of CG of a tractor, Moment of Inertia of a tractor.	1
	Determination of Moment of Inertia of a tractor.	1
10	Traction performance of a traction wheel	2
	Total	**16**

Reference Books:

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

Rodichev V and G Rodicheva. Tractors and Automobiles.

Singh Kirpal. Automobile Engineering – Vol I.

Heitner Joseph. Automotive Mechanics: Principles and Practices.

C.B.Richey. Agricultural Engineering Handbook.

John Deere. Fundamentals of Service Hydraulics.

Relevant BIS Test Codes for Tractors.

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	**Agricultural Structures and Environmental Control**	**PFE-3.5.3**	**3 (2+1)**	**2**	**1**	**0**

Course content:

Theory:

Planning and layout of farmstead. Scope, importance and need for environmental control, physiological reaction of livestock environmental factors, environmental control systems and their

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

Practical:

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Planning and layout of farmstead	1
2	Scope, importance and need for environmental control	1
3	physiological reaction of livestock environmental factors	1
4	environmental control systems and their design,	1
5	control of temperature, humidity and other air constituents by ventilation and other methods	2
6	Livestock production facilities, BIS Standards for dairy, piggery, poultry and other farm structures	2
7	Design, construction and cost estimation of farm structures; animal shelters, compost pit, fodder silo, fencing and implement sheds, barn for cows, buffalo, poultry, etc	4
8	Storage of grains, Causes of spoilage, Water activity for low and high moisture food and its limits for storage	3
9	Moisture and temperature changes in grain bins; Traditional storage structures and their improvements, Improved storage structures (CAP, hermetic storage, Pusa bin, RCC ring bins), Design consideration for grain storage godowns, Bag storage structures, Shallow and Deep bin, Calculation of pressure in bins, Storage of seeds	4
10	Rural living and development, rural roads, their construction cost and repair and maintenance	2
11	Sources of water supply, norms of water supply for human being and animals	2
12	drinking water standards and water treatment suitable to rural community	2
13	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.	4

14	Estimation of domestic power requirement, source of power supply and electrification of rural housing.	3
Total		**32**
Practical		
S.No.	**Topic**	**No. of Practical**
1	Measurements for environmental parameters and cooling load of a farm building	2
2	Design and layout of a dairy farm	1
3	Design and layout of a poultry house	1
4	Design and layout of a goat house/sheep house	1
5	Design of a farm fencing system	1
6	Design of a feed/fodder storage structures	2
7	Design of grain storage structures	2
8	Design and layout of commercial bag and bulk storage facilities	2
9	Study and performance evaluation of different domestic storage structure	2
10	Estimation of a Farm building	2
	Total	**16**

Suggested Readings:

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

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

Nathonson, J.A. Basic Environmental Technology, Prentice Hall of India, New Delhi.

Venugopal Rao, P. Text Book of Environmental Engineering, Prentice Hall of India, New Delhi.

Garg, S.K. Water Supply Engineering, Khanna Publishers, New Delhi-6.

Dutta, B.N. Estimating and Costing in Civil Engineering, Duttta & CO, Lucknow.

Khanna, P.N. Indian Practical Civil Engineer's Hand Book, Engineer's Publishers, New Delhi.

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

Banerjee, G.C. A Text Book of Animal Husbandry, Oxford IBH Publishing Co, New Delhi

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	**Post Harvest Engineering of Cereals, Pulses and Oil Seeds**	**PFE-3.5.4**	**3 (2+1)**	**2**	**1**	**0**

Course content:

Theory

Cleaning and grading, aspiration, scalping; size separators, screens, sieve analysis, capacity and effectiveness of screens. Various types of separators: specific gravity, magnetic, disc, spiral, pneumatic, inclined draper, velvet roll, colour sorters, cyclone, shape graders. Size reduction: principle, Bond's law, Kick's law, Rittinger's law, procedure (crushing, impact, cutting and shearing), Size reduction machinery: Jaw crusher, Hammer mill, Plate mill, Ball mill. Material

handling equipment. Types of conveyors: Belt, roller, chain and screw. Elevators: bucket, Cranes & hoists. Trucks (refrigerated/ unrefrigerated), Pneumatic conveying. Drying: moisture content and water activity; Free, bound and equilibrium moisture content, isotherm, hysteresis effect, EMC determination, Psychrometric chart and its use in drying, Drying principles and theory, Thin layer and deep bed drying analysis, Falling rate and constant rate drying periods, maximum and decreasing drying rate period, drying equations, Mass and energy balance, Shedd's equation, Dryer performance, Different methods of drying, batch-continuous; mixing-non-mixing, Sun-mechanical, conduction, convection, radiation, superheated steam, tempering during drying, Different types of grain dryers: bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray. Mixing: Theory of mixing of solids and pastes, Mixing index, types of mixers for solids, liquid foods and pastes. Milling of rice: Conditioning and parboiling, advantages and disadvantages, traditional methods, CFTRI and Jadavpur methods, Pressure parboiling method, Types of rice mills, Modern rice milling, different unit operations and equipment. Milling of wheat, unit operations and equipment. Milling of pulses: traditional milling methods, commercial methods, pre-conditioning, dry milling and wet milling methods: CFTRI and Pantnagar methods. Pulse milling machines, Milling of corn and its products. Dry and wet milling. Milling of oilseeds: mechanical expression, screw press, hydraulic press, solvent extraction methods, preconditioning of oilseeds, refining of oil, stabilization of rice bran., Extrusion cooking: principle, factors affecting, single and twin screw extruders. By-products utilization.

Practical

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Cleaning and grading, aspiration, scalping; size separators, screens, sieve analysis, capacity and effectiveness of screens. Various types of separators: specific gravity, magnetic, disc, spiral, pneumatic, inclined draper, velvet roll, colour sorters, cyclone, shape graders.	4
2	Size reduction: principle, Bond's law, Kick's law, Rittinger's law, procedure (crushing, impact, cutting and shearing), Size reduction machiner y: Jaw crusher, Hammer mill, Plate mill, Ball mill.	4
3	Material handling equipment. Types of conveyors: Belt, roller, chain and screw. Elevators: bucket, Cranes & hoists. Trucks (refrigerated/ unrefrigerated), Pneumatic conveying.	4

4	Drying: moisture c ontent and water activity; Free, bound and equilibrium moisture content, isotherm, hysteresis effect, EMC determination, Psychrometric chart and its use in drying, Drying principles and theory, Thin layer and deep bed drying analysis, Falling rate and cons tant rate drying periods, maximum and decreasing drying rate period, drying equations, Mass and energy balance, Shedd's equation, Dryer performance, Different methods of drying, batch-continuous; mixing-non-mixing, Sun-mechanical, conduction, convection, r adiation, superheated steam, tempering during drying, Different types of grain dryers: bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray.	6
5	Mixing: Theory of mixing of solids and pastes, Mixing index, types of mixers for solids, liquid foods and pastes.	2
6	Milling of rice: Conditioning and parboiling, advantages and disadvantages, traditional methods, CFTRI and Jadavpur methods, Pressure parboiling method, Types of rice mills, Modern rice milling, different unit operations and equipment.	4
7	Milling of wheat, unit operations and equipment.	2
8	Milling of pulses: traditional milling methods, commercial methods, pre - conditioning, dry milling and wet milling methods: CFTRI and Pantnagar methods. Pulse milling machines, Milling of corn and it s products. Dry and wet milling.	2
9	Milling of oilseeds: mechanical expression, screw press, hydraulic press, solvent extraction methods, preconditioning of oilseeds, refining of oil, stabilization of rice bran.	2
10	Extrusion cooking: principle, factor s affecting, single and twin screw extruders. By-products utilization.	2
Total		**32**
Practical		
S.No.	Topic	**No. of Practical**
1	Study of different types of cleaners and separators and performance evaluation	1
2	Determination of separation/cleaning efficiency	1
3	Study of different size reduction machines and performance evaluation	1
4	Determination of fineness modulus and uniformity index	1
5	Study of different types of conveying and elevating equipments	1
6	Study of different types of mixers	1
7	Measurement of moisture content: dry basis and wet basis	1
8	Study on drying characteristics of grains and determination of drying constant	1
9	Determination of EMC (Static/dynamic method)	1
10	Study of various types of dryers	1
11	Study of different equipments in rice mills and performance evaluation	1
12	Study of different equipments in pulse mills and performance evaluation	1
13	Study of different equipments in oil mills and performance evaluation	1
14	Process flow charts related to processing of cereals and pulses	1
15	Process flow charts related to processing of oil seeds	1
16	Visit to grain processing industries	1
	Total	**16**

Suggested Readings

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

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

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

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

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

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

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

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

Brooker, D.B., Bakker-Arkema,F.W., Hall, C.W. 1992. Drying and storage of grains and oilseeds, AVI publication

Sr. No.	Course Name	Course No.	Credit	L	P	T
5	Soil and Water Conservation Engineering	SWCE-3.5.5	2 (2 + 1)	2	1	0

Course content :

Theory:

Soil erosion - Introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion. Water erosion - Mechanics and forms - splash, sheet, rill, gully, ravine and stream bank erosion. Gullies - Classification, stages of development. Soil loss estimation – Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity - estimation by KE>25 and EI30 methods. Soil erodibility - topography, crop management and conservation practice factors. Measurement of soil erosion - Runoff plots, soil samplers. Water erosion control measures - agronomical measures - contour farming, strip cropping, conservation tillage and mulching. Engineering measures– Bunds and terraces. Bunds - contour and graded bunds - design and surplussing arrangements. Terraces - level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stonewall and trenching. Gully and ravine reclamation - principles of gully control - vegetative measures, temporary structures and diversion drains. Grassed waterways and design. Wind erosion- Factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes.Land capability classification. Rate of sedimentation, silt monitoring and storage loss in tanks..

Practical:

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

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1.	Soil erosion - Introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion	2
2.	Water erosion - Mechanics and forms - splash, sheet, rill, gully, ravine and stream bank erosion	3
3.	Gullies - Classification, stages of development.	2
4.	Soil loss estimation – Universal soil loss equation (USLE) and modified USLE	2
5.	Rainfall erosivity - estimation by KE>25 and EI_{30} methods	1
6.	Soil erodibility - topography, crop management and conservation practice factors	2
7.	Measurement of soil erosion - Runoff plots, soil samplers	2
8.	Water erosion control measures - agronomical measures - contour farming, strip cropping, conservation tillage and mulching	3
9.	Engineering measures– Bunds and terraces	3
10.	Bunds - contour and graded bunds - design and surplussing arrangements	2
11.	Terraces - level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stonewall and trenching	3
12.	Gully and ravine reclamation - principles of gully control - vegetative measures, temporary structures and diversion drains	2
13.	Grassed waterways and design	1
14.	Wind erosion- Factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes	2
15.	Land capability classification. Rate of sedimentation, silt monitoring and storage loss in tanks.	2
Total		**32**
Practicals		
S.No.	**Topic**	**No. of Practicals**
1	Study of different types and forms of water erosion	1
2	Exercises on computation of rainfall erosivity index	1
3	Computation of soil erodibility index in soil loss estimation	1
4	Determination of length of slope (LS) and cropping practice (CP) factors for soil loss estimation by USLE and MUSLE	1
5	Exercises on soil loss estimation/measuring techniques	1
6	Study of rainfall simulator for erosion assessment	1
7	Estimation of sediment rate using Coshocton wheel sampler and multi-slot devisor	1
8	Determination of sediment concentration through oven dry method	1
9	Design and layout of contour bunds	1
10	Design and layout of graded bunds	1
11	Design and layout of broad base terraces	1
12	Design and layout of bench terraces	1
13	Design of vegetative waterways	1

14	Exercises on rate of sedimentation and storage loss in tanks	1
15	Computation of soil loss by wind erosion	1
16	Design of shelterbelts and wind breaks for wind erosion control	1
17	Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures	1
	Total	**17**

Suggested Readings

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

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

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

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

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

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

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

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
6	**Watershed Planning and Management**	**SWCE-3.5.6**	**2 (1 + 1)**	**1**	**1**	**0**

Course content :

Theory:

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

Practical:

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1.	Watershed - introduction and characteristics	1
2.	Watershed development - problems and prospects, investigation, topographical survey,	1
3.	Watershed development - soil characteristics, vegetative cover, present land use practices and socio-economic factors	1
4.	Watershed management - concept, objectives, factors affecting, watershed planning based on land capability classes,	1
5.	Watershed management - hydrologic data for watershed planning, watershed codification	1
6.	Watershed management - delineation and prioritization of watersheds – sediment yield index	1
7.	Water budgeting in a watershed	1
8.	Management measures - rainwater conservation technologies - *in-situ* and *ex-situ* storage	1
9.	Management measures - water harvesting and recycling	1
10.	Dry farming techniques - inter-terrace and inter-bund land management	1
11.	Integrated watershed management - concept, components, arable lands - agriculture and horticulture, non-arable lands - forestry, fishery and animal husbandry	1
12.	Effect of cropping systems, land management and cultural practices on watershed hydrology	1
13.	Watershed programme - execution, follow-up practices, maintenance, monitoring and evaluation	1
14.	Participatory watershed management - role of watershed associations, user groups and self-help groups	1
15.	Planning and formulation of project proposal for watershed management programme including cost-benefit analysis	2
Total		**16**

Practicals		
S.No.	**Topic**	**No. of Practicals**
1	Exercises on delineation of watersheds using toposheets	1
2	Surveying and preparation of watershed map	2
3	Quantitative analysis of watershed characteristics and parameters	1

4	Watershed investigations for planning and development	2
5	Analysis of hydrologic data for planning watershed management	2
6	Water budgeting of watersheds	1
7	Prioritization of watersheds based on sediment yield index	1
8	Study of functional requirement of watershed development structures	1
9	Study of watershed management technologies	1
10	Practice on softwares for analysis of hydrologic parameters of watershed	2
11	Study of role of various functionaries in watershed development programmes	1
12	Techno-economic viability analysis of watershed projects	1
13	Visit to watershed development project areas	1
	Total	**17**

Suggested Readings

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

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

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

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

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

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

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

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

Sr. No	Course Name	Course No.	Credit	L	P	T
7	**Drainage Engineering**	**IDE-3.5.7**	**2(1+1)**	**1**	**1**	**0**

Course Content:

Theory:

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

Practical:

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

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

Planning of Lecture		
Sr. No	**Topics to be covered in Lecture**	**Proposed No. of Lecture**
1.	Water logging - causes and impacts; drainage, objectives of drainage, familiarization with the drainage problems of the state	2
2.	Surface drainage coefficient, types of surface drainage, design of surface drains	2
3.	Sub-surface drainage: purpose and benefits, investigations of design parameters - hydraulic conductivity, drainable porosity, water table	2
4.	Derivation of Hooghoudt's and Ernst's drain spacing equatio ns	2
5.	Design of subsurface drainage system; drainage materials, drainage pipes, drain envelope; layout, construction and installation of drains	3
6.	Drainage structures; vertical drainage; bio -drainage; mole drains	2
7.	Salt balance, reclamation of sal ine and alkaline soils, leaching requirements	2
8.	Conjunctive use of fresh and saline water	2
	Total	**17**
Practical		
Sr. No	**Topics**	**No. of Practical**
1.	*In-situ* measurement of hydraulic conductivity by single auger hole and inverse auger hole method	1
2.	Estimation of drainage coefficients	1
3.	Installation of piezometer and observation wells	1
4.	[illegible]	1
5.	Determination of drainable porosity	1
6.	Design of surface drainage systems	3
7.	Design of gravel envelop	1
8.	Design of subsurface drainage systems	3
9.	Determination of chemical properties of soil and water	1
10.	Study of drainage tiles and pipes	1
11.	Installation of sub-surface drainage system	1
12.	Cost analysis of surface and sub-surface drainage system.	1
13.	Determination of gypsum requirement for land reclamation	1
	Total	**17**

Suggested Readings

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

Ritzema H.P.1994 Drainage Principles and Applications, ILRI Publication 16, Second Edition (Completely Revised).

