Course Curriculum of First Semester
as per the ICAR - Sixth Deans' Committee Report for the Academic Programmes in
AGRICULTURAL ENGINEERING

- UG-Certificate in Agricultural Engineering
- UG-Diploma in Agricultural Engineering
- UG-Degree: B.Tech. (Agricultural Engineering)

Mahatma Phule Krishi Vidyapeeth, Rahuri

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UG Degree Syllabus State Coordinator

with

UG Degree Syllabus Discipline Coordinators &

DICC - UG Degree Syllabus Core Committee

Submitted to the

Directors of Instruction Coordination Committee

~ w.e.f. AY, 2024-25 ~

Course Layout

B.Tech. (Agricultural Engineering)

Semester: I (New) ***w.e.f.*** **Academic Year: 2024-25**

Sr. No.	Course No.	Course Title	Credit Hrs.	Remark
1.	**CAC-111**	*Deeksharambh* (Induction-cum-Foundation Course)	2(0+2)	NG (2 Weeks)
2.	**AEC-111**	National Service Scheme (NSS-I)/ National Cadet Corps (NCC-I)	1(0+1)	
3.	**MATH-111***	Basic Mathematics*	2(2+0)	NG & Need-based
4.	**AGEN-111**	Crop Production and Protection Technology	4(3+1)	(MDC)
5.	**GAE-111**	Introduction to Agricultural Engineering	4(3+1)	
6.	**SWCE-111**	Surveying and Levelling	3(1+2)	
7.	**FMPE-111**	Workshop Technology and Practice	2(0+2)	
8.	**REE-111**	Basic Electrical Gadgets and Instruments	3(2+1)	
9.	**COMP-111**	Agricultural Informatics and Artificial Intelligence	3(2+1)	
		Total Credits Hrs.	**20(11+9) G 4(2+2) NG**	

CAC: Common Academic Course, **AEC**: Ability Enhancement Course,
MDC: Multidisciplinary Course, **SEC**: Skill Enhancement Course,
G: Gradial, **NG**: Non-Gradial

Note: *MATH-111 for **PCB** student and for **PCM** or **PCMB** student, there is no need to offer any Need-based course.

Currently, during AY 2024-25, **AEC-112** & **MDC-111** are being offered in II-semester as **AEC-122** & **MDC-121**, respectively. However, this layout is subject to change and will be regularized **w.e.f. AY 2025-26**, wherein said courses will be offered in I-semester by shifting any 2 above listed courses to II-semester.

Semester	**:**	**I**	
Course No.	**:**	**CAC-111**	**Credit Hrs. : 2 (0+2) NG/ 2 Weeks**
Course Title	**:**	***Deeksharambh* (Induction-cum-Foundation Course)**	
Non-Gradial Common Academic Course for the said UG degree with the activities to be conducted during initial two weeks.			

Objectives:

(i) To create a platform for students to help for Cultural Integration of students from different backgrounds,

(ii) To know about the operational framework of academic process in the University, instilling life and social skills,

(iii) To create Social awareness, Ethics and Values, Team work, Leadership, Creativity,

(iv) To identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

ACTIVITIES

- Introduction/Orientation and Discussions on operational framework of academic process in University/ College, as well as interactions with Academic and Research Managers of the University.
- Interaction with Alumni, Business Leaders, Perspective Employers, Outstanding Achievers in related fields and people with inspiring life experiences.
- Students shall be made aware about the field of food processing, the industry, production, systems, importance of nutrition, packaging, quality issues involved, shelf life and the legal standards available using simple day-to-day example.
- Students shall be exposed to the job opportunities at various levels like production, product development, entrepreneurship opportunities and research opportunities that exist in this area of food processing technology.
- Group activities to identify the strength and weakness of students and to learn from each other's life experiences.
- Activities to enhance Cultural Integration of students from different backgrounds.
- Field visits to the relevant fields/ establishments.
- Sessions on Personality Development (Instilling Life and Social skills, Social awareness, Ethics and Values, Team work, Leadership etc.) and imbibing the Communication skills.

Note: *The details of the relevant activities will be decided by the parent University in line with the above-mentioned broad activities.*

Semester : I		
Course No. : AEC-111	**Credit Hrs. : 1(0+1)**	
Course Title : National Service Scheme (NSS-I) / National Cadet Corps (NCC-I)		
Gradial Common Course across all UG degrees		

Course No.: AEC-111	**Course Title: National Service Scheme-I (NSS-I)**	**Credit Hrs.: 1(0+1)**

SYLLABUS

PRACTICAL

Introduction and Basic Components of NSS

- Orientation: History, Objectives, Principles, Symbol, Badge; Regular Programs under NSS.
- Organizational structure of NSS, Code of conduct for NSS volunteers, Points to be considered by NSS Volunteers' awareness about Health.
- NSS program activities. Concept of regular activities, Special camping, Day camps, Basis of adoption of village/slums, Conducting survey, Analysing Guiding financial patterns of scheme, Youth program/schemes of GOI, Coordination with different agencies and maintenance of diary. Understanding youth. Definition, Profile, Categories, Issues and Challenges of youth; and Opportunities for youth who is agent of the social change.
- Community mobilization. Mapping of community stakeholders, Designing the message as per problems and their culture; Identifying methods of mobilization involving youth-adult partnership. Social harmony and National integration.
- Indian history and culture, role of youth in nation building, Conflict resolution and peace building. Volunteerism and Shramdaan. Indian tradition of volunteerism, its need, importance, motivation and constraints; Shaman as part of volunteerism.
- Citizenship, Constitution, and Human rights. Basic features of constitution of India, Fundamental rights and duties, Human rights, Consumer awareness and rights and Right to information. Family and Society. Concept of family, Community (PRIs and other community-based organizations) and Society.

TEACHING SCHEDULE

PRACTICAL [AEC-111]

Exercise No.	Exercise Topic	Weightage (%)
1	Orientation, History, Objectives, Principles, Symbols, Badge	10
2	Regular Programmes under NSS	10
3	Organisational Structure of NSS	10
4	Code of Conduct of NSS Volunteer	10
5	Points to be considered about NSS Volunteers awareness about Health	5
6	NSS Programme Activities- Concept of Regular activities	5
7	NSS Programme Activities- Special Campaign	5
8	NSS Programme Activities- Day Camps	5
9	NSS Programme Activities- Adoption of village, Conducting survey, Analysing Guiding financial patterns of scheme	5
10	NSS Programme Activities- Youth programs/schemes of GOI, Coordination with different agencies and maintenance of diary. Understanding youth. Definition, Profile, Categories, Issues and Challenges of youth and Opportunities for youth who is agent of the social change.	5
11	Community Mobilization- Mapping of community stakeholders, Designing the message as per problems and their culture; Identifying methods of mobilization involving youth-adult partnership.	5
12	Community Mobilization-Culture, Social harmony and National integration.	5
13	Indian History and Culture- Role of youth in Nation Building	5
14	Volunteerism and Shramdaan: Indian tradition of volunteerism, its need, importance, motivation and constraints; Shaman as part of volunteerism.	5
15	Citizenship, Constitution and Human Rights: Basic features of constitution of India, Fundamental rights and duties, Human rights, Consumer awareness and rights and Right to information.	5
16	Family and Society: Concept of family, Community (PRIs and other community-based organizations) and Society.	5
	Total=	**100**

Course No.: AEC-111	Course Title: National Cadet Corps-I (NCC-I)	Credit Hrs.: 1(0+1)

SYLLABUS

Objective: To integrate and develop qualities of leadership, discipline, character and patriotism and foster the NCC Motto: **"Unity and Discipline"** among the youth.