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

Kadam U.S., Thokal R.T., Gorantiwar S.D. and Powar A.G. 2007. Agricultural Drainage-Principles and Practices, Westville Publishing House.

FAO Irrigation and Drainage Paper No. 6, 9, 15, 16, 28 and 38. Rome, Italy.

Sr. No.	Course Name	Course No.	Credit	L	P	T
8	Renewable Power Sources	REE-3.5.8	3 (2+1)	2	1	0

Course Content:

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

Practical

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

Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Energy consumption pattern & energy resources in India.	2
2	Renewable energy options, potential and utilization.	2
3	Biogas technology and mechanisms, generation of power from biogas, Power generation from urban, municipal and industrial waste. Design & use of different commercial sized biogas plant.	5
4	Solar thermal and photovoltaic Systems for power generation.	2
5	Calculation of energy through photovoltaic power generation and cost economics	3
6	Central receiver (Chimney) and distributed type solar power plant	3
7	OTEC, MHD, hydrogen and fuel cell technology	2
8	Wind farms. Aero-generators. Wind power generation system.	3
9	Power generation from biomass (gasification & Dendro thermal)	3
10	Mini and micro small hydel plants.	2
11	Fuel cells and its associated parameters.	2
	Total	**29**

Planning of Practical

Sr. No.	Topics	Proposed No. of Practicals
1	Performance evaluation of solar water heater;	1
2	Performance evaluation of solar cooker;	1
3	Characteristics of solar photovoltaic panel;	1
4	Performance evaluation of solar air heater/dryer	1
5	Study and demonstration of Gas Chromatography for producer gas estimation	1

6	Study and demonstration of orsat apparatus for biogas gas estimation	1
7	Determination of the calorific value	1
8	Estimation of Ash content of Biomass	1
9	Estimation of Moisture content of Biomass	1
10	Estimation of fixed carbon and volatile matter of Biomass	1
11	Performance evaluation of biomass gasifier engine system (throatless & downdraft),	1
12	Performance evaluation of a fixed dome type biogas plant;	1
13	Performance evaluation of floating drum type biogas plant;	1
14	Testing of diesel engine operation using dual fuel and gas alone.	1
15	Study and demonstration of Mini and micro small hydel plants	1
16	Study and demonstration of Fuel cells	1
	Total	**16**

Suggested Readings

Garg H.P. 1990. Advances in Solar Energy Technology; D. Publishing Company, Tokyo.

Alan L: Farredbruch & R.H. Buse. 1983. Fundamentals of Solar Academic Press, London.

Bansal N.K., Kleemann M. & Meliss Michael. 1990. Renewable Energy Sources & Conversion Technology; Tata Mecgrow Publishing Company, New Delhi.

Rathore N. S., Kurchania A. K. & N.L. Panwar. 2007. Non Conventional Energy Sources, Himanshu Publications. Mathur, A.N. & N.S. Rathore. 1992. Biogas Production Management & Utilization. Himanshu Publications, Udaipur. Khandelwal, K.C. & S.S. Mahdi. 1990. Biogas Technology.

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

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

Reed TB and Das A. Handbook of Biomass Downdraft Gasifier Engine System. The Biomass Energy Foundation Press, Colorado; 1984.

Sr. No.	Course Name	Course No.	Credit	L	P	T
9	**Skill Development Training – I (Student READY) Registration Only**	**CAE-3.5.9**	**5 (0+5)**	**0**	**5**	**0**
At the end of 4th Semester 4 weeks for training & 1 week for evaluation						

SEMESTER – VI

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	Computer Programming and Data Structures	CSE-3.6.1	3 (1 + 2)	1	2	0

Course content:

Theory:

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

Practical:

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

Planning of lectures		
Sr. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Introduction to high-level languages.	1
2	Primary data types and user defined data types.	1
3	Variables, typecasting, Operators and expression evaluating	3
4	Managing input and output	1
5	Decision making	2
6	Looping & Array	2
7	User defined functions & scope and visibility of a variable	2
8	String functions	1
9	Structures and union	1
10	Pointers, Stack, Queue and Link list	2
Total		**16**
Practicals		
Sr.No.	**Topic**	**No. of Tutorials**
1	Familiarizing with Turbo C ID	2
3	Developing, Debugging and executing simple C programs	4
4	Developing programs using Decision making statements	2
5	Developing programs using Entry control loop statements	3
6	Developing programs using Exit control loop statements	2
7	Developing programs using nested control structures	2
8	Familiarizing with one dimensional arrays	2
9	Familiarizing with two dimensional arrays	2
10	Developing programs using string functions	2

11	Familiarizing with structures and union	1
12	Creating user defined functions	2
13	Developing programs using local, global & external variables	1
14	Familiarizing with pointers	1
15	Implementing Stacks , Queue, Link list	4
	Total	**30**

Suggested Reading

Rajaraman V. 1985. Computer Oriented Numerical Methods. Prentice Hall of India. Pvt. Ltd., New Delhi.

Balagurusamy E. 1990. Programming in 'C'. Tata McGraw Hill Publishing Co. Ltd., 12/4 Asaf Ali Road, New Delhi.

Rajaraman V. 1995. Computer Programming in 'C'. Prentice Hall of India Pvt.Ltd., New Delhi.

Bronson G and Menconi S. 1995. A First Book of 'C' Fundamentals of 'C' Programming. Jaico Publishing House, New Delhi

Sahni S.. Data Structures, Algorithms and Applications in C++. University press (India) Pvt Ltd / Orient Longman Pvt. Ltd.

Michael T. Goodrich, R. Tamassia and D Mount. Data structures and Algorithms in C++. Wiley Student Edition, John Wiley and Sons.

Mark Allen Weiss. Data Structures and Algorithm Analysis in C++. Pearson Education.

Augenstein, Langsam and Tanenbaum. Data structures using C and C++. PHI/Pearson Education.

Drozdek Adam. Data Structures and Algorithms in C++. Vikas Publishing House / Thomson International Student Edition.

Agarwal, Ajay. The Complete Reference Guide: Data Structure through C. ISBN: 8178840448; Publisher: Cyber Tech Publications.

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	**Farm Machinery and Equipment-II**	**FMPE-3.6.2**	**3 (2 + 1)**	**2**	**1**	**0**

Course content:

Theory:

Introduction to plant protection equipment – sprayers and dusters. Classification of sprayers and sprays. Types of nozzles. Calculations for calibration of sprayers and chemical application rates. Introduction to interculture equipment. Use of weeders – manual and powered. Study of functional requirements of weeders and main components. Familiarization of fertilizer application equipment. Study of harvesting operation – harvesting methods, harvesting terminology. Study of mowers – types, constructional details, working and adjustments. Study of shear type harvesting devices – cutter bar, inertial forces, counter balancing, terminology, cutting pattern. Study of reapers, binders and windrowers – principle of operation and constructional details. Importance of hay conditioning, methods of hay conditioning, and calculation of moisture content of hay. Introduction to threshing systems – manual and mechanical systems. Types of threshing drums and their applications. Types of threshers- tangential and axial, their constructional details and cleaning systems. Study of factors affecting thresher performance. Study of grain combines, combine terminology, classification of

grain combines, study of material flow in combines. Computation of combine losses, study of combine troubles and troubleshooting. Study of chaff cutters and capacity calculations. Study of straw combines – working principle and constructional details. Study of root crop diggers – principle of operation, blade adjustment and approach angle, and calculation of material handled. Study of potato and groundnut diggers. Study of Cotton harvesting – Cotton harvesting mechanisms, study of cotton pickers and strippers, functional components. Study of maize harvesting combines. Introduction to vegetables and fruit harvesting equipment and tools.

Practical:

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

Planning of lectures		
Sr. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1.	Introduction to plant protection equipment – sprayers and dusters. Classification of sprayers and sprays. Types of nozzles. Calculations for calibration of sprayers and chemical application rates.	2
2.	Introduction to interculture equipment. Use of weeders – manual and powered. Study of functional requirements of weeders and main components. Familiarization of fertilizer application equipment.	2
3.	Study of harvesting operation – harvesting methods, harvesting terminology.	2
4.	Study of mowers – types, constructional details, working and adjustments. Study of shear type harvesting devices – cutter bar, inertial forces, counter balancing, terminology, cutting pattern.	4
5.	Study of reapers, binders and windrowers – principle of operation and constructional details.	2
6.	Importance of hay conditioning, methods of hay conditioning, and calculation of moisture content of hay.	2
7.	Introduction to threshing systems – manual and mechanical systems. Types of threshing drums and their applications. Types of threshers - tangential and axial, their constructional details and cleaning systems. Study of factors affecting thresher performance.	2
8.	Study of grain combines, combine terminology, classification of grain combines, study of material flow in combines.	3
9.	Computation of combine losses, study of combine troubles and troubleshooting.	2

10.	Study of chaff cutters and capacity calculations.	1
11.	Study of straw combines – working principle and constructional details.	2
12.	Study of root crop diggers – principle of operation, blade adjustment and approach angle, and calculation of material handled. Study of potato and groundnut diggers.	2
13.	Study of Cotton harvesting – Cotton harvesting mechanisms, study of cotton pickers and strippers, functional components.	2
14.	Study of maize harvesting combines.	1
15.	Introduction to vegetables and fruit harvesting equipment and tools.	1
	Total	**30**

Practicals

Sr.No.	Topic	No. of Tutorials
1.	Familiarization with plant protection and interculture equipment.	2
2.	Study of sprayers, types, functional components. Study of dusters, types and functional components. Calculations for chemical application rates. Study of nozzle types and spread pattern using patternator.	2
3.	Familiarization with manual and powered weeding equipment and identification of functional components.	2
4.	Study of fertilizer application equipment including manure spreaders and fertilizer broadcasters.	1
5.	Study of various types of mowers, reaper, reaper binder. Study of functional components of mowers and reapers.	2
6.	Familiarization with threshing systems, cleaning systems in threshers. Calculations of losses in threshers.	1
7.	Familiarization with functional units of Grain combines and their types. Calculations for grain losses in a combine.	2
8.	Study of root crop diggers and familiarization with the functional units and attachments.	1
9.	Familiarization with the working of cotton and maize harvesters.	1
10.	Familiarization with vegetable and fruit harvesters.	1
	Total	**15**

Suggested Reading

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

Smith HP and LH Wilkey. Farm Machinery and Equipment.

Culpin Claude. Farm Machinery.

Srivastava AC. Elements of Farm Machinery.

Lal Radhey and AC Datta. Agricultural Engineering.

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	Post Harvest Engineering of Horticultural Crops	PFE-3.6.3	2 (1+1)	1	1	0

Course content:

Theory

Importance of processing of fruits and vegetables, spices, condiments and flowers. Characteristics

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

Practical

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

Planning of lectures		
Sr. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Importance of processing of fruits and vegetables, spices, condiments and flowers	1
2	Characteristics and properties of horticultural crops important for processing,	1
3	Peeling: Different peeling methods and devices (manual peeling, mechanical peeling, chemical peeling, and thermal peeling),	1
4	Slicing of horticultural crops: equipment for slicing, shredding, crushing, chopping, juice extraction, etc.,	1
5	Blanching: Importance and objectives; blanching methods, effects on food (nutrition, colour, pigment, texture),	1
6	Chilling and freezing: Application of refrigeration in different perishable food products, Thermophilic, mesophilic & Psychrophilic micro -organisms, Chilling requirements of different fruits and vegetables,	1
7	Freezing of food, freezing time calculations, slow and fast freezing, Equipment for chilling and freezing (mechanical & cryogenic), Effect on food during chilling and freezing,	1
8	Cold storage heat load calculations and cold storage design, refrigerated vehicle and cold chain system,	1

9	Dryers for fruits and vegetables, Osmo-dehydration	1
10	Packaging of horticultural commodities, Packaging requirements (in terms of light transmittance, heat, moisture and gas proof, micro organisms, mechanical strength)	1
11	Different types of packaging materials commonly used for raw and processed fruits and vegetables products, bulk and retail packages and packaging machines, handling and transportation of fruits and vegetables	1
12	Pack house technology, Minimal processing, Common methods of storage, Low temperature storage, evaporative cooled storage, Controlled atmospheric storage, Modified atmospheric packaging, Preservation Technology,	1
13	General methods of preservation of fruits and vegetables, Brief description and advantages and disadvantages of different physical/ chemical and other methods of preservation,	1
14	Flowcharts for preparation of different finished products	1
15	Important parameters and equipment used for different unit operations, Post harvest management and equipment for spices and flowers,	1
16	Quality control in Fruit and vegetable processing industry. Food supply chain	1
Total		**16**

Practical

Sr.No.	Topic	No. of Practical
1	Performance evaluation of peeler	1
2	Performance evaluation of slicer	1
3	Performance evaluation of juicer	1
4	Performance evaluation of pulper	1
5	Performance evaluation of blanching equipment	1
6	Testing adequacy of blanching	1
7	Study of cold storage and its design	3
8	Study of CAP and MAP storage	1
9	Study of Minimal processing of vegetables	1
10	Preparation of value added products	3
11	Visit to fruit and vegetable processing industry	1
12	Visit to spice processing unit/ plant	1
	Total	**16**

Suggested Readings

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

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

Pandey, R.H. 1997. Postharvest Technology of fruits and vegetables (Principles and practices). Saroj Prakashan, Allahabad.

Sudheer, K P. and Indira, V. 2007. Post Harvest Engineering of horticultural crops. New India Publishing House.

Girdhari Lal, G. S. Siddappa, G. L. Tandon, 1986. Preservation of Fruits and Vegetables. Indian Council of Agricultural Research

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	**Water Harvesting and Soil Conservation structures**	**SWCE-3.6.4**	**3 (2 + 1)**	**2**	**1**	**0**

Course content :

Theory:

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

Practical:

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

Planning of lectures

Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1.	Water harvesting -principles, importance and issues	1
2.	Water harvesting techniques - classification based on source, storage and use	2
3.	Runoff harvesting – short-term and long-term techniques	1
4.	Short-term harvesting techniques - terracing and bunding, rock and ground catchments.	2
5.	Long-term harvesting techniques - purpose and design criteria	1
6.	Structures - farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes	2
7.	Farm pond - components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction	2
8.	Percolation pond - site selection, design and construction details	1
9.	Design considerations of *nala* bunds. Soil erosion control structures - introduction, classification and functional requirements	2
10.	Permanent structures for soil conservation and gully control - check dams, drop, chute and drop inlet spillways	3

11.	Design requirements, planning for design, design procedures - hydrologic, hydraulic and structural design and stability analysis	2
12.	Hydraulic jump and its application	1
13.	Drop spillway - applicability, types - straight drop, box-type inlet spillways - description, functional use, advantages and disadvantages, straight apron and stilling basin outlet, structural components and functions	3
14.	Loads on head wall, variables affecting equivalent fluid pressure, triangular load diagram for various flow conditions	2
15.	creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension	2
16.	Chute spillway - description, components, energy dissipaters, design criteria of Saint Antony Falls (SAF) stilling basin and its limitations	3
17.	Drop inlet spillway - description, functional use and design criteria	2
Total		**32**
Practicals		
Sr.No.	Topic	**No. of Practicals**
1	Study of different types of farm ponds	1
2	Computation of storage capacity of embankment type of farm ponds	1
3	Design of dugout farm ponds	1
4	Design of percolation pond and *nala* bunds	1
5	Runoff measurement using H-flume	1
6	Exercise on hydraulic jump	1
7	Exercise on energy dissipation in water flow	1
8	Hydrologic, hydraulic and structural design of drop spillway and stability analysis	2
9	Design of SAF stilling basins in chute spillway	2
10	Hydrologic, hydraulic and structural design of drop inlet spillway	2
11	Design of small earthen embankment structures	1
12	Practice on softwares for design of soil and water conservation structures	2
13	Field visit to watershed project areas treated with soil and water conservation measures / structures	1
	Total	**17**

Suggested Readings

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

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

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

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

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

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

Theib Y. Oweis, Dieter Prinz and Ahmed Y. Hachum. 2012. Rainwater Harvesting for Agriculture

in the Dry Areas. CRC Press, Taylor and Francis Group, London.

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

Sr. No	Course Name	Course No.	Credit	L	P	T
5	Groundwater, Wells and Pumps	IDE-3.6.5	3(2+1)	2	1	0

Course Content:

Theory:

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

Practical :

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

Planning of Lecture		
Sr. No	**Topics to be covered in Lecture**	**Proposed No. of Lecture**
1.	Occurrence and movement of ground water; aquifer and its types; classification of wells, fully penetrating tubewells and open wells, familiarization of various types of bore wells; design of open wells; groundwater exploration techniques; methods of drilling of wells: percussion, rotary, reverse rotary; design of tubewell and gravel pack, installation of well screen, completion and development of well	6
2.	Groundwater hydraulics -determination of aquifer parameters by different method such as Theis, Jacob and Chow's, Theis recovery method; well interference, multiple well systems, estimation of ground water potential, quality of ground water; artificial gro undwater recharge techniques	6
3.	Pumping systems: water lifting devices; different types of pumps, classification of pumps, component parts of centrifugal pumps, priming	6

4.	pump selection, installation and trouble shooting	3
5.	performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics	4
6.	hydraulic ram, propeller pumps, mixed flow pumps and their performance characteristics	4
7.	deep well turbine pump and submersible pump	3
	Total	**32**

Practical

Sr. No	Topics	No. of Practical
1.	Verification of Darcy's Law	1
2.	Study of different drilling equipments	1
3.	Sieve analysis for gravel and well screens design	1
4.	Estimation of specific yield and specific retention	1
5.	Testing of well screen	1
6.	Estimation of aquifer parameters by Theis method, Coopers-Jacob method, Chow method	1
7.	Theis Recovery method	1
8.	Well design under confined and unconfined conditions	1
9.	Well losses and well efficiency	1
10.	Estimating ground water balance	1
11.	Study of artificial ground water recharge structures	1
12.	Study of radial flow and mixed flow centrifugal pumps, multistage centrifugal pumps, turbine, propeller and other pumps	1
13.	Installation of centrifugal pump	1
14.	Testing of centrifugal pump and study of cavitations	1
15.	Study of hydraulic ram	1
16.	Study and testing of submersible pump.	1
17.	Estimation of different irrigation water quality parameter.	1
	Total	**17**

Suggested Readings

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

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

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
6	Tractor and Farm Machinery Operation and Maintenance	FMPE-3.6.6	2 (0+ 2)	0	2	2

Course Content:

Practical :

Familiarization with different makes and models of agricultural tractors. Identification of functional systems including fuels system, cooling system, transmission system, steering and hydraulic systems. Study of maintenance points to be checked before starting a tractor. Familiarization with controls on a tractor. Safety rules and precautions to be observed while driving a tractor. Driving

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

Practicals		
Sr.No.	**Topic**	**No. of Practicals**
1.	Familiarization with different makes and models of agricultural tractors.	1
2.	Identification of functional systems including fuels system, cooling system, transmission system, steering and hydraulic systems.	4
3.	Study of maintenance points to be checked before starting a tractor.	1
4.	Familiarization with controls on a tractor. Safety rules and precautions to be observed while driving a tractor. Driving practice of tractor.	8
5.	Practice of operating a tillage tool (mould-board plough/ disc plough) and their adjustment in the field. Study of field patterns while operating a tillage implement.	3
6.	Hitching & De-hitching of mounted and trail type implement to the tractor	1
7.	Driving practice with a trail type trolley – forward and in reverse direction.	4
8.	Introduction to tractor maintenance – precautionary and break-down maintenance.	1
9.	Tractor starting with low battery charge. Introduction to trouble shooting in tractors.	1
10.	Familiarization with tools for general and special maintenance.	1
11.	Introduction to scheduled maintenance after 10, 100, 300, 600, 900 and 1200 hours of operation	1
12.	Safety hints. Top end overhauling. Fuel saving tips. Preparing the tractor for storage	1
13.	Care and maintenance procedure of agricultural machinery during operation and off-season	1
14.	Repair and maintenance of implements – adjustment of functional parameters in tillage implements. Replacement of broken components in tillage implements. Replacement of furrow openers and change of blades of rotavators.	1
15.	Maintenance of cutter bar in a reaper.	1
16.	Adjustments in a thresher for different crops, Replacement of V-belts on implements	1
17.	Setting of agricultural machinery workshop.	1
	Total	**32**

Reference Books

Ghosh RK and S Swan. Practical Agricultural Engineering.

Black PO and WE Scahill. Diesel Engine Manual.

Southorn N. Tractor operation and maintenance.

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

Operators manuals of tractors.

Service manuals provided by manufacturers.

Sr. No.	Course Name	Course No.	Credit	L	P	T
7	Dairy and Food Engineering	PFE-3.6.7	3 (2 + 1)	2	1	0

Course content :

Theory:

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

Practical:

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Dairy development in India.	1
2	Engineering, thermal and chemical properties of milk and milk products.	4
3	Unit operation of various dairy and food processing systems.	2
4	Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization, centrifugation and cream separation.	4
5	Preparation methods and equipment for manufacture of cheese, *paneer*, butter and ice cream. Process flow charts for product manufacture.	3

6	Filling and packaging of milk and milk products.	2
7	Evaporation of food products: principle, types of evaporators, steam economy, multiple effect evaporation, vapour recompression.	3
8	Drying of liquid and perishable foods: principles of drying, spray drying, drum drying, freeze drying.	3
9	Filtration: principle, types of filters; Membrane separation, RO, Nano-filtration, Ultra filtration and Macro-filtration, equipment and applications.	3
10	Dairy plant design and layout, Plant utilities; Principles of operation and equipment for thermal processing, Canning, Aseptic p rocessing, Non-thermal and other alternate thermal processing in Food processing.	3
11	Deterioration in food products and their controls, Physical, chemical and biological methods of food preservation. Nanotechnology: History, fundamental concepts, tools and techniques nanomaterials, applications in food packaging and products, implications, environmental impact of nanomaterials and their potential effects on global economics, regulation of nanotechnology.	4
Total		**32**

Practicals

Sr.No.	Topic	No. of Practical
1	Study of dairy development in India.	1
2	Study of homogenizers.	1
3	Study of pasteurizers.	1
4	Study of sterilizers.	1
5	Study of separators.	1
6	Study of butter churns.	1
7	Study of evaporators.	1
8	Study of milk dryers.	1
9	Study of filling equipments.	1
10	Study of freezers.	1
11	Study of filtration.	1
12	Study of equipments related to receiving of milk.	1
13	Visit to multi-product dairy plant.	1
14	Estimation of steam requirements.	1
15	Process flow chart for manufacture of cheese & paneer.	1
16	Process flow chart for preparation of butter and ice cream.	1
	Total	**16**

Suggested Readings

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

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

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

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

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

Farrel, A.W. 1963. Engineering for dairy and food products. Wiley

Sr. No.	Course Name	Course No.	Credit	L	P	T
8	**Bio-Energy Systems: Design and Applications**	**REE-3.6.8**	**3 (2+1)**	**2**	**1**	**0**

Course Content:

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

Practical

Study of anaerobic fermentation system for industrial application, Introduction of insulation and different types of insulation used in renewable energy gadgets, Study of gasification for industrial process heat, Study of biodiesel production unit, Study of biomass densification technique (briquetting, pelletization, and cubing), Integral bio energy system for industrial application, Study of bio energy efficiency in industry and commercial buildings, Study and demonstration of energy efficiency in building.

Planning of Lectures		
Sr. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Fermentation processes and its general requirements.	2
2	An overview of aerobic and anaerobic fermentation processes and their industrial application.	2
3	Heat transfer processes in anaerobic digestion systems, land fill gas technology and potential.	2
4	Biomass Production: Wastelands, classification and their use through energy plantation, selection of species, methods of field preparation and transplanting. Harvesting of biomass and coppicing characteristics.	3
5	Biomass preparation techniques for harnessing (size reduction, densification and drying).	3
6	Thermo-chemical degradation. History of small gas producer engine system. Chemistry of gasification. Gas producer – type, operating principle. Gasifier fuels, properties, preparation, conditioning of producer gas.	4
7	Application, shaft power generation, thermal application and economics.	3
8	Trans-esterification for biodiesel production.	3
9	A range of bio-hydrogen production routes.	2
10	Environmental aspect of bio-energy, assessment of greenhouse gas mitigation potential.	3
	Total	27
Planning of Practical		
Sr. No.	Topics	Proposed No. of Practicals
1	Study of anaerobic fermentation system for industrial application,	1
2	Introduction of insulation and different types of insulation used in renewable energy gadgets	1

3	Study of gasification for industrial process heat	1
4	Study of biodiesel production unit	1
5	Study of biomass densification technique (briquetting, pelletization, and cubing)	1
6	Integral bio energy system for industrial application	1
7	Study of bio energy efficiency in industry and commercial buildings	1
8	Study and demonstration of energy efficiency in building	1
9	Study of biomass harvesting technology	1
10	Study and demonstration of heat transfer processes used in renewable energy gadgets	1
11	Study of modern greenhouse technologies	1
12	Demonstration of producer gas cooling - cleaning system	1
13	Study of shaft power generation through producer gas technology	1
14	Study of shaft power generation through fermentation process	1
15	Study of different characteristics of biodiesel.	1
16	Testing of biodiesel in diesel engine.	1
17	Study of bio-hydrogen production routes.	1
	Total	**17**

Suggested Readings

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

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

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

Reed TB and Das A. Handbook of Biomass Downdraft Gasifier Engine System. The Biomass Energy Foundation Press, Colorado; 1984.

SEMESTER – VII

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	**Skill Development Training – II (Student READY) Registration Only**	**CAE-4.7.1**	**5 (0+5)**	**0**	**5**	**0**
At the end of 6th Semester 4 weeks for training & 1 week for evaluation						

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	**10-weeks Industrial Attachment / Internship (Student READY) Registration Only**	**CAE-4.7.2**	**10 (0+10)**	**0**	**10**	**0**
8 weeks for training & 2 weeks for evaluation						

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	**10-weeks Experimental Learning on campus (Student READY) Registration Only**	**CAE-4.7.3**	**10 (0+10)**	**0**	**10**	**0**
8 weeks for training & 2 weeks for evaluation						

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	**Educational Tour (Registration Only)**	**CAE-4.7.4**	**2 (0+2)**	**0**	**2**	**0**
Educational tour during winter / January break						

SEMESTER – VIII

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	Elective Course		3 (2+1)	2	1	0

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	Elective Course		3 (2+1)	2	1	0

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	Elective Course		3 (2+1)	2	1	0

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	Project Planning and Report Writing (Student Ready)	**CAE-4.8.4**	10 (0+10)	0	10	0

Elective Courses (any three courses) 9 (6+3)

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	Floods and Control Measures	SWCE-4.8.1	3 (2 + 1)	2	1	0

Course content :

Theory:

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

Practical:

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

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1.	Floods - causes of occurrence, flood classification - probable maximum flood, standard project flood, design flood, flood estimation	2

1.	methods of estimation; estimation of flood peak - rational method, empirical methods, unit hydrograph method	2
2.	Statistics in hydrology, flood frequency methods - log normal, Gumbel's extreme value, log-Pearson type-III distribution; depth-area-duration analysis	2
3.	Flood forecasting	1
4.	Flood routing - channel routing, Muskingum method,	2
5.	reservoir routing, modified Pul's method	2
6.	Flood control - history of flood control, structural and non-structural measures of flood control	1
7.	storage and detention reservoirs, levees, channel improvement	1
8.	Gully erosion and its control structures - design and implementation	1
9.	Ravine control measures	1
10.	River training works, planning of flood control projects and their economics	2
11.	Earthen embankments - functions, classification - hydraulic fill and rolled fill dams - homogeneous, zoned and diaphragm type, foundation requirements, grouting	3
12.	seepage through dams, flow net and its properties, seepage pressure, seepage line in composite earth embankments, drainage filters, piping and its causes	2
13.	Design and construction of earthen dam, stability of earthen embankments against failure by tension, overturning, sliding etc.	2
14.	stability of slopes - analysis of failure by different methods	2
15.	Subsurface dams - site selection and constructional features	2
16.	Check dam - Small earthen embankments - types and design criteria	2
17.	Subsurface dams - site selection and constructional features	2
Total		**32**
Practicals		
Sr.No.	**Topic**	**No. of Practicals**
1.	Determination of flood stage-discharge relationship in a watershed	1
2.	Determination of flood peak-area relationships	1
3.	Determination of frequency distribution functions for extreme flood values using Gumbel's method	1
4.	Determination of confidence limits of the flood peak estimates for Gumbel's extreme value distribution	1
5.	Determination of frequency distribution functions for extreme flood values using log-Pearson Type-III distribution	1
6.	Determination of probable maximum flood, standard project flood and spillway design flood	1
7.	Design of levees for flood control, Design of jetties	1
8.	Study of vegetative and structural measures for gully stabilization, Design of gully/ravine control structures and cost estimation	1
9.	Designing, planning and cost- benefit analysis of a flood control project	1
10.	Study of different types, materials and design considerations of earthen dams	1
11.	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	1
12.	Stability of slopes of earth dams by friction circle and other methods	1
13.	Construction of flow net for isotropic and anisotropic media	1
14.	Computation of seepage by different methods	1
15.	Determination of settlement of earth dam	1
16.	Input-output-storage relationships by reservoir routing	1
17.	Visit to sites of earthen dam and water harvesting structures	1
	Total	**17**

Suggested Readings

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

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

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

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

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

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

Arora, K.R. 2014. Soil Mechanics and Foundation Engineering (Geotechnical Engineering). Standard Publishers Distributors, Delhi.