PRACTICAL

- Aims, Objectives, Organization of NCC and NCC Song. DG's Cardinals of Discipline.
- Drill- aim, General words of command, Attention, Stands-at-ease, Stand-easy and Turning.
- Sizing, Numbering, Forming in three ranks, Open and Close order march and Dressing.
- Saluting at the halt, Getting on parade, Dismissing and Falling-out.
- Marching, Length of pace and time of marching in quick/slow time and halt. Side pace, Pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.
- Marking time, Forward march and halt. Changing step, Formation of squad and squad drill.
- Command and control, Organization, Badges of rank, Honours and Awards.
- Nation Building- Cultural heritage, Religions, Traditions and Customs of India. National integration. Values and ethics, Perception, Communication, Motivation, Decision making, Discipline and duties of good citizens. Leadership traits, Types of leadership. Character/ Personality development. Civil defence organization, Types of emergencies, Fire fighting, Protection. Maintenance of essential services, Disaster management, Aid during development projects.
- Basics of Social Service, Weaker sections of society and their needs, NGO's and their contribution, Contribution of youth towards Social welfare and Family planning.
- Structure and Function of human body, Diet and Exercise, Hygiene and Sanitation. Preventable diseases including AIDS, Safe blood donation, First aid, Physical and mental health. Adventure activities. Basic principles of Ecology, Environmental conservation, Pollution and its control.

TEACHING SCHEDULE

PRACTICAL [AEC-111]

Exercise No.	Exercise Topic	Exercise Sub-topics/ Titles	Weightage (%)
1-2	Introduction to NCC	Aims, Objectives, NCC Organizational structure, NCC Song, DG's Cardinals of Discipline.	4
3-5	Drill Basics	Aim of drill, General words of command, Positions of attention, Stand-at-ease and Stand-easy, Turning.	8
6-8	Formation Drills	Sizing, Numbering, Forming in three ranks, Open and Close order march and Dressing.	8
9-11	Saluting Drills and Parade Movements	Saluting at halt, Getting on parade, Dismissing and Falling-out.	8
12-14	Marching Techniques	Length of pace and time of marching in Quick/slow march, Side pace, Forward/rear pace, Turning on the march, Wheeling and Saluting on the march	10
15-17	Squad Formation and Control	Marking time, Forward march, Halt, Changing step, Formation of squad and Squad drill.	10
18-19	Command and Control in NCC	Organization, Badges of rank, Honours and Awards.	4
20-22	Nation Building and Citizenship; Leadership	Cultural heritage, Religions, Traditions, Customs of India, National integration, Values and Ethics, Communication, Leadership traits, Discipline and Motivation, Character/ Personality Development.	12
23-24	Civil Defence and Emergency Management	Types of emergencies, Fire fighting techniques, Maintenance of essential services, Disaster management and Aid during development projects, Civil Defence Organizations.	10
25-26	Social Service and Youth Welfare	Weaker sections of society, Role of NGOs, Youth participation in Social welfare and Family planning	8
27-29	Health, Hygiene and First Aid	Human body structure, Diet, Hygiene, Preventable diseases (including AIDS), Safe blood donation, First aid practices, Mental and Physical health.	10
30-32	Environment and Ecology	Basic Principles of Ecology, Environmental conservation, Pollution and its control, Adventure activities.	8
		Total =	**100**

Semester	**:**	**I**	
Course No.	**:**	**MATH-111***	**Credit Hrs. : 2(2+0) Need-based; G/NG**
Course Title	**:**	**Basic Mathematics**	
***Gradial** Need-based Common Course for **B.Tech. (Biotechnology)**; ***Non-Gradial** Need-based Common Course for **B.Tech. (Agril. Engg.)** & **B.Tech. (Food Technology)**			

SYLLABUS

Objectives:

(i) To study the basic principles and functions in mathematics like limits and continuity,

(ii) To study differentiation and integration,

(iii) To study matrices and determinants.

THEORY

Functions:

Function and types of functions, Limit: Introduction, left-handed and right-handed limits, Algebra of limits, Standard limits. Continuity: Definition of continuity, continuity of algebraic functions. Continuity of trigonometric and exponential functions.

Differentiation:

Differentiation by the first principle, Rules of Differentiation: sum, difference, product and quotient formulae, differentiation using the chain rule, differentiation of functions in parametric and implicit form, logarithmic differentiation, geometrical interpretation of derivative. Successive differentiation, maxima and minima.

Integration:

Definition of indefinite integrals, Integrals of elementary functions (Formulae only), Theorems of integration (without proof), Integration by substitution, integration by partial fractions, integration by parts, Definition of definite Integral with examples, properties of definite integral (without proof).

Matrices and Determinants:

Definition of determinants, example up to Third order determinant, properties of determinant (statements only), Definition of matrix, types of matrices, Algebra of Matrix (addition, subtraction and multiplication), inverse of matrix, Solution of linear equations by Crammer's rule.

TEACHING SCHEDULE

THEORY [MATH-111]

Lecture No.	Topic	Subtopics/ Key Points	Weightage (%)
1-5	**Functions:**	Definition of Function, Types of functions	15
		Some Basic Functions: Definition and Properties of: Constant Function, Identity Function, Power Function. Polynomial Function, Linear, quadratic and cubic function, Radical Function, Rational Function. Exponential, Logarithmic and Trigonometric Function	
	Limit:	Introduction, Definition of Limit, left-handed and right-handed limits, Algebra of limits	
		Standard limits: Method of Factorization, Rationalization, Limit of Trigonometric, Exponential Logarithmic and Functions. Limit of Infinity	
	Continuity:	Definition of continuity, Continuity of algebraic functions, Continuity of trigonometric and exponential functions.	
6 -15	**Differentiation:**	Definition, Differentiation by the first principle, Derivative of Some standard functions (Formulae only), Rules of Differentiation (Sum, Difference, Product and quotient without proof), Differentiation using the chain rule, Differentiation of functions in parametric and implicit form, Logarithmic Differentiation, Successive differentiation, Maxima and minima	30
16 -25	**Indefinite and Definite Integration**:	Definition of indefinite Integral, Integrals elementary functions (Formulae only) Theorems of integration (without proof) Methods of Integration: Integration by Substitution, Integration by parts, Integration by partial fractions Some special integrals formulae only. Definition of definite Integral with examples Properties of definite integral (Without proof)	30
26 -32	**Determinants and Matrices:**	Definition of determinants, Expansion up to third order determinant, Properties of determinant (statements only) Definition of matrix, Order of Matrix, Types of matrices, Algebra of Matrices, Inverse of matrix by elementary transformations, Solution of linear equations by Crammer's rule	25
		Total=	**100**

Suggested Readings:

1. NCERT, 2012, Mathematics of Class XII, NCERT, India.
2. A Textbook of Mathematics XI and XII (Part I and II) Maharashtra State Board of Secondary and Higher Secondary Education, Pune.
3. Sharma RD, 2014, Mathematics of Class XII, Dhanpat Rai Publisher.

Semester	**:**	**I**			
Course No.	**:**	**AGEN-111**	**Credit Hrs.**	**:**	**4(3+1)**
Course Title	**:**	**Crop Production and Protection Technologies**			

SYLLABUS

Objectives:

(i) To enable the students to have basic idea on crop production and protection practices to understand the domain of agricultural sciences,

(ii) To impart the basic knowledge of the different types of machineries/equipments that can be adopted for the said operations.

THEORY

AGRONOMY:

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; Time and method of sowing of major field crops, seed rate for important crops; Methods and time of application of manures and fertilizers, fertigation; Basic principles of natural farming, organic farming and sustainable agriculture; Soil-water-plant relationship, crop coefficients, water requirement of crops and critical stages for irrigation; Weeds and their management in crops; Crop rotation, cropping systems, cropping scheme, relay cropping, mixed cropping and intercropping.

SOIL SCIENCE:

Soil forming processes; Classification and composition of soil, 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 of irrigation water; Essential plants nutrients- their functions and deficiency symptoms in plants; Important inorganic fertilizers and their reactions in soils; Gypsum requirement for reclamation of sodic soils and neutralizing RSC; Liquid fertilizers and their solubility and compatibility.

HORTICULTURE:

Types of Horticultural crops; Sowing and planting times and methods; Seed rate and seed treatment for vegetable crops; Macro- and micro- propagation methods; Types of plant growing structures; Pruning and training; Water requirements and critical stages; Management of orchard; Major pests and diseases of horticultural crops and their management.

PRACTICAL

AGRONOMY: Identification of crops and their varieties, seeds and weeds; Study of different fertilizer application methods and weed control methods; Judging the maturity time for harvesting of crop; Study of seed viability and germination test.

SOIL SCIENCE: Identification of rocks and minerals; Examination of soil profile in the field; Determination of bulk density, particle density and porosity of soil; Determination of organic carbon of soil; Identification of nutrient deficiency symptoms of crops in the field; Determination of gypsum requirement of sodic soils.