Garg, S.K. 2014. Soil Mechanics and Foundation Engineering. Khanna Publishers Pvt. Ltd., New Delhi.

Stephens Tim. 2010. Manual on Small Earth Dams - A Guide to Siting, Design and Construction. Food and Agriculture Organization of the United Nations, Rome.

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	Wasteland Development	SWCE-4.8.2	3 (2 + 1)	2	1	0

Course content :

Theory:

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

Practical:

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

Planning of lectures		
Sr. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1.	Land degradation – concept, classification - arid, semiarid, humid and sub-humid regions	2
2.	Land degradation – denuded range land and marginal lands	2
3.	Wastelands - factors causing, classification and mapping of wastelands	2
4.	planning of wastelands development - constraints, agro-climatic conditions, development options, contingency plans	2
5.	Conservation structures - gully stabilization, ravine rehabilitation, sand dune stabilization	2
6.	Conservation structures - water harvesting and recycling methods	2
7.	Afforestation - agro-horti-forestry-silvipasture methods, forage and fuel crops - socioeconomic constraints	2
8.	Shifting cultivation, optimal land use options	2
9.	Wasteland development – hills, semi-arid, coastal areas, water scarce areas	2
10.	Wasteland development – reclamation of waterlogged and salt-affected lands	2
11.	Mine spoils- impact, land degradation and reclamation and rehabilitation	2
12.	Mine spoils- slope stabilization and mine environment management	2
13.	Micro-irrigation in wastelands development	2
14.	Sustainable wasteland development - drought situations, socio-economic perspectives	2
15.	Government policies, Participatory approach	2
16.	Preparation of proposal for wasteland development and benefit-cost analysis	2
Total		**32**
Practicals		
Sr.No.	Topic	**No. of Practicals**
1.	Mapping and classification of wastelands	2
2.	Identification of factors causing wastelands	2
3.	Estimation of vegetation density and classification	2
4.	Planning and design of engineering measures for reclamation of wastelands	3
5.	Design and estimation of different soil and water conservation structures under arid, semiarid and humid conditions	2
6.	Planning and design of micro-irrigation in wasteland development	2
7.	Cost estimation of the above measures / structures	2
8.	Visit to wasteland development project sites	2
	Total	**17**

Suggested Readings

Abrol, I.P., and V.V. Dhruvanarayana. 1998. Technologies for Wasteland Development. ICAR, New Delhi.

Ambast, S.K., S.K. Gupta and Gurcharan Singh (Eds.) 2007. Agricultural Land Drainage - Reclamation of Waterlogged Saline Lands. Central Soil Salinity Research Institute, Karnal, Haryana.

Hridai Ram Yadav. 2013. Management of Wastelands. Concept Publishing Company. New Delhi.

Karthikeyan, C., K. Thangaraja, C. Cinthia Fernandez and K. Chandrakandon. 2009. Dryland Agriculture and Wasteland Management. Atlantic Publishers and Distributors Pvt. Ltd., New Delhi.

Rattan Lal and B.A. Stewart (Ed.). 2015. Soil Management of Smallholder Agriculture. Volume 21

of Advances in Soil Science. CRC Press, Taylor and Francis Group, Florida, USA.

Robert Malliva and Thomas Missimer. 2012. Arid Lands Water Evaluation and Management. Springer Heidelberg, New York.

Swaminathan, M.S. 2010. Science and Integrated Rural Development. Concept Publishing Company (P) Ltd., Delhi.

The Energy and Resources Institute. 2003. Looking Back to Think Ahead-Green India 2047. Growth with Resource Enhancement of Environment and Nature. New Delhi.

Virmani, S.M. (Ed.). 2010. Degraded and Wastelands of India: Status and Spatial Distribution. ICAR, New Delhi.

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	Information Technology for Land and Water Management	SWCE-4.8.3	3 (2 + 1)	2	1	0

Course content :

Theory:

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

Practical:

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

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1.	Concept of Information Technology (IT) and its application potential	2
2.	Role of IT in natural resources management	2
3.	Existing system of information generation and organizations involved in the field of land and water management	2

1.	Application and production of multimedia	2
2.	Internet application tools and web technology	2
3.	Networking system of information	2
4.	Problems and prospects of new information and communication technology	2
5.	Development of database concept for effective natural resources management	2
6.	Application of remote sensing, geographic information system (GIS) and GPS	4
7.	Rational data base management system, Object oriented approaches,	2
8.	Information system, decision support systems and expert systems	2
9.	Agricultural information management systems - use of mathematical models and programmes	3
10.	Application of decision support systems, multi sensor data loggers and overview of software packages in natural resource management	3
11.	. Video-conferencing of scientific information.	2
Total		**32**
Practicals		
Sr.No.	**Topic**	**No. of Practicals**
1.	Multimedia production. Internet applications: E-mail, voice mail, web tools and technologies	2
2.	Handling and maintenance of new information technologies and exploiting their potentials	2
3.	Exercises on database management using database and spreadsheet programmes	2
4.	Usage of remote sensing, GIS and GPS survey in information generation and processing	2
5.	Exercises on running computer software packages dealing with water balance, crop production, land development, land and water allocation, watershed analysis etc	2
6.	Exercises on simple decision support and expert systems for management of natural resources	2
7.	Multimedia production using different softwares	2
8.	Exercises on development of information system on selected theme(s)	2
9.	Video-conferencing of scientific information	1
	Total	**17**

Suggested Readings

Climate-Smart Agriculture – Source Book. 2013. Food and Agriculture Organization, Rome.

Daniel P. Loucks and Eelco van Beek. 2005. Water Resources Systems Planning and Management - An Introduction to Methods, Models and Applications. UNESCO, Paris.

Dipak De and Basavaprabhu Jirli (Eds.). 2010. Communication Support for Sustainable Development. Ganga Kaveri Publishing House, Varanasi – 221001.

FAO. 1998. Land and Water Resources Information Systems. FAO Land and Water Bulletin 7, Rome.

Fuling Bian and Yichun Xie (Eds.). 2015. Geo-Informatics in Resource Management and Sustainable Ecosystem. Springer, New York.

ICFAI Business School (IBS). 2012. Information Technology and Systems. IBS Centre for Management Research, Hyderabad.

Robert Malliva and Thomas Missimer. 2012. Arid Lands Water Evaluation and Management. Environmental Science. Springer, New York.

Sarvanan. R. 2011. Information and Communication Technology for Agriculture and Rural Development. New India Publishing Agency, New Delhi.

Soam, S.K., P.D. Sreekanth and N.H. Rao (Eds.). 2013. Geospatial Technologies for Natural Resources Management. New India Publishing Agency, Delhi.

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	Remote Sensing and GIS Applications	SWCE-4.8.4	3 (2 + 1)	2	1	0

Course content :

Theory:

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

Practical:

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

Planning of lectures		
Sr. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1.	Basic component of remote sensing (RS), advantages and limitations of RS	2
2.	possible use of RS techniques in assessment and monitoring of land and water resources	2
3.	electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface; major atmospheric windows	2
4.	principal applications of different wavelength regions	1

1.	typical spectral reflectance curve for vegetation, soil and water; spectral signatures	2
2.	different types of sensors and platforms, contrast ratio and possible causes of low contrast	2
3.	aerial photography; types of aerial photographs, scale of aerial photographs	2
4.	planning aerial photography- end lap and side lap	1
5.	stereoscopic vision, requirements of stereoscopic photographs	1
6.	air-photo interpretation- interpretation elements; photogrammetry- measurements on a single vertical aerial photograph	2
7.	measurements on a stereo-pair- vertical measurements by the parallax method; ground control for aerial photography	2
8.	satellite remote sensing, multispectral scanner- whiskbroom and push-broom scanner; different types of resolutions	2
9.	analysis of digital data- image restoration; image enhancement; information extraction, image classification, unsupervised classification, supervised classification	2
10.	important consideration in the identification of training areas, vegetation indices;	2
11.	microwave remote sensing. GIS and basic components,	1
12.	different sources of spatial data, basic spatial entities, major components of spatial data	1
13.	Basic classes of map projections and their properties,	1
14.	Methods of data input into GIS, Data editing, spatial data models and structures,	1
15.	Attribute data management, integrating data (map overlay) in GIS,.	1
16.	Application of remote sensing and GIS for the management of land and water resources	2
Total		**32**
Practicals		
Sr.No.	Topic	**No. of Practicals**
1.	Familiarization with remote sensing and GIS hardware;	1
2.	use of software for image interpretation	2
3.	Interpretation of aerial photographs and satellite imagery;	2
4.	Basic GIS operations such as image display;	2
5.	Study the various features of GIS software package;	3
6.	Scanning, digitization of maps and data editing	2
7.	Data base query and map algebra;	2
8.	GIS supported case studies in water resources management.	3
	Total	**17**

Suggested Readings

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

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

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

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

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

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

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

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

Sr. No	Course Name	Course No.	Credit	L	P	T
5	Management of Canal Irrigation System	IDE-4.8.5	3(2+1)	2	1	0

Course Content:

Theory:

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

Practical:

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

Planning of Lecture		
Sr. No	Topics to be covered in Lecture	Proposed No. of Lecture
1	Purpose benefits and ill effects of irrigation; typical network of canal irrigation system and its different physical components; canal classification based on source of water, financial output, purpose, discharge and alignment	6
2	Canal alignment: general considerations for alignment; performance indicators for canal irrigation system evaluation	4

3	Estimation of water requirements for canal command areas and determination of canal capacity; water duty and delta, relationship between dut y, base period and delta, factors affecting duty and method of improving duty	6
4	Silt theory: Kennedy's theory, design of channels by Kennedy's theory, Lacey's regime theory and basic regime equations, design of channels by Lacey's theory,	4
5	Maintenance of unlined irrigation canals, measurement of discharge in canals, rostering (canal running schedule) and warabandhi, necessity of canal lining: advantages and disadvantages,	4
6	Types of canal lining and desirable characteristics for the suita bility of lining materials; design of lined canals; functions of distributary head and cross regulators	4
7	Canal falls, their necessity and factors affecting canal fall; sources of surplus water in canals and types of canal escapes; requirements of a goo d canal outlet and types of outlet.	4
	Total	**32**

Practicals

Sr. No	Topics	No. of Practicals
1	Determination of canal capacity	2
2	Layout of canal alignments on topographic maps, drawing of canal sections in cutting, full banking and partial cutting and partial banking;	3
3	Determination of longitudinal section of canals;	2
4	Design of irrigation canals based on silt theories;	2
5	Design of lined canals;	3
6	Formulation of warabandhi;	2
7	Study of canal outlets, regulators, escapes and canal falls.	2
	Total	**16**

Suggested Readings

Arora, K.R. 2001. Irrigation, Water Power and Water Resources Engineering. Standard Publishers Distributors, Delhi.

Garg S. K. 2014. Irrigation Engineering and Hydraulic Structures, Khanna Publishers New Delhi.

Sahasrabudhe SR. 2011. Irrigation Engineering and Hydraulic structures. SK Kataria & Sons Reprint 2015.

Sr. No	Course Name	Course No.	Credit	L	P	T
6	**Minor Irrigation and Command Area Development**	**IDE-404**	**3(2+1)**	**2**	**1**	**0**

Course Content:

Theory:

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

Practical :

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

Planning of Lecture		
Sr. No	**Topics to be covered in Lecture**	**Proposed No. of Lecture**
1.	Factors affecting performance of irrigation projects	3
2.	Types of minor irrigation systems in India	2
3.	Lift irrigation systems: feasibility, type of pumping stations and their site selection, design of lift irrigation systems	5
4.	Tank Irrigation: grouping of tanks, storage capacity, supply works and sluices	4
5.	Command area development (CAD) programme - components, need, scope, and development approaches, historical perspec tive, command area development authorities -functions and responsibilities	4
6.	On farm development works, reclamation works	4
7.	Use of remote sensing techniques for CAD works	4
8.	Water productivity: concepts and measures for enhancing water productivity	4
9.	Farmers' participation in command area development	2
	Total	**32**
Practical		
Sr. No	**Topics**	**No. of Practical**
1.	Preparation of command area development layout plan	4
2.	Irrigation water requirement of crops	2
3.	Preparation of irrigation schedules	2
4.	Planning and layout of water conveyance system	2
5.	Design of surplus weir of tanks	2
6.	Determination of storage capacity of tanks	2
7.	Design of intake pipe and pump house.	2
	Total	**16**

Suggested Readings

Arora, K.R. 2001. Irrigation, Water Power and Water Resources Engineering. Standard Publishers Distributors, Delhi.

Garg S. K. 2014. Irrigation Engineering and Hydraulic Structures, Khanna Publishers New Delhi.

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

Sahasrabudhe SR. 2011. Irrigation Engineering and Hydraulic structures. SK Kataria & Sons Reprint 2015.

Sr. No	Course Name	Course No.	Credit	L	P	T
7	**Precision Farming Techniques for Protected Cultivation**	**IDE-4.8.7**	**3(2+1)**	**2**	**1**	**0**

Course Content:

Theory:

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

Practical:

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

Planning of Lecture		
Sr. No	**Topics to be covered in Lecture**	**Proposed No. of Lecture**
1.	Protected cultivation: Introduction, History, origin, development, National and International Scenario, components of green house, perspective	2
2.	Types of green houses, polyhouses /shed nets, Cladding materials	1
3.	Plant environment interactions – principles of limiting factors, solar radiation and transpiration, greenhouse effect, light, temperature, relative humidity, carbon dioxide enrichment	3
4.	Design and construction of green houses – site selection, orientation, design, construction, design for ventilation requirem ent using exhaust fan system, selection of equipment	3

1.	Greenhouse cooling system – necessity, methods – ventilation with roof and side ventilators, evaporative cooling, different shading material fogging, combined fogging and fan -pad cooling system, design of cooling system, maintenance of cooling and ventilation systems, pad care etc.	4
2.	Greenhouse heating – necessity, components, methods, design of heating system.	2
3.	Root media – types – soil and soil less media, composition, estimation, preparation and disinfection, bed preparation. Planting techniques in green house cultivation.	3
4.	Fogging system for greenhouses and net houses – introduction, benefits, design, installation and material requirement. Maintenance of irrigation and fogging systems.	3
5.	Fertilization – nutrient deficiency symptoms and functions of essential nutrient elements, principles of selection of proper application of fertilizers, fertilizer scheduling, rate of application of fertilizers, methods, automated fertilizer application.	4
6.	Greenhouse climate measurement, control and management. Insect and disease management in greenhouse and net houses	3
7.	Selection of crops for greenhouse cultivation, major crops in greenhouse – irrigation requirement, fertilizer management, cultivation, harvesting and post harvest techniques; Economic analysis.	4
	Total	**32**

Practical

Sr. No	Topics	No. of Practical
1.	Estimation of material requirement for construction of greenhouse ;	3
2.	Determination of fertilization schedule and rate of application for various crops;	1
3.	Estimation of material requirement for preparation of root media	1
4.	Root media preparation, bed preparation and disinfections;	1
5.	Study of different planting techniques ;	1
6.	Design and installation of irrigation system;	1
7.	Design and installation of fogging system ;	1
8.	Greenhouse heating;	1
9.	Study of different greenhouse environment control instruments;	1
10.	Study of operation maintenance and fault detection in irrigation system;	1
11.	Study of operation maintenance and fault detection in fogging system;	1
12.	Economic analysis of greenhouses and net houses;	2
13.	Visit to greenhouses.	1
	Total	**16**

Suggested Readings

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

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
8	Water Quality and Management Measures	IDE-4.8.8	3 (2 + 1)	2	1	0

Course content :

Theory:

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

Practical:

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

Planning of lectures		
Sr. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1.	Natural factors affecting quality of surface water and groundwater	3
2.	Water quality objectives in relation to domestic, industrial and agricultural activities	4
3.	Drinking water quality standards, irrigation water quality classification as per USSL and All Indian Coordinated Research Project (AICRP) criteria	4
4.	Point and non-point water pollution sources	3
5.	Water contamination due to inorganic and organic compounds	3
6.	Water contamination related to agricultural chemicals, food industry, hydrocarbon and synthetic organic compounds	3
7.	Arsenic and fluoride contamination in groundwater and remedial measures	4
8.	Water decontamination technologies	4
9.	Cultural and management practices for using poor quality water for irrigation	4
Total		**32**
Practicals		
Sr.No.	Topic	**No. of Practicals**
1.	Water quality analysis and classification according to USSL and AICRP criteria	3
2.	Soil chemical analysis and estimation of lime and gypsum requirements	2
3.	Study of salinity development under shallow and deep water table conditions	3
4.	Study of contamination movement and transport in soil profile	2
5.	Study of different water decontamination techniques	3
6.	Study of different cultural and management practices for using poor quality water for irrigation	2
	Total	**17**

Suggested Readings

FAO. 1996. Control of water pollution from agriculture - FAO irrigation and drainage paper 55.

Gray, N.F. Water Technology. Raj Kamal Electric Press, Kundli, Haryana.

Hussain, S.K. 1986. Text Book of Water Supply and Sanitary Engineering. Oxford & IBH Publishing Co. New Delhi.

Manahan, S.E. 2009. Fundamentals of Environmental Chemistry. CRC Press, New York.

McGauhey, P.H. 1968. Engineering Management of water quality. McGraw Hill Book Company, New York.

Minhas, P.S. and Tyagi, N.K. 1998. Guidelines for irrigation with saline and alkali waters. Bull. No, 1/98, CSSRI, Karnal, p. :36.

Punmia, B.C. and Lal, P.B.B. 1981. Irrigation and water power engineering. Standard Publishers Distributors, Delhi.

Sr. No	Course Name	Course No.	Credit	L	P	T
9	Landscape Irrigation Design and Management	IDE-4.8.9	3(2+1)	2	1	0

Course Content:

Theory:

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

Practical:

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

Planning of Lecture		
Sr. No	**Topics to be covered in Lecture**	**Proposed No. of Lecture**
1.	Conventional method of landscape irrigation- hose irrigation system, quick release coupling system and portable sprinkler with hose pipes	4
2.	Modern methods of landscape irrigation - pop-up sprinklers, spray pop -up sprinkler, shrub adopter, drip irrigation and bubblers	6
3.	Merits and demerits of conventional and modern irrigation systems	3
4.	Types of landsca pes and suitability of different irrigation methods, water requirement for different landscapes, Segments of landscape irrigation systems,	5

1.	Main components of modern landscape irrigation systems and their selection criteria; Types of pipes, pressure ratings, sizing and selection criteria;	6
2.	Automation system for landscape irrigation - main components, types of controllers and their application,	4
3.	Design of modern landscape irrigation systems, operation and maintenance of landscape irrigation system s.	5
	Total	**32**

Practical

Sr. No	Topics	No. of Practical
1.	Study of irrigation equipments for landscapes;	2
2.	Design and installation of irrigation system for landscape, determination of water requirement.	3
3.	Determination of power requirement, pump selection.	2
4.	Irrigation scheduling of landscapes, Study of irrigation controllers and other equipments,	3
5.	Use of AutoCAD in irrigation design: blocks & symbols, head layout, zoning and valves layout, pipe sizing, Pressure calculations etc.,.	4
6.	Visit to landscape irrigation system and its evaluation	2
	Total	**16**

Suggested Readings

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

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

Smith Stepehen W. Landscape Irrigation and Management. John Wiley and Sons.

Sr. No.	Course Name	Course No.	Credit	L	P	T
10	**Plastic Applications in Agriculture**	**REE-4.8.10**	**3 (2+1)**	**2**	**1**	**0**

Course Content:

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

Practical

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

Planning of Lectures		
Sr. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Introduction of protected cultivation and plasticulture - types and quality of plastics used in soil and water conservation, production agriculture and post harvest management.	2
2	Quality control measures. Present status and future prospective of plasticulture in India.	3
3	Water management - use of plastics in in-situ moisture conservation and rain water harvesting.	3
4	Plastic film lining in canal, pond and reservoir. Plastic pipes for irrigation water management, bore-well casing and subsurface drainage. Drip and sprinkler irrigation systems	3
5	Use of polymers in control of percolation losses in fields. Soil conditioning - soil solarisation, effects of different colour plastic mulching in surface covered cultivation	3
6	Nursery management - Use of plastics in nursery raising, nursery bags, trays etc. Controlled environmental cultivation - plastics as cladding material, green / poly / shade net houses, wind breaks, poly tunnels and crop covers	4
7	Plastic nets for crop protection - anti insect nets, bird protection nets. Plastic fencing. Plastics in drying, preservation, handling and storage of agricultural produce, innovative plastic packaging solutions for processed food products.	3
8	Plastic cap covers for storage of food grains in open. Use of plastics as alternate material for manufacturing farm equipment and machinery.	3
9	Plastics for aquacultural engineering and animal husbandry - animal shelters, vermi-beds and inland fisheries. Silage film technique for fodder preservation.	3
10	Agencies involved in the promotion of plasticulture in agriculture at national and state level. Human resource development in plasticutlure applications.	3
	Total	**30**

Planning of Practical		
Sr.No.	**Topics**	**Proposed No. of Practicals**
1	Study of solar greenhouse for agriculture production	1
2	Design, estimation and laying of plastic films in lining of canal, reservoir and water harvesting ponds	1
3	Study of plastic components of drip and sprinkler irrigation systems, laying and flushing of laterals. Study of components of subsurface drainage system.	2
4	Study of different colour plastic mulch laying. Design, estimation and installation of green, poly and shade net houses, low tunnels etc	1

5	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	2
6	Study on use of plastics in nursery, plant protection, inland fisheries, animal shelters, preparation of vermi-bed and silage film for fodder preservation.	1
7	Study of plastic parts in making farm machinery.	1
8	Visits to nearby manufacturing units/dealers of PVC pipes, drip and sprinkler irrigation systems, greenhouse/ polyhouse/shadehouse/ nethouse etc.	1
9	Visits to farmers' fields with these installations.	1
	Total	**11**

Suggested Readings

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

Brown, R.P. 2004. Polymers in Agriculture and Horticulture. RAPRA Review Reports : Vol. 15, No. 2, RAPRA Technology Limited, U.K.

Central Pollution Control Board. 2012. Material on Plastic Waste Management. Parivesh Bhawan, East Arjun Nagar, Delhi-110032.

Charles A. Harper. 2006. Handbook of Plastics Technologies. The Complete Guide to Properties and Performance. McGraw-Hill, New Delhi.

Dubois. 1978. Plastics in Agriculture. Applied Science Publishers Limited, Essex, England.

Manas Chanda, Salil K. Roy. 2008. Plastics Fundamentals, Properties, and Testing. CRC Press.

Ojha,T.P. and Michael, A.M., 2012, Principles of Agricultural Engineering - I. Jain Brothers, Karol Bagh, New Delhi.

Pandey, P.H. 2014. Principles and Practices of Agricultural Structures and Environmental Control. Kalyani Publishers, Ludhiana, India.

Shankar, A.N. 2014. Integrated Horticulture Development in Eastern Himalayas, Plasticulture in Agri-Horticulture Systems, 241-247.

Srivastava, R.K., R.C. Maheswari, T.P. Ojha, and A. Alam. 1988. Plastics in Agriculture. Jain Brothers, Karol Bagh, New Delhi.

Sr.No.	Course Name	Course No.	Credit	L	P	T
11	**Mechanics of Tillage and Traction**	**FMPE - 402**	**3(2+1)**	**2**	**1**	**0**

Course Content:

Theory:

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

Practical:

Measurement of static and dynamic soil parameters related to tillage, soil parameters related to puddling and floatation, draft for passive rotary and oscillating tools, slip and sinkage under dry and

wet soil conditions and load and fuel consumption for different farm operations; Weight transfer and tractor loading including placement and traction aids; Studies on tyres, tracks and treads under different conditions, and soil compaction and number of operations.

Sr. No.	Topic of course	Proposed No. of Lectures
1	Introduction to mechanics of tillage tools	2
2	Engineering properties of soil,	2
3	Principles and concepts	2
4	Stress strain relationship	2
5	Design of tillage tools, principles of soil cutting	2
6	Design equation	2
7	Force analysis	2
8	Application of dimensional analysis in soil dynamics and traction prediction equation	2
9	Introduction to traction and mechanics	2
10	Off road traction and mobility	2
11	Traction model	2
12	Traction improvement,	2
13	Tyre size, tyre lug geometry and their effects	2
14	Tyre testing	2
15	Soil compaction and plant growth	2
16	Variability and application of GIS in soil dynamics	2
	Total	**32**
Practicals		
Sr. No.	**Topic**	**No. of Practicals**
1	Measurement of static and dynamic soil parameters related to tillage	2
2	Soil parameters related to puddling and floatation,	2
3	Draft for passive rotary and oscillating tools	2
4	Slip and shrinkage under dry and wet soil conditions and load and fuel consumption for different farm operations	2
5	Weight transfer and tractor loading including placement and traction aids	2
6	Studies on tyres	2
7	Tracks and treads under different conditions,	2
8	Soil compaction and number of operations	2
	Total	**16**

Suggested Readings:

Vandenberg and Gill. Tillage and Traction.

Liljedahl JB and others. Tractor and Power Units.

Daniel Hill. Fundamentals of Soil Physics.

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
12	**Farm Machinery Design and Production**	**FMPE-4.8.12**	**3(2+1)**	**2**	**1**	**0**

Course Content:

Theory:

Introduction to design parameters of agricultural machines & design procedure. Characteristics of

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

Practical:

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

Sr. No.	Topic of course	Proposed No. of Lectures
1	Introduction to design parameters of agricultural machines & design procedure	2
2	Characteristics of farm machinery design	2
3	Research and development aspects of farm machinery	2
4	Design of standard power transmission components used in agricultural machines: mechanical & hydraulic units.	2
5	Introduction to safety in power transmission	2
6	Application of design principles to the systems of selected farm machines	2
7	Critical appraisal in production of Agricultural Machinery; Advances in material used for agricultural machinery	2
8	Cutting tools including CNC tools and finishing tools	2
9	Advanced manufacturing techniques including powder metallurgy	2
10	EDM (Electro-Discharge Machining)	2
11	Heat Treatment of steels including pack carburizing, shot pining process, etc	2
12	Limits, Fits & Tolerances	2
13	Jigs & Fixtures	2
14	Industrial lay-out planning	2
15	Quality production management	2
16	Reliability. Economics of process selection. Familiarization with Project Report	2
	Total	**32**
Practicals		
Sr. No.	**Topic**	**No. of Practicals**
1	Familiarization with different design aspects of farm machinery and selected components	2
2	Solving design problems on farm machines & equipment	2
3	Visit to Agricultural machinery manufacturing industry	2
4	Tractor manufacturing industry Jigs and Fixtures – study in relation to agricultural machinery	2
5	Fits, tolerances and limits	2
6	Layout planning of a small scale industry	2
7	Problems on Economics of process selection	2
8	Preparation of a project report	1
9	Case study for manufacturing of simple agricultural machinery.	1
	Total	**16**

Suggested Readings:

Richey, C.B. Agricultural Engineering Handbook.

Adinath M and AB Gupta. Manufacturing Technology.

Sharma PC and DK Aggarwal. Machine Design.

Narula V. Manufacturing process.