HORTICULTURE: Identification and description of important fruits, flowers and vegetables crops; Study of different garden tools; Preparation of nursery bed; Practices of pruning and training in some important fruit crops; Study of cultural operations for vegetable crops (sowing, fertilizer application, mulching, irrigation and weed control); Seed extraction techniques; Visit to commercial greenhouse/ polyhouse.

Suggested Readings [AGEN-111]:

1. Ahamad S, Anwar Ali and Sharma P K (Eds.). 2018. Plant Disease Management in Horticultural Crops. Daya Publishing House, Delhi.
2. Biswas T D and Mukharjee S K. 1987. A Textbook of Soil Science. Tata McGraw-Hill publishing Co. Ltd.
3. Brady N C and Ray R Weill. 2002. The Nature and Properties of Soil. Pearson Education Inc. New Delhi.
4. Chadha K L. 2003. Handbook of Horticulture. ICAR Publication, New Delhi.
5. Das D K. 2020. Introductory to Soil Science. Kalyani publication, Ludhiana.
6. Dey G C. 2013. Fundamentals of Agronomy. Jain Book Depot.
7. Ghildyal B P and Tripathy R P. 1987. Soil Physics. Wiley Eastern Ltd., New Delhi.
8. Hillel D. 1982. Introduction to Soil Physics. Academic Press, New York.
9. Indian Society of Soil Science. 2002. Fundamentals of Soil Science. ISSC, IARI, New Delhi.
10. Janick J. 1979. Horticultural Science. Surjeet Publications, Delhi.
11. Kumar N. 2017. Introduction to Horticulture. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
12. Muthukrishnan N, Ganapathy N, Nalini R and Rajendran R. 2005. Pest Management in Horticultural Crops. New Madura Publishers, Madurai, Tamil Nadu.
13. Reddy S R. 2020. Principles of Agronomy. Kalyani Publisher.
14. Reddy Yellamanda T and Reddy Shankar G H. 1995. Principles of Agronomy. Kalyani Publishers, Ludhiana.
15. Sehgal J L. 1996. Soil Pedology. Kalyani Publication, Ludhiana.
16. Singh Jitendra. 2018. Fundamentals of Horticulture. Kalyani Publishers, Ludhiana.
17. Singh S S and Singh R. 2013. Principles and Practices of Agronomy. Kalyani Publisher.
18. Sudheer K P and Indira V. 2016. Post-harvest Technology of Horticultural Crops. New India Publishing Agency, New Delhi.

TEACHING SCHEDULE

THEORY [AGEN-111]

Lecture No.	Topic with Sub-topics	Weightage (%)
AGRONOMY		
1	Introduction and scope of Agronomy	2
2	Classification of crops (with e.g.)	2
3	Effect of different weather parameters on crop growth and development	2
4	Principles of tillage, tilth and its characteristics	2
5	Crop seasons	2
6	Time and methods of sowing of major field crops, Seed rate for important crops	2
7-8	Methods and time of application of manures and fertilizers, Fertigation	3
9-10	Basic principles of Natural farming, Organic farming and Sustainable Agriculture	4
11-12	Soil-Water-Plant relationship, Crop coefficients, Water requirement of crops and Critical stages for irrigation	4
13-14	Weeds and their management in crops	4
15-16	Crop rotation, Cropping systems, Cropping schemes, Relay cropping, Mixed cropping and Intercropping	4
	Sub-Total =	**33**
SOIL SCIENCE		
17	Soil forming processes	2
18	Classification and composition of soil, Soil taxonomy orders	2
19-20	Important soil physical properties and their importance; Soil particle distribution	4
21	Soil inorganic colloids– their composition, properties and origin of charge	2
22	Ion exchange in soil and nutrient availability	2
23-24	Soil organic matter– its composition and decomposition, effect on soil fertility	4
25-26	Soil reaction – acidic, saline and sodic soils	4
27	Quality of irrigation water	2
28	Essential plants nutrients- their functions and deficiency symptoms in plants	4
29-30	Important inorganic fertilizers and their reactions in soils	4
31	Gypsum requirement for reclamation of sodic soils and neutralizing RSC	2
32	Liquid fertilizers and their solubility and compatibility	2
	Sub-Total =	**34**

Continued…

HORTICULTURE		
33-34	Types of horticultural crops (with e.g.)	4
35	Sowing and planting time and methods	4
36	Seed rate and seed treatment for major/ important vegetable crops	3
37-38	Macro- and micro-propagation methods	5
39-40	Types of plant growing structures	4
41-42	Pruning and training	4
43	Water requirements and critical stages	2
44-45	Management of orchard	3
46-48	Major pests and diseases of horticultural crops and their management	4
	Sub-Total =	**33**
	Total =	**100**

PRACTICAL [AGEN-111]

Exercise No.	Exercise Title
AGRONOMY	
1-2	Identification of crops and their varieties, seeds and weeds
3	Study of different fertilizer application methods and weed control methods
4	Judging the maturity time for harvesting of crop
5	Study of seed viability and germination test
SOIL SCIENCE	
6	Identification of rocks and minerals; Examination of soil profile in the field
7	Determination of bulk density, particle density and porosity of soil
8	Determination of organic carbon of soil
9	Identification of nutrient deficiency symptoms of crops in the field
10	Determination of gypsum requirement of sodic soils
HORTICULTURE	
11	Identification and description of important fruits, flowers and vegetables crops
12	Study of different garden tools
13	Preparation of nursery bed; Study of cultural operations for vegetable crops (sowing, fertilizer application, mulching, irrigation and weed control)
14	Practices of pruning and training in some important fruit crops
15	Seed extraction techniques
16	Visit to commercial greenhouse/ polyhouse

Semester	**:**	**I**		
Course No.	**:**	**GAE-111**	**Credit Hrs.**	**: 4 (3+1)**
Course Title	**:**	**Introduction to Agricultural Engineering**		

SYLLABUS

Objectives: To enable the students to have basic idea on different agricultural engineering applications of machinery for different farm operations, post-harvest, technologies on renewable energy, soil and water conservation, irrigation and farm structure and allied areas.

THEORY

FARM MACHINERY AND POWER ENGINEERING:

Importance of Agricultural Mechanization for today's Agriculture; Different sectors of Farm Machinery for employment for Agricultural Engineers; Scope of research and higher studies in Farm Machinery and Power in India and abroad; Farm mechanization needs and strategy, Classification of farm machinery on the basis of unit operations; Principles of selection of machinery for different sizes of land and matching power sources; Different types of equipment for tillage, sowing, planting and transplanting, fertilizer application, weed control, plant protection; Harvesting and threshing equipment for rice, wheat, maize, cotton, sugarcane, fruits, tuber crops and other locally important crops; Functions and capabilities of tractor and power tillers; Introduction to the IC engine systems, fuel and air supply systems, cooling and lubricating systems, and electrical systems in a tractor; Basic parts of a power tiller; Hitching system.

RENEWABLE ENERGY ENGINEERING:

Introduction to Renewable Energy Engineering for today's Agriculture; Different sectors of employment in Renewable Energy Engineering; Scope of research and higher studies in renewable energy Engineering in India and abroad. Types of Solar energy collectors; Application of Solar energy: Solar water heating system and Solar dryer; Solar photovoltaic system: components and applications; Wind energy: Working principle of WECS, Types and components of WECS; Biogas production and types of biogas plants.

SOIL AND WATER CONSERVATION ENGINEERING:

Importance of Soil and Water Conservation Engineering for today's Agriculture; Different sectors of employment in Soil and Water Conservation Engineering; Scope of research and higher studies in Soil and Water Conservation Engineering in India and abroad. Different agronomical measures for control of water erosion, mixed cropping, crop rotation, tillage practices, mulching; Different engineering measures, gully control measures; Use of topographical survey and contour maps; Different types of water harvesting structures.

IRRIGATION AND DRAINAGE ENGINEERING:

Importance of Irrigation and Drainage Engineering for today's Agriculture; Different sectors of employment in Irrigation and Drainage Engineering; Scope of research and higher studies in Irrigation and Drainage Engineering in India and abroad. Introduction to soil-plant-water relationship; Equipment for measurement of irrigation water viz., weirs, notches, orifices and mouth pieces; Introduction to different surface irrigation methods as border, furrow and check basin, sprinkler, drip irrigation and their different components; Underground water conveyance methods in pipes; Introduction to planning of drainage systems; Introduction to centrifugal pumps and different components.

FARM STRUCTURE ENGINEERING:

Importance of Farm Structural Engineering for today's Agriculture, Scope of research and higher studies in Farm Structural Engineering and Environment management in India and abroad. Different types of Agriculture structures, Introduction to planning layout of farmsteads, animal houses, poultry houses; Different types of grain storage structures; Greenhouse and its different parts, Low cost protected structures.

PROCESS AND FOOD ENGINEERING:

Importance of Process and Food Engineering for today's Agriculture; Different sectors of employment in Process and Food Engineering; Scope of research and higher studies Process and Food Engineering in India and abroad. Classification of different types of agricultural commodities as durables, perishables etc.; Moisture content and its importance in grain storage: common reasons of food spoilage, food preservation methods; Different primary operations and their necessity; Methods and equipments used for cleaning, washing, sorting, grading, peeling, size reduction; Different types of traditional and modern storage structures, Storage of perishables commodities; Different types of packaging materials and their suitability for various food products; Basic principles of value addition of food as drying and dehydration, evaporation, thermal processing, refrigerated and frozen storage, Chemical preservation and other novel methods.

PRACTICAL

Study of various implements (tillage, sowing, planting, weeding, fertilizer application); Study of farm implements (pesticide application, harvesting and threshing); Study of various components of tractor and matching implements; Study of various components of power tiller and matching implements. Study of biogas plants and operational parameters, Study of solar energy application systems. Visit to a watershed, Study on various components of sprinkler and drip irrigation. Study on various components centrifugal pump. Visit to a greenhouse with modern irrigation system. Study of various post-harvest operations, study of different food processing equipments, value addition of common crops. Visit to implement manufacturing unit, Visit to mechanized farm, Visit to food processing industry.

TEACHING SCHEDULE

THEORY [GAE-111]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
FARM MACHINERY AND POWER ENGINEERING			
1	Importance of Agricultural Mechanization	Importance of Agricultural Machinery for today's Agriculture; Different sectors of Farm Machinery for employment for Agricultural Engineers; Scope of research and higher studies in Farm Machinery and Power in India and abroad	5
2	Farm Mechanization	Farm mechanization advantages, strategy, Classification of farm machinery on the basis of unit operations; Selection of machinery for different sizes of land and matching power sources	
3	Tillage	Tillage: Types, Tillage machinery, Introduction to M.B. plough, disc plough, subsoiler, harrows, cultivators	5
4	Planting	Seed drill, planters, zero till drill, calibration, rice and vegetable transplanter	
5	Intercultural Equipments	Fertilizer applicators, types of weeders, uses, intercultural equipments	
6	Spraying Equipments	Sprayers: Manual and battery-operated knapsack sprayer, mist blowers, boom sprayer	5
7	Harvesting Equipments	Introduction to harvesting machines for rice, wheat, maize, cotton, sugarcane, fruit crop, tuber crop, sugarcane	
8	Threshing Equipments	Introduction to thresher for rice, wheat, maize; Combine harvester	
9	Engine	Introduction to the IC engine: C.I. and S.I. engines, their working principles, engine components their functions, valve operating mechanism, firing order in multi cylinder engine and trouble shooting	5
10	Engine System	Intake, exhaust system: types of air cleaner, their working, exhaust system Fuel supply system: in tractor, components their functions, carburetor, components, working principle, trouble shooting	

Continued…

11	Tractor systems	Cooling system: types, components and functions. Lubrication system: types, combination of splash and pressure system, components and function trouble shooting. Electrical system of tractor: Battery, electrolyte, charging, discharging system: components and functions	5
12	Tractor and Power tiller	Functions and capabilities of tractor and power tiller, Basic parts of a power tiller; Tractor hitching system	
		Sub-Total =	**25**
RENEWABLE ENERGY ENGINEERING			
13	Introduction to Renewable Energy Sources	Importance of renewable energy for today's agriculture; Different sectors of renewable energy for employment for Agricultural Engineers; Scope of research and higher studies in renewable energy in India and abroad. Definition, Classification, Types, Advantages/limitations and prospectus of renewable energy sources. Comparison between Conventional (Commercial) and Non-conventional energy (Renewable energy) sources.	5
14	Solar Energy Collector	Working principal and function of solar collector. Types and Application of solar collectors; Advantages and disadvantages of different solar collectors over each other.	
15	Application of Solar energy	Generalized classifications of solar energy applications; Solar Water Heating System: Working Principle, types, advantages and uses. Solar Drying System: Working principle, Types, advantages and uses.	
16	Solar Photovoltaics Systems	Definition and Principles of photovoltaic effect, Solar cell and semiconductor junction, Basic photovoltaics system for power generation; Applications, advantages and disadvantages of solar photovoltaic system	3
17	Wind Energy Systems	Basic components of wind energy conversion system, Types of wind energy machines; Applications, advantages and disadvantages of wind energy system	

Continued…

18	Biogas Production and Types	Working, Components, Classification and Types of Biogas plants Comparison of floating gas and fixed dome, Applications of biogas system, Factors affecting biogas generation	2
		Sub-Total =	**10**
SOIL AND WATER CONSERVATION ENGINEERING			
19	Importance of Soil and Water Conservation for today's Agriculture	Principles, Benefits, Problems by erosion, causes of erosion, Different sectors of employment in SWCE, Scope of research and higher studies in SWCE in India and Abroad	4
20	Agronomical Measures for Control of Water Erosion	Mixed cropping, crop rotation, tillage practices, mulching	
21	Different Engineering Measures; Temporary Gully Control Measures	Single row brusho wood dam, Double row brusho wood dam, Loose rock fill dam, log check dam, netting dam	3
22	Permanent Gully Control Structures	Drop inlet spillway, chute spillway and straight drop spillway (functional uses, adaptability, advantages, limitations of all)	3
23	Survey and Maps	Contour lines, Characteristics of contour lines, use of contour maps and topographical maps	2
24	Different Types of Water Harvesting Structures	Roof harvesting, Runoff harvesting (short term and long-term storage), flood water harvesting.	3
		Total =	**15**
IRRIGATION AND DRAINAGE ENGINEERING			
25	Importance and Scope	Importance of Irrigation and Drainage Engineering for today's Agriculture; Different sectors of employment in Irrigation and Drainage Engineering; Scope of research and higher studies in Irrigation and Drainage Engineering in India and abroad.	5
	Introduction to Soil-Plant-Water Relationship	Soil-Plant-Water Relationship: Relevant Terms/Definitions	
	Water Relations of Soil	Kinds of soil water, Movement of water into soils, Infiltration, Evaporation and Transpiration (Definitions only)	
26	Measurement of Irrigation Water	Units of measurement of water, Methods of water measurement, Weir and notches (Rectangular, Cipoletti weir, V-notch weir, Orifices, Parshall flume) Mouthpieces	

Continued…

27	Surface Irrigation Methods	Methods of irrigation- Border irrigation: Basic details only Check basin irrigation: Basic details only Furrow irrigation: Basic details only	5
28	Sprinkler, Drip irrigation and their Different Components	Sprinkler irrigation system: Basics, adaptability, limitations, Types of sprinkler systems: Components of sprinkler system (*List of components and their functions only*) Drip irrigation system: Basics, Advantages of drip system; Components of drip systems (*List of components and their functions only*)	
29	Underground Water Conveyance Methods in Pipes	Basics, Pipes for underground water distribution systems, Discharge capacity of pipelines	5
30	Introduction to Planning of Drainage Systems	Basics of Drainage- Definitions, Water logging- Definition, Causes of water logging, Benefits of Drainage, Drainage coefficient and Subsurface drainage.	
31	Introduction to Centrifugal Pumps and Different Components	Basics, Principle of operation of Centrifugal pumps, Centrifugal pump classification, components of centrifugal pump	
		Total =	**15**
FARM STRUCTURE ENGINEERING			
32	Importance	Importance of Farm Structural Engineering for today's Agriculture, Scope of research and higher studies in Farm Structural Engineering and Environment management in India and abroad	3
	Farmstead Planning	Introduction, location, size and arrangement, Defects in traditional houses, Rooms of improved farm house.	
33	Dairy barn and Poultry housing	Types of Dairy barns, Types of poultry houses with drawings	2.5
34	Grain Storage Structures	Grain storage methods, requirements of good storage structures, indigenous storage structures- Bukhari, Morai and Kothar structure, Grain bins- cylindrical, Rectangular and Pusa bin.	2
35	Protected Structures	Factors affecting plant growth, Greenhouse effect, Orientation of Greenhouse, Classification of Greenhouse based on shape. Greenhouse, Shade-net house and Low cost protected structures with drawings.	2.5
		Total =	**10**