Singh S. Mechanical Engineer's Handbook.

Chakrabarti NR. Data book for Machine Design.

Sr. No.	Course Name	Course No.	Credit	L	P	T
13	Human Engineering and Safety	FMPE-4.8.13	3 (2 + 1)	2	1	3

Course content :

Theory

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

Practical

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

Planning of lectures		
Sr. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Human factors in system development – concept of systems; basic processes in system development, performance reliability, human performance.	4
2	Information input process, visual displays, major types and use of displays, auditory and factual displays. Speech communications.	4
3	Biomechanics of motion, types of movements, Range of movements, strength and endurance, speed and accuracy, human control of systems.	4
4	Human motor activities, controls, tools and related devices.	3
5	Anthropometry: arrangement and utilization of work space,	4
6	Atmospheric conditions, heat exchange process and performance, air pollution.	3
7	Dangerous machine (Regulation) act,	3

8	Rehabilitation and compensation to accident victims,	3
9	Safety gadgets for spraying, threshing, Chaff cutting and tractor & trailer operation etc.	4
	Total	**32**

Practicals		
Sr. No.	**Topic**	**No. of Practicals**
1.	Calibration of the subject in the laboratory using bi-cycle ergo-meter.	2
2.	Study and calibration of the subject in the laboratory using mechanical treadmill.	2
3.	Use of respiration gas meter from human energy point of view.	2
4.	Use of Heart Rate Monitor.	1
5.	Study of general fatigue of the subject using Blink ratio method,	1
6.	Familiarization with electro-myograph equipment.	1
7.	Anthropometric measurements of a selected subjects.	2
8.	Optimum work space layout and locations of controls for different tractors.	1
9.	Familiarization with the noise and vibration equipment	2
10.	Familiarization with safety gadgets for various farm machines.	2
	Total	**16**

Reference Books

Chapanis A. 1996. Human Factors in System Engineering. John Wiley & Sons, New York.

Dul J. and Weerdmeester B.1993. Ergonomics for Beginners. A Quick Reference Guide. Taylor and Francis, London.

Mathews J. and Knight A. A. 1971. Ergonomics in Agricultural Equipment Design. National Institute of Agricultural Engineering.

Astrand P. And and Rodahl K. 1977. Textbook of Work Physiology. Mc Hill Corporation, New York.

Mark S. Sanders and Ernest James McCormick. 1993. Human Factors in Engineering and Design. Mc Hill Corporation, New York.

Keegan J J, Radke AO. 1964. Designing vehicle seats for greater comfort. SAE Journal;72:50~5.

Yadav R, Tewari V.K. 1998. Tractor operator workplace design-a review. Journal of Terra mechanics 35: 41-53.

Sr. No.	Course Name	Course No.	Credit	L	P	T
14	Tractor Design and Testing	FMPE-4.8.14	3 (2 + 1)	2	1	0

Course content :

Theory

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

Practical

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

Planning of lectures		
Sr. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1.	Procedure for design and development of agricultural tractor,	2
2.	Study of parameters for balanced design of tractor for stability & weight distribution, traction theory.	2
3.	Hydraulic lift and hitch system design	2
4.	Design of mechanical power transmission in agricultural tractors: single disc, multi disc and cone clutches.	2
5.	Rolling friction and anti-friction bearings.	1
6.	Design of Ackerman Steering and tractor hydraulic steering.	2
7.	Study of special design features of tractor engines and their selection viz. cylinder, piston, piston pin, crankshaft, etc.	2
8.	Design of seat and controls of an agricultural tractor.	2
9.	Tractor Testing.	2
	Total	**17**
Practicals		
Sr. No.	**Topic**	**No. of Practicals**
1.	Design problem of tractor clutch – (Single/ Multiple disc clutch).	1
2.	Design of gear box (synchromesh/constant mesh), variable speed constant mesh drive.	2
3.	Selection of tractor tires – Problem solving.	2
4.	Problem on design of governor.	1
5.	Design and selection of hydraulic pump.	1
6.	Engine testing as per BIS code.	2
7.	Drawbar performance in the lab; PTO test and measure the tractor power in the lab/field.	1
8.	Determining the turning space, turning radius and brake test	1
9.	Hydraulic pump performance test	1
10.	Air cleaner and noise measurement test	1
11.	Visit to tractor testing centre/industry.	1
	Total	**16**

Reference Books

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

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

Maleev VL. Internal Combustion Engines.

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

Richey C.B. Agricultural Engineering Handbook.

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
15	Hydraulic Drives and Controls	FMPE-4.8.15	3 (2 + 1)	2	1	0

Course content :

Theory

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

Practical

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

Planning of lectures		
Sr.No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Hydraulic Basics: Pascal's Law, Flow, Energy, Work, and Power.	3
2	Hydraulic Systems, Color Coding, Reservoirs, Strainers and Filters, Filtering Material and Elements.	3
3	Accumulators, Pressure Gauges and Volume Meters, Hydraulic Circuit, Fittings and Connectors.	3
4	Pumps, Pump Classifications, operation, performance, Displacement, Design of Gear Pumps, Vane Pumps, Piston Pumps.	4
5	Hydraulic Actuato rs, Cylinders, Construction and Applications, Maintenance, Hydraulic Motors.	3
6	Installation, Valve Failures and Remedies, Valve Assembly, Troubleshooting of Valves Hydraulic Circuit Diagrams and Troubleshooting,	3
7	United States of American Standards Institute USASI.	3
8	Graphical Symbols in Tractor hydraulics, nudging system, ADDC.	3
9	Pneumatics: Air services, logic units, Fail safe and safety systems	3
10	Robotics: Application of Hydraulics and Pneumatics drives in agricultural systems, Programmable Logic Controls (PLCs).	4
	Total	**32**
Practicals		
Sr. No.	**Topic**	**No. of Practicals**
1.	Introduction to hydraulic systems	2
2.	Study of hydraulic pumps, hydraulic actuators	2

3.	Study of hydraulic motors, hydraulic valves, colour codes and circuits	3
4.	Building simple hydraulic circuits.	2
5.	Study of hydraulics in tractors.	2
6.	Introduction to pneumatics, pneumatics devices, pneumatics in agriculture	3
7.	Use of hydraulics and pneumatics for robotics.	2
	Total	**16**

Reference Books

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

Anthony E. Fluid Power and Applications.

Majumdar. Oil Hydraulic System.

Merit. Hydraulic Control Systems.

John Deere. Fundamentals of Service Hydraulics.

Sr.No.	Course Name	Course No.	Credit	L	P	T
16	Precision Agriculture and System Management	FMPE- 412	3(2+1)	2	1	0

Course Content:

Theory:

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

Practical:

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

Sr. No.	Topic of course	Proposed No. of Lectures
1	Precision Agriculture – need and functional requirements	2
2	Familiarization with issues relating to natural resources	2
3	Familiarization with equipment for precision agriculture including sowing and planting machines	2
4	Power sprayers, land clearing machines, laser guided land levelers, straw-chopper, straw-balers, grain combines, etc	3
5	Introduction to GIS based precision agriculture and its applications.	3
6	Introduction to sensors and application of sensors for data generation	3
7	Database management.	2
8	System approach in farm machinery management	2

9	System concept	2
10	Problems on machinery selection	3
11	Maintenance and scheduling of operations	3
12	Application to PERT and CPM for machinery system management	3
13	Various application rates for fertilizer as well as for pesticides/weedicides	2
	Total	**32**
Practicals		
Sr. No.	**Topic**	**No. of Practicals**
1	Familiarization with precision agriculture problems and issues	2
2	Familiarization with various machines for resource conservation	4
3	Solving problems related to various capacities, pattern efficiency, system limitation, etc	4
4	Problems related to cost analysis and inflation and problems related to selection of equipment, replacement, break-even analysis, time value of money etc.	4
	Total	**14**

Suggested Readings:

Kuhar J E. The Precision Farming Guide for Agriculturist.

Dutta SK. Soil Conservation and land management.

Sigma and Jagmohan. Earth Moving Machinery.

Wood and Stuart. Earth Moving Machinery.

DeMess MN. Fundamentals of Geographic Information System.

Hunt Donnell. Farm Power and Machinery Management.

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
17	Food quality and control	PFE-4.8.17	3 (2+1)	2	1	0

Course content:

Theory

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

Practical

Examination of cereals & pulses from one of go-downs and market shops in relation to FPO and BIS specifications, Detection of adulteration and examination of ghee for various standards of

AGMARK & BIS standards, Detection of adulteration and examination of spices for AGMARK and BIS standards, Detection of adulteration and examination of milk and milk products for BIS standards, Detection of adulteration and examination of fruit products such as jams, jellys, marmalades for FPO specification, Visit to quality control laboratory, Case study of statistical process control in food processing industry, Study of registration process and licensing procedure under FSSAI, Study of sampling techniques from food processing establishments, Visit to food processing laboratory and study of records and reports maintained by food processing laboratory.

Planning of lectures		
Sr. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Basics of Food Science and Food Analysis and Concepts	1
2	Objectives and need of food quality	1
3	Measurement of colour, flavour, consistency, vis cosity, texture and their relationship with food quality and composition.	3
4	Sampling; purpose, sampling techniques, sampling procedures for liquid, powdered and granular materials	2
5	Quality control, Quality control tools	3
6	Statistical quality control	2
7	Sensory evaluation methods, panel selection methods	2
8	Interpretation of sensory results	1
9	Instrumental method for testing quality	2
10	Food adulteration and food safety	3
11	TQM and TQC, consumer preferences and acceptance	1
12	Food Safet y Management Systems GAP, GHP, GMP, Hazards and HACCP (Hazard analysis and critical control point)	2
13	Sanitation in food industry (SSOP)	2
14	Food Laws and Regulations in India	2
15	FSSAI, Food grades and standards BIS, AGMARK, PFA, FPO, ISO 9000, 22000 Series	3
16	CAC (Codex Alimantarious Commission),Traceability and Quality Assurance system in a process plant, Bio safety and Bioterrorism	2
Total		**32**
Practical		
Sr.No.	Topic	**No. of Practical**
1	Examination of cereals & pulses from one of go-downs and market shops in relation to FPO and BIS specifications	2
2	Detection of adulteration and examination of ghee for various standards of AGMARK & BIS standards	1
3	Detection of adulteration and examination of spices for AGMARK and BIS standards	1
4	Detection of adulteration and examination of milk and milk products for BIS standards	2
5	Detection of adulteration and examination of fruit products such as jams, jellys, marmalades for FPO specification	1
6	Visit to quality control laboratory	1
7	Case study of statistical process control in food processing industry	2
8	Study of registration process and licensing procedure under FSSAI	2
9	Study of sampling techniques from food processing establishments	1
10	Visit to food processing laboratory	1
11	Study of records and reports maintained by food processing laboratory	2
	Total	**16**

Suggested Readings

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

Srilakshmi B, Food Science.

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

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

Potter NN and Hotchkiss JH, Food Science.

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

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
18	Food Plant Design and Management	PFE-4.8.18	3 (2+1)	2	1	0

Course content:

Theory

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

Practical

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

Planning of lectures		
S. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Selection criteria of food plant location	1
2	Selection of processes, plant capacity	1
3	Requirements of plant building and its components	1
4	Project design, flow diagrams, selection of equipment, process and controls	2
5	Objectives and principles of food plant layout	1

6	Salient features of processing plants for cereals, pulses, oilseeds, horticultural and vegetable crops, poultry, fish and meat products, milk and milk products	3
7	Introduction to Finance	1
8	Introduction to Marketing and Food Product Marketing	1
9	Food Business Analysis and Strategic Planning	2
10	Supply chain management for retail food products	2
11	Entrepreneurship development in food industry	3
12	SWOT analysis, generation, incubation and commercialization of ideas and innovations	2
13	New product development process	2
14	Government schemes and incentive for promotion of entrepreneurship	2
15	Govt. policy on small and medium scale food processing enterprise, export and import policies relevant to food processing sector	3
16	procedure of obtaining license and registration under FSSAI	2
17	Cost analysis and preparation of feasibility report	3
Total		**32**
Practical		
Sr.No.	Topic	**No. of Practical**
1	Preparation of project report	1
2	Preparation of feasibility report	1
3	Salient features and layout of pre processing house	1
4	Salient features and layout of Milk and Milk product plants	1
5	Evaluation of given layout	1
6	Salient features, design and layout of modern rice mill,	1
7	Salient features, design and layout of Bakery and related product plant	1
8	Study of different types of records relating to production of a food plant	1
9	Study of different types of records relating to finance of a food plant	1
10	Study of different types of records relating to marketing of a food business	1
11	Presentations, Brain storming and SWOT analysis to start a food processing business	6
	Total	**16**

Suggested Readings

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

López Antonio. Gómez. Food Plant Design.

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

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

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

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
19	Food Packaging Technology	PFE-4.8.19	3 (2+1)	2	1	0

Course content:

Theory:

Factors affecting shelf life of food material during storage, Interactions of spoilage agents with environmental factors as water, oxygen, light, pH, etc. and general principles of control of the

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

Practical:

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

Planning of lectures		
Sr. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Factors affecting shelf life of food material during storage	1
2	Interactions of spoilage agents with environmental factors as water, oxygen, light, pH, etc. and general principles of control of the spoilage agents; Difference between food infection, food intoxication and allergy	3
3	Packaging of foods, requirement, importance and scope, frame work of packaging strategy, environmental considerations,	2
4	Packaging systems, types: flexible and rigid; retail and bulk; levels of packaging; special solutions and packaging machines, technical packaging systems and data management packaging systems	2
5	Different types of packaging materials, their key properties and applications, Metal cans, manufacture of two piece and three piece cans,	3

6	Plastic packaging, different types of polymers used in food packaging and their barrier properties. manufacture of plastic packaging materials, profile extrusion, blown film/ sheet extrusion, blow molding, extrusion blow molding, injection blow molding, stretch blow molding, injection molding	3
7	Glass containers, types of glass used in food packaging, manufacture of glass and glass containers, closures for glass containers.	1
8	Paper and paper board packaging, paper and paper board manufacture process, modification of barrier properties and characteristics of paper/ boards	1
9	Relative advantages and disadvantages of different packaging materials; effect of these materials on packed commodities.	2
10	Effect of these materials on packed commodities. Nutritional labelling on packages, CAS and MAP, shrink and cling packaging, vacuum and gas packaging; Active packaging, Smart packaging, Packaging requirement for raw and processed foods, and their selection of packaging materials	3
11	Factors affecting the choice of packaging materials, Disposal and recycle of packaging waste, Printing and labelling, Lamination	3
12	Package testing: Testing methods for flexible materials, rigid materials and semi rigid materials; Tests for paper (thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply bond test, surface oil absorption test, etc.),	3
13	Plastic film and laminates (thickness, tensile strength, gloss, haze, burning test to identify polymer, etc.),	2
14	Aluminum foil (th ickness, pin holes, etc.), glass containers (visual defects, colour, dimensions, impact strength, etc.), metal containers (pressure test, product compatibility, etc.).	3
Total		**32**
Practical's		
Sr.No.	Topic	**No. of Practical's**
1	Identification of different types of packaging materials	2
2	Determination of tensile/ compressive strength of given material/package	2
3	To perform different destructive and non-destructive tests for glass containers	2
4	Vacuum packaging of agricultural produces	1
5	Determination of tearing strength of paper board	1
6	Measurement of thickness of packaging materials	1
7	To perform grease resistance test in plastic pouches	1
8	Determination of bursting strength of packaging material	1
9	Determination of water-vapour transmission rate	1
10	Shrink wrapping of various horticultural produce	1
11	Testing of chemical resistance of packaging materials	1
12	Determination of drop test of food package	1
13	visit to relevant industries.	1
	Total	**16**

Suggested Readings:

Coles, R., McDowell, D., Kirwan, M .J. 2003. Food Packaging Technology. Blackwell Publishing Co.