Continued…

AGRICULTURAL PROCESS ENGINEERING			
36	Importance	Importance of Agricultural Processing, Different employment sectors for processing and Food Engineers, Scope of research and higher studies in processing and Food Engineering in India and abroad.	5
37	Agricultural Commodities	Its classification as durables, perishables, etc. Common reasons of spoilage and different preservation methods	
38	Unit Operations	Cleaning, sorting, grading	
39	Grain Processing Equipments	Air screen cleaner, Specific gravity separator, Indented cylinder and Disk separator, Spiral separator	5
40	Unit Operation of Fruit and Vegetable Processing	Methods of sorting, grading, washing, peeling of fruits and vegetables	
41	Size Reduction	Method and Equipment	5
42	Moisture content and its Representation	Wet and dry basis moisture content; Numerical only on conversion of wet and dry basis	
43-44	Drying and Dehydration	Principles of drying, importance and advantages of drying, different methods of drying	5
45	Thermal Processing	Sterilization, pasteurization, blanching and evaporation	5
46	Storage	Storage of perishables, air tight storage	
47	Packaging	Different types of packaging materials	
48	Novel Processing	Different novel processing techniques (in brief)	
		Sub-Total =	**25**
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [GAE 111]

Exercise No.	Exercise Title
FARM MACHINERY AND POWER ENGINEERING	
1	Study of tillage, sowing and planting equipments
2	Study of weeding, fertilizer application, pesticide application equipments
3	Study of harvesting and threshing equipments
4	Study of matching implements of tractor and power tiller
5	Study of various components of tractor and power tiller
6	Study of intake exhaust, lubrication and cooling systems
7	Study of fuel, ignition system and electrical system of tractor
RENEWABLE ENERGY ENGINEERING	
8	Study of various types of biogas plants and operating parameters.
9	Study of various applications of solar energy systems.
SOIL AND WATER CONSERVATION ENGINEERING	
10	Study of various Soil and Water Conservation measures
IRRIGATION AND DRAINAGE ENGINEERING	
11	Study on various components of sprinkler and drip irrigation
12	Study on various components centrifugal pump
PROCESSING AND FOOD ENGINEERING	
13	Determination of moisture content of agricultural produce
14	Value addition of horticultural crops
15	Value addition of food grains
Common for all above Departments*	
16	Visit to implement manufacturing unit, mechanised farm, Visit to watershed, Visit to a greenhouse with modern irrigation system, Visit to a food processing industry.

Suggested Readings [GAE 111]:

FARM MACHINERY AND POWER ENGINEERING

1. Jain S C and Philip G 2009. Farm Machinery: An Approach. Second Ed. Standard Publisher and distributor, New Delhi
2. Michel A.M. and Ojha T.P. 2003. Principles of Agricultural Engineering-I, Jain Brothers, New Delhi
3. Nakra C.P 1980. 1980. Farm Machines and Equipments, Dhanpat Rai Publishing Company Pvt Ltd. New Delhi.

RENEWABLE ENERGY ENGINEERING

1. Rai G.D.2017. Non-Conventional Energy Sources, Khanna Publishers, New Delhi.
2. Rai G.D.2014. Solar Energy Utilization, Khanna Publishers, New Delhi.
3. Rathore N. S., Panwar N.L. & Kurchaniya A. K. 2008. Renewable Energy-Theory and Practices, Himanshu Publications, Udaipur.
4. Kalbande S. R., Bhale V. M. & Sedani S.R. 2022. Renewable Energy Technologies, Narendra Publications, New Delhi.

SOIL AND WATER CONSERVATION ENGINEERING

1. Michael, A.M. and T.P. Ojha 2020. Principles of Agricultural Engineering. Volume II. 5th Edition, Jain Brothers, New Delhi.
2. Suresh, R. 2020. Soil and Water Conservation Engineering. Standard Publ. Distributors, New Delhi.
3. Suresh, R. 2009. Soil and Water Conservation Engineering. Standard Publ. Distributors, New Delhi.

IRRIGATION AND DRAINAGE ENGINEERING

1. Irrigation: Theory and Practice (2nd Edition) by A.M. Michael,Vikas Publishing House, New Delhi.
2. Principles of Agricultural Engineering- Vol.-II (3rd Edition), A.M. Michael and T.P. Ojha published by Jain Brothers, New Delhi.
3. Fluid Mechanics and Hydraulic Machines by R.K. Bansal, Laxmi Publication New Delhi.

FARM STRUCTURE ENGINEERING

1. Principles of Agricultural Engineering, Volume-I by T.P. Ojha and A.M. Michael, Jain Brothers, New Delhi -110 005 (Fourth Edition, 2003).
2. Greenhouse Technology and Applications by Vilas M. Salokhe and Ajay K. Sharma. Agrotech Publishing Academy, Udaipur (Raj.), First Edition (2006).

PROCESS AND FOOD ENGINEERING

1. Chakraverty, A. Post Harvest Technology of Cereals, Pulses and Oilseeds Oxford & IBH Publishing Pvt Ltd 66, Janpath, New Delhi 110001.
2. Sahay K.M .and K.K. Singh, Unit operations of Agricultural Processing-2022 Vikas Publishing house, Pvt. Ltd.576, Masjid Road, Jangpura, New Delhi 110014.
3. Girdharilal, G.S. Siddappa and G.L. Tandon, Preservation of Fruits and Vegetables Indian Council of Agricultural Research, New Delhi.
4. Akash Pare and B L. Mandhyan, Food Process Engineering and Technology Nipa GenX Electronic Resources and Solutions Pvt Ltd, Pritam Pura New Delhi.
5. I.S. Singh, Post-Harvest Handling and Processing of Fruits and Vegetables, Westville Publishing houses, New Delhi.

Semester	**:**	**I**		
Course No.	**:**	**SWCE-111**	**Credit Hrs.**	**: 3(1+2)**
Course Title	**:**	**Surveying and Levelling**		

SYLLABUS

Objectives: To enable the students to conduct the survey work for any area and also to prepare layout of engineering structures.

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, methods, advantages and disadvantages. Levelling, levelling difficulties and error in levelling, contouring, computation of area and volume; Theodolite traversing, introduction to setting of curves; Total station; Introduction to GPS survey, Remote Sensing and GIS use in survey.

PRACTICAL

Linear measurements using different instruments; Reconnaissance survey in the field; Use of field book; Study on various types of chain used in chain survey and its components; Study of errors in chain surveying; Use of ranging rods and ranging in the field; Obstacles during chaining; Offsets in chain survey; Cross Staff; Survey of an area; Preparation of map; Study on various types of compass; Compass survey of an area; Plotting of compass survey; Plane table surveying and different methods; Study on various types of levels and its components; Setting up of dumpy level in the field; Computation of various methods for RL; Study on Levelling, L section and X sections and its plotting; Measurement of slope in the field; Study on contour and its characteristics; 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; Use of minor instruments; Use of total station, Use of modern computers for surveying.

Suggested Readings [SWCE-111]:

1. Kanetkar T.P. and S.V. Kulkarni, Surveying and Levelling, Part 1, 24th edition, reprint, 2017.
2. Remote Sensing and GIS by M. Anji Reddy.
3. Kanetkar T.P. and S.V. Kulkarni Surveying and Levelling, Part 2, 21st edition, reprint 1983.
4. Agor R.A Textbook of Surveying & Levelling. Khanna Publishers, New Delhi.
5. Arora K R. 1990. Surveying (Vol.I), Standard Book House, Delhi.
6. Kanetkar T P. 1993. Surveying and Levelling. Pune Vidyarthi Griha, Prakashan, Pune.
7. Punmia B C. 1987. Surveying (Vol.I). Laxmi Publications, New Delhi.

TEACHING SCHEDULE

THEORY [SWCE-111]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1-4	Surveying	Definitions, Object of Survey, Primary Divisions of Survey, Classification and use of survey	30
		Principle of surveying, Measurement, Units of measurements, Methods of locating points, Precision in surveying, Works of the surveyor.	
		Reconnaissance survey in the field; Principles of Chain Surveying, Triangulation survey, offsets in chain survey, ranging and types of ranging	
		Chaining, Type of chains used in chain survey and its components, Errors in lengths due to incorrect chain, Numerical on chain and tape corrections	
5	Computation of area and volume	Computation of areas, Computation of earth work volume, Prizmoidal formula and Numerical, Planimeter	
6	Instruments for setting right angles	Instruments for setting right angles, Cross staff, Prism square and optical square, Obstacles during chaining, Numerical	
7-8	Compass survey	Types and Methods of Traverse survey, Prismatic Compass, Surveyor Compass, Bearing of line, and computation of angles.	25
		Local attraction and numerical, Magnetic declinations, Dip of needles, Plotting of traverse survey, Errors and limitation of compass survey.	
9-10	Plane Table Surveying	Plane Tabling, Instruments and Accessories. Advantages and Disadvantages, setting and orienting tables,	
		Methods of Plane tabling, Radiation, Intersection, Traversing and Resection, Errors in Plane Tabling	
11-13	Levelling	Terms used in Levelling, Types of levels, Levelling staffs, Focusing, Bench Marks, Adjustment of Level.	25
		Principles of levelling, Reduction of levels, Booking of staff reading, Numerical.	
		Classification of levelling, Differential, Profile, Cross sectioning, effect of curvature and refraction, check levelling, Reciprocal and precise levelling.	
14	Contouring	Contouring, Characteristics of contours Use of contours, Locating the contours, Interpolation of contours.	20
15	Theodolite Traversing	Theodolites, Traversing, Measurement of horizontal and vertical angle, Introduction to setting of curves, Total Survey Stations	
16	GPS, RS & GIS use in survey	Introduction to GPS, Remote Sensing and GIS use in survey	
		Total=	**100**

TEACHING SCHEDULE

PRACTICAL [SWCE-111]

Exercise No.	Exercise Title
1	Reconnaissance survey in the field, introduction to different linear measuring instruments and Use of Field Book
2	Study on various types of chain used in chain survey and its components
3	Study of errors in chain survey
4	Study of direct ranging of survey line and Offsets in chain survey
5	Study of indirect ranging of survey line
6	Study on various obstacles or obstructions in Chaining
7	Chain survey of an area by Triangulation using cross staff
8	Plotting of chain survey and computation of area
9	Study of Prismatic Compass and surveyor compass,
10	Open traverses survey of Road or Stream and Plotting
11	Closed Traverse survey of field / building and Plotting
12	Plane Table survey by Radiation Methods
13	Plane Table survey by Intersection Methods
14	Plane Table survey by Traversing Methods
15	Study of different levels, levelling staff and their adjustment
16	To study booking of staff reading to determine the reduced level
17	To study the simple and differential levelling to determine reduced levels
18	To study the profile levelling and determine reduced levelling
19	To study the plotting of profile levelling and compute cutting and filling
20	To study the contour survey of field
21	Plotting of contours, interpolation of contours and determine the slope of field
22	Study the software for drawing of contours
23	Cross sectioning of gully or nala and plotting
24	L-section of a gully or nala and plotting
25	To study the Theodolite, Measurement of vertical and horizontal angle by Theodolite
26	Determine the height of object with Theodolite
27	Setting of curves with Theodolite
28	Study of Total Survey Station and height of object with Total Survey Station
29	Study of Minor Instruments (Abney level, hand level, Box sextant and Clinometers)
30	Study of Planimeter and measurement of area from map
31	Study of GPS and Measuring area with GPS
32	Study of DEM and preparation of contour map in GIS

Semester	**:**	**I**			
Course No.	**:**	**FMPE-111**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Workshop Technology and Practice**			

SYLLABUS

Objectives: To expose the students to the basic manufacturing processes involved for production of different machine elements and to facilitate hands-on experience of using these machines.

PRACTICAL

Introduction about different shops in the workshop; Safety and precautions to be taken in the workshop; Study of different tools used for fitting and different fitting operations; Study of various measuring instruments used for fitting; Exercise in fitting: sawing, filing and right angle fitting of MS flat; Working with complex fitting jobs: operations of drilling, reaming, and threading and with tap dies; Preparation of a paper weight; Study of various carpentry tools, types of wood and their characteristics and working with carpentry tools; Preparation of simple joints in carpentry: cross half lap joint or T-half joint, Mortise and Tenon joint in carpentry; Preparation of dovetail joint in carpentry; Study of welding, types of welding, oxyacetylene gas welding, types of flames, welding techniques and equipment used for gas welding, working with welding equipment; Working with electric arc welding; Equipment and tools, safety and precautions taken in arc welding; Preparation of Butt joint and lap joint with ARC welding; Preparation of Lap and Butt joints using gas welding; Working on a lathe machine and study of different tools used in lathe machine; Exercise on simple turning, step turning in lathe machine; Preparation of job on taper turning, drilling, knurling and threading in lathe machine; Working with different machines in machine shop such as shaper ,milling machine, etc. and with different tools used in machine shop; Exercise on bending, shaping etc.; Exercise on Drawing, Punching, Riveting; Making different types of sheet metal joints using G.I. sheets; Practice job on shaper; Changing a round MS rod into square section with a shaper; Exercise on a milling machine such as making a slot, gear tooth forming and indexing.

Suggested Readings [FMPE-111]:

1. Chapman W.A.J. 2018. Workshop Technology (Vol. I and II), Arnold Publishers (India) Pvt Ltd. New Delhi.
2. Hajra Choudhari, S. K. Roy N, Hajra Choudhary A.K. 2017. Elements of Workshop Technology (Vol. I and II), Media Promoters and Publishers Pvt Ltd, Mumbai
3. Khurmi R.S and Gupta J.K. 2018 A Textbook of Workshop Technology. S. Chand and Company Ltd., New Delhi.
4. Raghuwanshi B.S. 2016. A Course on Workshop Technology (Vol. I and II), Dhanpat Rai and Sons, New Delhi.

TEACHING SCHEDULE

PRACTICAL [FMPE-111]

Exercise No.	Exercise Title
1	Introduction about different shops in the manufacturing workshop, study of safety tools and safety precautions/measures
2	Exercise in fitting shop: sawing, filing
3	Exercise in fitting shop: right-angle fitting of MS flat
4	Exercise on operations of drilling, reaming
5	Exercise on operations of threading and with tap dies
6	Preparation of a paper weight
7	Preparation of cross half lap joint or T-half joint in carpentry
8	Preparation of Mortise and Tenon joint in carpentry
9	Preparation of dovetail joint in carpentry
10	Preparation of Butt joint with ARC welding
11	Preparation of Lap joint with ARC welding
12	Preparation of Butt joint using gas welding
13	Preparation of Lap joint using gas welding
14	Introduction and demonstration on a lathe machine
15	Exercise on simple turning in lathe machine
16	Exercise on step turning in lathe machine
17	Preparation of job on taper turning in lathe machine
18	Preparation of job on drilling in lathe machine
19	Preparation of job on knurling in lathe machine
20	Preparation of job on threading in lathe machine
21	Introduction and demonstration on shaper machine
22	Introduction and demonstration on milling machine
23	Exercise on Bending
24	Exercise on Shaping
25	Exercise on Drawing
26	Exercise on Punching
27	Exercise on Riveting
28	Making different types of sheet metal joints using G.I. sheets
29	Exercise on changing a round MS rod into square section with a shaper
30	Introduction and demonstration of a slot making with milling machine
31	Introduction and demonstration of a gear tooth forming
32	Introduction and demonstration of indexing mechanisms.

Semester	**:**	**I**			
Course No.	**:**	**REE-111**	**Credit Hrs.**	**:**	**3(2+1)**
Course Title	**:**	**Basic Electrical Gadgets and Instruments**			

SYLLABUS

Objectives:

(i) To enable the students to take up repair and maintenance of different common electrical gadgets.