Gosby, N.T. 2001. Food Packaging Materials. Applied Science Publication

John, P.J. 2008. A Handbook on Food Packaging Narendra Publishing House,

Mahadevia, M., Gowramma, R.V. 2007. Food Packaging Materials. Tata McGraw Hill

Robertson, G. L. 2001. Food Packaging and Shelf life: A Practical Guide. Narendra Publishing House.

Robertson, G. L. 2005. Food Packaging: Principles and Practice. Second Edition. Taylor and Francis Pub.

Sr. No.	Course Name	Course No.	Credit	L	P	T
20	Development of Processed Products	PFE-4.8.20	3 (2+1)	2	1	0

Course content:

Theory

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

Practical

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

Planning of lectures		
Sr. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Process design	1
2	Water activity and concept of mass and energy balance	2
3	Process flow chart with mass and energy balance	1
4	New product development	2
5	Technology for value added products from cereal, pulses and oil seeds	3
6	Milling, puffing, flaking, Roasting, Bakery products, snack food	3
7	Extruded products	1
8	Oil extraction and refining	1
9	Technology for value added products from fruits, vegetables and spices	3
10	Canned foods and Frozen foods	2
11	Fruit juices, Sauce, Sugar based confection, Candy,	2
12	Fermented food product	1
13	Cryogenic grinding and critical fluid extraction technology	2
14	Technology for animal produce processing	2
15	Meat, poultry, fish, egg products,	2
16	Health food, Nutra-ceuticals and functional food	2
17	Organic food	2
Total		**32**

Practical		
Sr.No.	Topic	**No. of Practical**
1	Process design and process flow chart preparation	3
2	Preparation of different value added products	4
3	Visit/ study of to roller wheat flour milling, rice milling, spice grinding mill,	3
4	Visit/ study of milk plant, dal and oil mill fruit/vegetable processing plants	3
5	Study of operations and machinery	1
6	Study of Process flow diagram	1
7	Study of various models of the machines used in a sugar mill/ processing plants	1
	Total	**16**

Suggested Readings

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

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

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

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

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

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

K. P. Sudheer, V. Indira 2007. Post Harvest Technology of Horticultural Crops, New India Publishing

Sr. No.	Course Name	Course No.	Credit	L	P	T
21	**Process Equipment Design**	**PFE-4.8.21**	**3 (2+1)**	**2**	**1**	**0**

Course content:

Theory :

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

Practical:

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

Planning of lectures		
Sr. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Introduction on process equipment design	1
2	Application of design engineering for processing equipments	1
3	Design parameters and general design procedure	1
4	Material specification	1

5	Types of material for process equipments	1
6	Design codes	1
7	Pressure vessel design	3
8	Design of cleaners	2
9	Design of tubular heat exchanger	2
10	shell and tube heat exchanger	2
11	plate heat exchanger	2
12	Design of belt conveyer	2
13	Design of screw conveyer	2
14	Design of bucket elevator	2
15	Design of dryers	3
16	Design of milling equipments	2
17	Optimization of design with respect to process efficiency energy and cost	2
18	Computer Aided Design	2
Total		**32**
Practical		
Sr.No.	**Topic**	**No. of Practical**
1	Design of pressure vessel	1
2	Design of cleaners	2
3	Design of, milling equipments	2
4	Design of tubular heat exchanger	2
5	Design of shell and tube type heat exchanger	1
6	Design of plate heat exchanger	1
7	Design of dryer, belt conveyor, bucket elevator, screw conveyor	1
8	Design of belt conveyor	2
9	Design of bucket elevator	2
10	Design of screw conveyor	2
	Total	**16**

Suggested Readings

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

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

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

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
22	**Photovoltaic Technology and Systems**	**REE-4.8.22**	**3 (2+1)**	**2**	**1**	**0**

Course Content:

Solar PV Technology: Advantages, Limitations, Current Status of PV technology, SWOT analysis of PV technology. Types of Solar Cell, Wafer based Silicon Cell, Thin film amorphous silicon cell Thin Cadmium Telluride (CdTe) Cell, Copper Indium Gallium Selenide (CiGS) Cell, Thin film crystalline silicon solar cell. Solar Photo Voltaic Module: Solar cell, solar module, solar array, series & parallel connections of cell, mismatch in cell, fill factor, effect of solar radiation and temperature on power output of module, I-V and power curve of module. Balance of Solar PV system: Introduction to batteries, battery classification, lead acid battery, Nicked Cadmium battery,

comparison of batteries, battery parameters, Charge controller: types of charge controller, function of charge controller, PWM type, MPPT type charge controller, Converters: DC to DC converter and DC to AC type converter. Application of Solar PV system. Solar home lighting system, solar lantern, solar fencing, solar street light, solar water pumping system, Roof top solar photovoltaic power plant and smart grid.

Practical

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

Planning of Lectures		
Sr. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Solar PV Technology: Advantages, Limitations, Current Status of PV technology.	2
2	SWOT analysis of PV technology.	3
3	Types of Solar Cell, Wafer based Silicon Cell, Thin film amorphous silicon cell Thin Cadmium Telluride (CdTe) Cell, Copper Indium Gallium Selenide (CiGS) Cell, Thin film crystalline silicon solar cell.	4
4	Solar Photo Voltaic Module: Solar cell, solar module, solar array, series & parallel connections of cell, mismatch in cell, fill factor, effect of solar radiation and temperature on power output of module, I-V and power curve of module.	4
5	Balance of Solar PV system: Introduction to batteries, battery classification, lead acid battery, Nicked Cadmium battery, comparison of batteries, battery parameters.	3
6	Charge controller: types of charge controller, function of charge controller, PWM type, MPPT type charge controller.	3
7	Converters: DC to DC converter and DC to AC type converter.	3
8	Application of Solar PV system. Solar home lighting system, solar lantern, solar fencing, solar street light, solar water pumping system.	3
9	Roof top solar photovoltaic power plant and smart grid.	3
	Total	28
Planning of Practical		
S.No.	Topics	Proposed No. of Practical
1	Study and demonstration different types of solar cells	1
2	Study of V-I characteristics of solar PV system	1
3	Study of smart grid technology and application	1
4	Study and demonstration of manufacturing technique of solar array	1
5	Study of different DC to DC and DC to AC converter	1
6	Study and demonstration of domestic solar lighting system	1
7	Study of various solar module technologies	1
8	Study of safe measurement of PV modules electrical characteristics	1
9	Commissioning of complete solar PV system	1
10	Visit to various industries manufacturing the solar photovoltaic system	1
	Total	**10**

Suggested Readings

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

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

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

Solar photovoltaic - fundamentals, technologies and applications, third edition by solanki, chetan singh ISBN: 978-81-203-5111-0.

Sr. No.	Course Name	Course No.	Credit	L	P	T
23	Waste and By-Products Utilization	REE-4.8.23	3 (2+1)	2	1	0

Course Content:

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

Practical

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

Planning of Lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Types and formation of by-products and waste; Magnitude of waste generation in different food processing industries.	2
2	Uses of different agricultural by-products from rice mill, sugarcane industry, oil mill etc..	2

3	Concept, scope and maintenance of waste management and effluent treatment, Temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues	4
4	Waste utilization in various industries.	2
5	Furnaces and boilers run on agricultural wastes and byproducts, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization	4
6	Waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants, concept of vermin-composting.	4
7	Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation, Secondary treatments: Biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons.	4
8	Tertiary treatments: Advanced waste water treatment process-sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal.	3
9	Assessment, treatment and disposal of solid waste; and biogas generation, Effluent treatment plants.	2
10	Environmental performance of food industry to comply with ISO-14001 standards.	2
	Total	29

Planning of Practical

Sr.No.	Topics	Proposed No. of practical
1	Determination of temperature pH, turbidity solids content	1
2	Determination of BOD of waste water	1
3	Determination of COD of waste water	1
4	Determination of ash content of agricultural wastes	1
5	Determination of un-burnt carbon in ash	1
6	Study about briquetting of agricultural residues	1
7	Estimation of excess air for better combustion of briquettes/wood	1
8	Study of extraction of oil from rice bran	1
9	Study on bioconversion of agricultural wastes	1
10	Recovery of germ and germ oil from by-products of cereals	1
11	Visit to various industries using waste and food by-products	2
	Total	**12**

Suggested Readings

Markel, I.A. 1981. Managing Livestock Waste, AVI Publishing Co.

Pantastico, ECB. 1975. Post Harvest Physiology, Handling and utilization of Tropical and Sub-tropical fruits and vegetables, AVI Pub. Co.

Shewfelt, R.L. and Prussi, S.E. 1992. Post-Harvest Handling – A Systems approach, Academic Press Inc.

USDA. 1992. Agricultural Waste Management Field Hand book. USDA, Washington DC.

Weichmann J. 1987. Post Harvest Physiology of vegetables, Marcel and Dekker Verlag.

V.K. Joshi & S.K. Sharma. Food Processing Waste Management: Treatment & Utilization. New India Publishing Agency.

Vasso Oreopoulou and Winfried Russ (Edited). 2007. Utilization of By-products and Treatment of waste in the Food Industry. Springer Science & Business media, LLC 233 New York.

Prashar, Anupama and Bansal, Pratibha. 2007-08. Industrial Safety and Environment. S.K. Kataria and sons, New Delhi

Garg, S K. 1998. Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering. Khanna Publishers, New Delhi

Bhatia, S.C.. 2001. Environmental Pollution and Control in Chemical Process Industries. Khanna Publishers, New Delhi.

Sr. No.	Course Name	Course No.	Credit	L	P	T
24	Artificial Intelligence	CSE-4.8.24	3(3+0)	3	0	0

Course content:

Theory:

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

Planning of lectures		
Sr. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Foundation and history of artificial intelligent, problems and techniques	2
2	AI programming languages, introduction to LISP and PROLOG	2
3	problem spaces and searches, blind search strategies, Breadth first- Depth first- heuristic search techniques	4
4	Hill climbing: best first-A* algorithm AO* algorithm- game tree, Min max algorithms, game playing- alpha beta pruning	5
5	Knowledge representation issues, predicate logic- logic programming, semantic nets- frames and inheritance, constraint propagation, representing knowledge using rules, rules based deduction systems	8
6	Reasoning under uncertainty, review of probability, Baye's probabilistic interferences and Dempster shafer theory, Heuristic methods, symbolic reasoning under uncertainty, Statistical reasoning, Fuzzy reasoning, Temporal reasoning, Non monotonic reasoning	7
7	Planning and planning in situational calculus, representation for planning, partial order planning algorithm, learning from examples, discovery as learning, learning by analogy, explanation based learning, neural nets, genetic algorithms	8

8	Principles of Natural language processing, rule based systems architecture, Expert systems, knowledge acquisition concepts, AI application to robotics, and current trends in intelligent systems	9
Total		**45**

Suggested Readings

Russell, S. and P. Norvig. 1998. Artificial Intelligence: A Modern Approach. Prentice Hall.

Rich, Elain and Kevin Knight. 1991. Artificial Intelligence. TMH.

Patrick Henry Winston. 1992. Artificial intelligence. Addition Wesley 3rd Ed.

Nilson Nils J. Principles of Artificial Intelligence. Norsa Publishing House.

Sr. No.	Course Name	Course No.	Credit	L	P	T
25.	**Mechatronics**	**ME-4.8.25**	**3 (2+1)**	**2**	**1**	**0**

Course content:

Theory

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

Practical

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

Planning of lectures		
Sr. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	Definition of mechatronics, measurement system	1
2	control systems, microprocessor based controllers	1
3	mechatronics approach. Sensors and transducers	2
4	performance terminology, Displacement, Position & Proximity Sensors, photo-electric transducers, flow transducers, optical sensors and transducers	2

5	Actuators, Mechanical Actuation Systems, Hydraulic & Pneumatic Actuation Systems, Electrical Actuation Systems	2
6	A.C. Motor, D.C. Motor, Stepper Motor. Signal conditioning process, filtering digital signal, multiplexers,	2
7	data acquisition, digital signal processing, measurement system, pulse modulation, data presentation systems	3
8	System modelling & control, Mathematical Models, Engineering Systems, Electro-mechanical & Hydraulic-mechanical Systems,	4
9	Modelling Dynamic Systems, Transfer Functions,	3
10	Control Modes, PID Controller. Micro-processor & computer, Computer and Interfacing, Micro-computer Structure, Micro-controllers	3
11	Application of Microcontrollers, PLC. Robotics, Robot components	3
12	robot classification and specification, Work envelopes, other basic parameters of robots.	2
13	Robot applications, Robot applications in manufacturing,	1
14	Material transfer and machine loading/unloading	1
15	Processing operations like Welding & painting, Assembly operations, Inspection automation, Future applications	3
Total		**33**

Tutorials

Sr.No.	**Topic**	**No. of Practicals**
1.	Design a mechatronics product/system and incorporate application of mechatronics for enhancing product values using rapid proto Typing Machine	2
2.	To study the hardware and software of mechatronics kit.	2
3.	To run a motor with PLC. To run a conveyor with computer	1
4.	To move a table in X-direction within the range of proximity sensors using Control-X software	1
5.	To study the movement of actuating cylinders and sensors.	1
6.	Study and demonstration on Robots	1
7.	Introduction to CAD software.	2
8.	Introduction to CAM software	2
9.	Manual part programming on CNC lathe,	2
10.	Manual part programming on milling and drilling	**2**
11.	Simulation on CNC lathe	**2**
12.	Simulation on CNC Mill	**2**
	Total	**20**

Suggested Readings

Bolton, W. Mechatronics. Pearson Education Asia.