(ii) To acquire the basic knowledge of instruments used for scientific measurements.

THEORY

Introduction to different electrical appliances used in agricultural buildings, structures and farm operations; Difference between AC and DC supply system; Introduction to AC fundamentals; AC through series RL, RC, and RLC circuits, parallel AC circuit, series and parallel resonance; Q-factor and bandwidth. Three-phase AC circuit: Concept of balanced three-phase AC circuits, line and phase quantity in star and delta network, power in three-phase circuit, various methods of three phase power measurement like (one wattmeter and two-wattmeter method). Diode and its applications: Rectifier, Clipper, Clamper, voltage multiplier and capacitive filter zener diode as voltage regulator. Transistor and its applications: Bipolar junction transistor, operating point. Various biasing methods, fixed, self-biasing and potential divider biasing method; OP-AMP, Ideal OP-AMP characteristics, Linear and non-linear applications of OP-AMP (adder, subtractor, integrator, active rectifier, comparator). Introduction to digital electronics and logic gates: Basic theorem of Boolean algebra, Combinational logic circuits (basic gates, SOP rule and K-map), binary adder. Principles of general instruments, measurement of displacement, temperature, velocity, force and pressure using different instruments like, strain gauges, load cell, thermistors, thermocouples, pyrometer, linear variable differential transformer (LVDT), capacitive transducers, RTD, instruments for measurement of speed, wind velocity, solar radiation, anemometer, multimeter etc.

PRACTICAL

BASIC ELECTRICAL AND ELECTRONICS GADGETS

To prepare an electrical switch board to control two light points, one plug point, one fan point and fuse (House wiring); To prepare an electrical switch board to control two light points using two two-way switch (staircase wiring); To connect and test a fluorescent lamp; To find faults and repair home appliances such as heater, electric iron, fans and mixer-grinder, etc.; To find faults and repair UPS; To measure the power requirement and power factor in a AC single phase series RLC circuit; To measure energy of a single phase AC circuit with the help of ammeter, voltmeter and power factor meter and energy meter; To measure the power consumption in a three-phase circuit using two-wattmeter method.

INSTRUMENTATION

To prepare a DC power supply unit using diode and filter circuit; To study the Zener diode as voltage regulator circuit; To study transistor characteristics in CE configurations; To verify different logic gates; To measure unknown resistance using Wheatstone bridge; To measure the displacement and to determine the characteristics of LVDT; To measure the displacement using LVDT and potentiometer; To measure the pressure using strain gauge and Bourden tube; To measure the temperature using RTD, thermistors and thermocouple and study their characteristics; To measure the speed, wind velocity, solar radiation etc., using different measuring tools like tachometer, anemometer, pyranometer, multimeter, etc.; To acquaint with different other types of instruments used in agriculture and food processing application

TEACHING SCHEDULE

THEORY [REE-111]

Lecture No.	Topic	Sub-topics/Key Points	Weightage (%)
1	Introduction to different Electrical Appliances used in Agricultural Buildings Structures and Farm Operations. Difference between AC and DC Supply systems.	Brief Introduction of electrical appliances used in: Electrified Dairy Farm, Electrified Fruit and Vegetable Farm, Electrified Livestock Farm, Electrified Poultry Farm, Electrified General Farm, Electrified Farm Shop, Definitions and Concepts of Time period, Frequency, Magnitude, Waveform to differentiate A.C. and D.C.	5
2-4	Introduction to AC Fundamentals	Generation of Alternating Voltages and Current Equation of Alternating Voltages and Current Cycle, Time Period, Frequency, Amplitude Different Forms of E.M.F equation Phase and Phase Difference, Root Mean-Square (R.M.S) Value and its Analytical Derivation Average Value and its Analytical Derivation Form, Crest or Peak or Amplitude Factor A.C Through Pure Ohmic Resistance, Pure Inductance and Pure Capacitance Alone.	10
5-6	AC through series RL, RC and RLC Circuits	A.C. Through Resistance and Inductance. Definition and Concept of Power Factor, Active Power, Reactive Power and Apparent Power. A.C. through Resistance and Capacitance A.C. through Resistance Inductance and Capacitance. Examples on A.C. through Resistance and Inductance.	
7	Parallel AC Circuit	Solving Parallel Circuit by Vector or Phasor Method	5
	Series and Parallel Resonance	Resonance in R-L-C series Circuit and in Parallel Circuit.	
	Q-factor and Bandwidth	Brief concept Q factor and Bandwidth	

Continued…

8-10	Three-phase AC Circuit	Concept of balanced three-phase AC circuits Generation of Poly phase Voltage. Phase sequence. Interconnection of Three Phases,	10
	Line and Phase Quantity in Star and Delta Network	Star or Wye Connection, Voltages and Currents in Star or Wye Connection, Delta or Mesh Connections; Voltages and Currents in delta or Mesh Connection	
11	Power in Three-phase Circuit	Power Measurement in 3-Phase Circuits, Three wattmeter Method, Two wattmeter Method (Balanced or Unbalanced Load), One Wattmeter Method.	5
12-16	Diode and its Applications	Principal, Types and Uses of Rectifier and Capacitive filter. Principal, Types and Uses of Clipper, Clamper, Voltage multiplier and Zener diode as Voltage regulator	5 5
17-19	Transistor and its Applications	Working principle of : Bi-polar junction Transistor with CE, CB, CC Operating point; Various biasing methods (viz., fixed, self and potential divider biasing methods).	10
20-22	Operational Amplifier (OP-AMP) and its Application	Basic concept of OP-AMP and its Ideal Characteristics; Linear and Non-linear applications of OP-AMP (adder, subtractor, integrator, active rectifier, comparator)	10
23-25	Introduction to Digital Electronics	Concept and Working of Logic gates. Basic theorem of Boolean Algebra. Combinational Logic circuits (Basic gates, Introduction to K-Map binary adder and SOP rule)	10
26-32	Measuring Instrumentation (Transducer and Sensors)	Principles of General instrumentation system with Block diagram; Electrical measurement of: Displacement [like, Linear variable differential transformer (LVDT), Capacitive transducers, Strain gauge]	10
		Temperature (Thermistors, Thermocouples, RTD, Pyrometer); Force (Strain gauge, Pressuductor load cell)	5
		Pressure (Strain gauges, Load cell, Capacitive, Potentiometric); Speed (Resonance tachometer, Eddy current Tachometer)	5
		Wind velocity (Anemometer); Solar radiation (Pyranometer).	5
		Total	**100**

TEACHING SCHEDULE

PRACTICAL [REE-111]

Exercise No.	Exercise Title
1	To prepare an electrical switch board to control two light points, one plug point, one fan point and fuse (House wiring).
2	To prepare an electrical switch board to control two light points using two two-way switch (Staircase wiring).
3	To connect and test a fluorescent lamp.
4	To find faults and repair home appliances such as heater, electric iron, fans and mixer-grinder and UPS etc.
5	To measure the power requirement and power factor in an AC single phase series RLC circuit.
6	To measure energy of a single-phase AC circuit with the help of ammeter, voltmeter and power factor meter and energy meter.
7	To measure the power consumption in a three-phase circuit using two-wattmeter method.
8	To prepare a DC power supply unit using diode and filter circuit.
9	To study the Zener diode as voltage regulator.
10	To study transistor characteristics in CE configurations.
11	To verify different logic gates.
12	To measure unknown resistance using Wheatstone bridge.
13	To measure the displacement and to determine the characteristics of LVDT and Potentiometer.
14	To measure the pressure using strain gauge and Bourden tube.
15	To measure the temperature using RTD, thermistors and thermocouple and study their characteristics.
16	To measure the speed, wind velocity, solar radiation etc., using different measuring tools like tachometer, anemometer, pyranometer, multimeter etc.