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

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

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

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

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

Sr. No.	Course Name	Course No.	Credit	L	P	T
26	Energy Conservation and Audit in Agricultural Industry	REE-4.8.26	3 (2+1)	2	1	0

Course Content:

General energy problem, Energy consumption in Agriculture Sector and other sectors, demand supply gap, Scope for energy conservation and its benefits, Energy conservation Principle-Maximum energy efficiency, Maximum cost effectiveness, Features of EC act Standards and labeling, designated consumers, Energy conservation Building codes (ECBC), Energy management concept and objectives, Initialing planning, Leading controlling, Promoting, Monitoring and reporting, Energy management programmes, Energy saving opportunities in electric motors, benefits of power factor improvement and its techniques-shunt capacitor, synchronous condenser etc, effects of harmonics on motors and remedies leading to energy conservation, energy conservation by VSD, Energy conservation in electric furnaces, ovens and boilers, lighting techniques- Natural, CFL, LED lighting sources and fittings,New Equipment technology, staffing , training, calculation and costing of energy conservation project, Depreciation, cost, sinking fund method cost evaluation by return on Investment (ROI) and pay back method etc, Risk analysis, case analysis, Performance improvement of existing power plant, cogeneration, small hydro, DG set, Demand side management, load response programmes; Types of tariff and restructuring of electric tariff Technical measures to optimize T and D losses, Energy audit and its benefits, Energy flow diagram Preliminary, Detailed energy audit. Methodology of -preliminary energy audit and Detailed energy audit –Phase I, Pre audit, Phase II- Audit and Phase III- Post audit, Energy audit report, Electrical Measuring Instruments - Power Analyser. Combustion analyzer, fuel efficiency monitor, thermometer-contact, infrared, pitot tube and manometer, water flowmeter, leak detector, tachometer and luxmeter, IE rules and regulations for energy audit Electricity act(Numerical).

Practical: CASE STUDY OF AGRO INDUSRY FOR THE FOLLOWING SUB STUDIES:

List various energy management systems prevailing in a Agro industry/Organization; Identify the energy management skills and strategies in the energy management system; Organize a energy management programme in a given industry; List the various energy conservation methods useful in a particular industry; Identify the critical areas where energy conservation is required; Select appropriate energy conservation method for the critical area identified; List the various energy conservation methods useful in power generation, transmission and distribution; Find out the payback period for a given energy conservation equipment; Determine depreciation cost of a given energy conservation project/equipment; Draw the energy flow diagram for a industry/shop floor division; Identify various measuring instruments used for energy audit; Use various measuring instruments for carrying out energy audit; Prepare a sample energy audit questionnaire; Prepare a energy audit report; Prepare a technical report on energy conservation act 2003; Prepare a technical report on ECBC 2.

Planning of Lectures		
Sr. No.	**Topics to be covered in Lecture**	**Proposed No. of Lectures**
1	General energy problem, Energy consumption in Agriculture Sector and other sectors, demand supply gap, Scope for energy conservation and its benefits	2
2	Energy conservation Principle-Maximum energy efficiency, Maximum cost effectiveness, Features of EC act Standards and labeling, designated consumers, Energy conservation Building codes (ECBC)	3

3	Energy management concept and objectives, Initialing planning, Leading controlling, Promoting, Monitoring and reporting, Energy management programmes	3
4	Energy saving opportunities in electric motors, benefits of power factor improvement and its techniques-shunt capacitor, synchronous condenser etc	3
5	effects of harmonics on motors and remedies leading to energy conservation, energy conservation by VSD	2
6	Energy conservation in electric furnaces, ovens and boilers, lighting techniques- Natural, CFL, LED lighting sources and fittings	3
7	New Equipment technology, staffing , training, calculation and costing of energy conservation project, Depreciation, cost, sinking fund method cost evaluation by return on Investment (ROI) and pay back method etc,	3
8	Risk analysis, case analysis, Performance improvement of existing power plant, cogeneration, small hydro, DG set, Demand side management, load response programmes	3
9	Types of tariff and restructuring of electric tariff Technical measures to optimize T and D losses,	2
10	Energy audit and its benefits, Energy flow diagram Preliminary, Detailed energy audit. Methodology of -preliminary energy audit and Detailed energy audit –Phase I, Pre audit, Phase II- Audit and Phase III- Post audit and Energy audit report	3
11	Electrical Measuring Instruments - Power Analyzer. Combustion analyzer, fuel efficiency monitor, thermometer-contact, infrared, pitot tube and manometer, water flow meter, leak detector, tachometer and lux meter	2
12	IE rules and regulations for energy audit Electricity act(Numerical).	2
	Total	32

Planning of Practical

Sr.No.	Topics	Proposed No. of Practicals
1	List various energy management systems prevailing in a Agro industry/Organization	1
2	Identify the energy management skills and strategies in the energy management system.	1
3	Organize a energy management programme in a given industry	1
4	List the various energy conservation methods useful in a particular industry	1
5	Identify the critical areas where energy conservation is required	1
6	List the various energy conservation methods useful in power generation, transmission and distribution	1
7	Select appropriate energy conservation method for the critical area identified	1
8	Find out the payback period for a given energy conservation equipment	1
9	Determine depreciation cost of a given energy conservation project/equipment	1
10	Draw the energy flow diagram for a industry/shop floor division	1
11	Identify various measuring instruments used for energy audit	1
12	Use various measuring instruments for carrying out energy audit	1
13	Prepare a sample energy audit questionnaire	1
14	Prepare a energy audit report	1
15	Prepare a technical report on energy conservation act 2003	1
16	Prepare a technical report on ECBC 2	1
	Total	**16**

References:

Electric Energy Generation, Utilisation and Conservation. Sivaganaraju, S Pearson, New Delhi, 2012

Electrical Power V. K. Mehta Khanna and Khanna Publishers, New Dehli

Electrical Power S. L. Uppal Khanna and Khanna Publishers, New Dehli
Art and Science of utilization of Electrical Energy H. Partab Dhanapat Rai and Sons, New Dehli
Prasanna Chandra Project Management Tata Mcgraw Hill, New Delhi
Prasanna Chandra Financial Management Tata Mcgraw Hill, New Delhi
Wayne C. Turner Energy Management Handbook –
Paul O Callaghan Energy management Mcgraw Hill, New Delhi
www.bee-india.com Fundamentals of electrical system Bureau of Energy Efficiency

Student READY Programme

Student READY programme was launched by the Hon'ble Prime Minister of India on 25th July, 2015

Introduction

The term **READY** refers to "Rural Entrepreneurship Awareness Development Yojana".

To reorient graduates of Agriculture and allied subjects for ensuring and assuring employability and develop entrepreneurs for emerging knowledge intensive agriculture, the component envisages the introduction of the program in all the Agricultural Universities as an essential prerequisite for the award of degree to ensure hands on experience and practical training.

Component of the programme: It is proposed to include following components in Student READY program.

i.	**Experiential Learning/Hands on Training**	**–**	**24 weeks**
ii.	**Skill Development Training**	**-**	**24 weeks**
iii.	**Rural Agriculture Work Experience**	**–**	**10 weeks**
iv.	**In Plant Training/ Industrial attachment**	**–**	**10 weeks**
v.	**Students Projects**	**-**	**10 weeks**

In some disciplines where some components, say, Experiential Learning is not possible at graduate level, the students will be given Hands on Training and/or Skill Development Training, but it should be (out of these 5 components) implemented for the complete year.

All the above mentioned components are interactive and are conceptualized for building skills in project development and execution, decision-making, individual and team coordination, approach to problem solving, accounting, quality control, marketing and resolving conflicts, etc. with end to end approach.

- Experiential Learning helps the student to develop competence, capability, capacity building, acquiring skills, expertise, and confidence to start their own enterprise and turn job creators instead of job seekers. This is step forward for earning while learning concept. Experiential Learning is major step forward for High Quality Professional Competence, Practical Work Experience in Real Life Situation to Graduates, Production Oriented Courses, Production to Consumption Project working, Facilitates producing Job Providers rather than Job Seekers and Entrepreneurial Orientation.
- Rural Agriculture Work Experience also enable the students to gain rural experience giving them confidence and enhancing on farm problem solving abilities in real life situations especially in contact with farmers, growers etc.
- In-plant training for a short period of time in relevant industry to gain the knowledge and experience of the work culture. In Plant training by reputed organization either MNC's or organised sectors provide an industrial exposure to the students as well as to develop their career in the high tech industrial requirements.
- Skill development component include use of Agriculture Systems & devices for enhancing functional skill. It is expected that basic infrastructure and Experiential Learning Unit available university may help in boosting livelihood ensuring opportunity.
- Student Project is essential for students interested in higher education. Through this component, they will know how to identify research problem, experimental set up and writing report etc.

For the discipline of Dairy Technology, Food science & Technology and Agricultural engineering there will 20 weeks in-plant training in place of RAWE. The students of Veterinary science discipline will undergo six months training at hospitals.

All the components as per suitability of course i.e. Experiential Learning, Skill Development Training, Rural Agriculture Work Experience (RAWE), Internship/in-plant training and Student Projects are included in the final year of study for 2 semesters to provide entrepreneurial skills, confidence and hands on experience. There are 20 credits for Experiential Learning/Skill Development Training (24 weeks), 10 credits

for RAWE (10 weeks programme) and 10 Credits for Industry Attachment/Student Project (10 weeks attachment to industry). For the students of Veterinary Science Experiential Learning is moduled as per VCI pattern.

Some of the important components of Student READY programme are given as follows:

I. Experiential Learning

a) Concept

The word 'experiential' essentially means that learning and development are achieved through personally determined experience and involvement, rather than on received teaching or training, typically in group, by observation, study of theory or hypothesis, bring in innovation or some other transfer of skills or knowledge. Experiential learning is a business curriculum-related endeavour which is interactive.

EL is for building (or reinforcing) skills in Project development and execution, decision-making, individual and team coordination, approach to problem solving, accounting, marketing and resolving conflicts, etc. The programme has end to end approach. Carefully calibrated activities move participants to explore and discover their own potential. Both activities and facilitation play a critical role in enhancing team performance.

b) Objectives

EL provides the students an excellent opportunity to develop analytical and entrepreneurial skills, and knowledge through meaningful hands on experience, confidence in their ability to design and execute project work.

The main objectives of EL are:

- To promote professional skills and knowledge through meaningful hands on experience.
- To build confidence and to work in project mode.
- To acquire enterprise management capabilities

c) Duration

The experiential learning programme will be offered for 180 days (one semester) period in the final year. As the programme is enterprise oriented, students and faculty are expected to attend the activities of the enterprise even on institutional holidays with total commitment, and without any time limit or restriction of working hours for ELP. The Experiential Learning Programme shall be run for full year by making two groups and rotating activities of the final year in two groups.

d) Attendance

The minimum attendance required for this programme is 85%. The attendance of a student will be maintained at the EL unit. The attendance particulars shall be communicated to the Chief Executive Officer (Associate Dean) by the Manager of the EL unit every week. The students will be eligible for the final evaluation of EL only when the attendance requirement is met with. Any student in the event of recording shortage of attendance has to re-register the EL when offered next by paying the assigned fee.

e) Students' Eligibility

To get the eligibility for registering the EL programme, the students should have completed all the courses successfully. No student should be allowed to take up the EL programme with backlog/repeat courses. The assignment/allotment of the EL programme shall be based on merit of the student at the end of 5th Semester. A separate certificate should be issued to the students after successful completion of EL course. Allotment of EL programmes amongst students to different modules should be done strictly on the basis of merit at the end of fifth semester. In this work experience students will know exact problems of farming & suggest appropriate technology and finally useful in enhancing productivity and profitability at farmers end.

II. Rural Agricultural Work Experience

The Rural Agricultural Work Experience (RAWE) helps the students primarily to understand the rural situations, status of Agricultural technologies adopted by farmers, prioritize the farmer's problems and to develop skills & attitude of working with farm families for overall development in rural area. The timings

for RAWE can be flexible for specific regions to coincide with the main cropping season.

2. Objectives

1. To provide an opportunity to the students to understand the rural setting in relation to agriculture and allied activities.
2. To make the students familiar with socio-economic conditions of the farmers and their problems.
3. To impart diagnostic and remedial knowledge to the students relevant to real field situations through practical training.
4. To develop communication skills in students using extension teaching methods in transfer of technology.
5. To develop confidence and competence to solve agricultural problems.
6. To acquaint students with on-going extension and rural development programmes.

III. In Plant Training (IPT)

Technology and globalization are ushering an era of unprecedented change. The need and pressure for change and innovation is immense. To enrich the practical knowledge of the students, in-plant training shall be mandatory in the last semester for a period of up to 10 weeks. In this training, students will have to study a problem in industrial perspective and submit the reports to the university. Such in-plant trainings will provide an industrial exposure to the students as well as to develop their career in the high tech industrial requirements. In-Plant training is meant to correlate theory and actual practices in the industries. It is expected that sense of running an industry may be articulated in right way through this type of industrial attachment mode.

OBJECTIVES

- To expose the students to Industrial environment, which cannot be simulated in the university.
- To familiarize the students with various Materials, Machines, Processes, Products and their applications along with relevant aspects of shop management.
- To make the students understand the psychology of the workers, and approach to problems along with the practices followed at factory
- To make the students understand the scope, functions and job responsibility-ties in various departments of an organization.
- Exposure to various aspects of entrepreneurship during the programme period

The students will be required to submit the report on various aspects and will be issued certificates upon successful completion of the student READY components. It is planned that **ICAR will provide Rs. 3000/pm per student for the duration of RAWE/ In- plant Training/ Hands-on Training (HOT) / Skill Development Training subject to a maximum of 6 months.**

Fifth Deans Committee after deliberations with the Conveners/Co-conveners and Subject Matter Specialists recommend the discipline-wise Student READY programs

AGRICULTURE ENGINEERING

Student READY program of the Agricultural Engineering is proposed to have the following components:

1. Student READY Skill Development Training -I for five weeks in the summer break after IV semester with a credit load of 0+5 credit hours.
2. Student READY Skill Development Training -II for five weeks in the summer break after VI semester with a credit load of 0+5 credit hours.
3. Industrial attachment of 10 weeks in VII semester with a credit load of 0+10 credit hours.
4. On campus Experiential Learning Program of 12 weeks in VII semester with a credit load of 0+10 credit hours.
5. Project Planning and Report Writing of 12 weeks during VII semester with a weightage of 0+10 credit hours.

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