Suggested Readings [REE-111]:

1. Boylestad R L and Nashelsky L N. 2011. Electronic Device and Circuit Theory. Pearson.
2. Ghosh S. 2007. Fundamentals of Electrical & Electronics Engineering, 2nd Ed PHI Learning, New Delhi.
3. Metha V K and Metha R. 2012. Basic Electrical Engineering, Fifth edition. S Chand & Co., New Delhi.
4. Metha V K and Metha R. 2012. Principle of Electronics, Fifth edition. S Chand & Co., New Delhi.
5. Rajput R K. 2007. Basic Electrical and Electronics Engineering. Laxmi Publications, New Delhi.
6. Theraja B L and Theraja A K. 2005. A Text Book of Electrical Technology Vol. I. and II, S Chand & Co., New Delhi.
7. Robert H. Brown, Farm Electrification. Allied Pacific Private Limited Bombay, Indian Edition.
8. Singh S K, Industrial Instrumentation and control, third edition, published by Tata McGraw-Hill Companies.

Semester	**:**	**I**		
Course No.	**:**	**COMP-111**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Agricultural Informatics and Artificial Intelligence**		

SYLLABUS

Objectives:

(i) To acquaint students with the basics of computer applications in Agriculture, multimedia, database management, application of mobile apps and decision-making processes etc.,

(ii) To provide basic knowledge of computer with applications in Agriculture,

(iii) To make the students familiar with Agricultural-Informatics, its components and applications in Agriculture and Artificial Intelligence.

THEORY

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components. Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/C++, etc. concepts and standard input/output operations. e-Agriculture, Concepts, design and development; Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, input-output files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc. Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in Agriculture. Agriculture Expert System, Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India. Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A*algorithm, IoT and Big Data; Use of AI in Agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of Smart Agriculture, Use of AI in food and nutrition science etc.

PRACTICAL

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-WORD and MS PowerPoint for creating, editing and presenting a scientific document, MS- EXCEL - Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

TEACHING SCHEDULE

THEORY [COMP-111]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1-3	**Introduction to Computers, Anatomy of Computers** **Memory Concepts:** **Operating System:**	Definitions Characteristics of Computer Components of Computer CPU: CU, ALU, MU Input Devices; Output Devices; Units of Memory: bit to TB, Types: Primary, Secondary Definitions and Types: Single user, Multiuser and features. OS Special Types (Brief Overview): Batch, Real-Time, Time Sharing, Distributed, Network OS. Functions of operating system	7
4-6	**Applications of MS-Office**	MS Word: Creating a New Document formatting option features Insertion of Table MS Excel: creating work sheet and graph, Functions for Data Analysis: AVERAGE, COUNT, SUM, MIN, MAX, MEDIAN, MODE, STDEV, STDEVP, VAR, VARP, CORREL, PERCENTILE Mathematical functions in excel: SUM, AVERAGE, AVERAGEIF, COUNT, COUNTIF, MOD, ROUND	7
7-9	**Database and DBMS**	Database, concepts and types, creating database, Uses of DBMS in Agriculture. Database concepts Database- Definition: Characteristics of Database Structure of Database Management System Tables: Concept of view, Primary key, Foreign key Creating database: SQL query: Create, Insert, Select, Delete, Update. Form: Steps for Creating Forms, Entering Data in forms Report using MS-ACCESS: Steps for Creating Reports, Printing reports.	7

Continued…

10	**Internet and World Wide Web (www)**	Concepts and components Internet: Introduction Definition of LAN, WAN, MAN and Internet Internet Service Provider (ISP) World Wide Web; Hypertext Web Browser Web Page and Websites E-Mail: Creating Email, Email Addresses, Using Email, Sending the message, CC and BCC; Search Engine	7
11-12	**Computer Programming**	General concepts, Introduction to Visual basic, java, FORTRAN, C, C++ etc.: concepts and standard input/output operations. C 'language - character set, data type, concepts and standard input/output – scanf( ), printf( ) operations Assignment - any five C simple language program	7
13-14	**e-Agriculture**	Concepts, Importance of IT in e-Agril., AGRINET: Introduction, Objectives. Advantages and Challenges in Agriculture.	7
15-16	**Crop Simulation Models**	Crop Simulation Models Definition, Concept: Requirement of Good Modeling. Input-output files, limitation, advantages Types: Statistical Models, weather analysis Dynamic Models, Mechanistic Models, Functional Models and Crop Modeling. Classifications of Models based on their Applications: Primary Model, Comprehensive Model, Summary of Model, Characteristics of Models, Uses of Models	7
17-19	**IOT and IT Applications in Agriculture**	IoT Definition, Challenges and Benefits of IOT in Agriculture Use of IoT Applications in Agriculture: Precision Farming, Agricultural Drones, Smart Greenhouses. IT Applications in Agriculture for Computation of Water and Nutrient Requirement of Crop. Role of IT Application in water and nutrient requirement. Brief introduction of: Computation of water and nutrient requirement using weather parameters. Advantages	7

Continued…

COMP-111…

20-21	**Computer-controlled Devices (Automated systems), Smartphone Apps and GPS**	Computer-controlled devices (automated systems) for Agri-input management- Examples of Automation Devices: Robotics Application in Planting, Drones for Irrigation, Harvest Automation Tools, Automated Tractors etc. AWS - Automatic Weather Station. AIS - Automatic Irrigation System. Smartphone Mobile Apps in Agriculture: Introduction- Irrigation Systems, Fertilizer Application, Pest and Disease Management Seeding and Planting, Harvesting Systems Weather Forecasting, Soil Testing and Analysis, Crop Management, Market Prices Farm Management, Financial and Insurance Services; Introduction and Uses to Geospatial Technology.	7
22-23	**Decision Support System (DSS)**	Decision support systems (DSS) Introduction, Concepts, Components, Types and Applications in Agriculture.	7
24-25	**Agriculture Expert System (AES)**	Introduction, Concepts, Components and Applications in Agriculture.	7
26-27	**Contingent / Crop Planning Calendars using IT Tools**	Introduction, Definition, Benefits, Steps to Prepare Contingent Crop Planning using IT Tools.	7
28-30	**Introduction and Uses to Artificial Intelligence and Overview**	Introduction and its uses to Artificial Intelligence and Overview and Examples of AI in Agriculture - Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; (Autonomous crop management and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce and other food processing applications).	8
31-32	**Digital India and Schemes to promote Digitalization of Agriculture in India**	Digital India and Schemes to promote Digitalization of Agriculture in India: Digital Agriculture in India: Status, Challenge, Digital India and Initiatives in Agriculture Sector. Digital Agriculture or NeGP-A 2.0	8
		Total	**100**

TEACHING SCHEDULE

PRACTICAL [COMP-111]

Exercise No.	Exercise Title
1-2	Study of computer components, accessories, practice of important DOS command Introduction to different Operating systems such as Windows, Unix/ Linux Creating files and folders, Files Management.
3-4	Use of MS-WORD, creating files and folders, files management and MS-POWERPOINT Presentation for creating, editing and presenting scientific documents. MS-EXCEL- Mathematical calculations, Preparation of Spread sheets. Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data Handling Macros, MS-EXCEL chart-Line, XY, Bar and Pie
5-6	MS-ACCESS- Creating Database, Preparing queries and reports.
7-8	Program in C-Language: a) Program to enter name and print name. b) Program to calculate sum and subtraction of numbers. c) Program to calculate Area of Circle. d) Program to calculate Area of Triangle e) Program to calculate Area of Rectangle.
9	Introduction to Internet, World Wide Web (WWW).
10-11	Hands-on Practice on Crop Simulation Model (CSM)(:- CROPWAT 8.0.
12-13	Use of Smartphone Apps (Developed by SAU).
14-15	Hands-on Practice on Decision Support System (DSS).
16	Introduction to India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings [COMP-111]:

1. Fundamentals of Computer by V. Rajaraman.
2. Introduction to Information Technology by Pearson.
3. Introduction to Database Management System by C. J. Date.
4. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India.
5. Introductory A g r i Informatics by Mahapatra, Subrat K et al, Jain Brothers Publication.
6. Russell, Stuart, Artificial Intelligence: A Modern Approach, Pearson Edition 2013.
7. Nilson N.J. 2001. Principles of Artificial Intelligence. Narosa.
8. Agricultural Informatics and Artificial Intelligence for B Tech (Agricultural Technology) by Prashant Publication.

Online resources: ***(COMP-111)***

- https://en.wikipedia.org/wiki/Computer
- https://www.javatpoint.com/computer
- https://iasri.icar.gov.in/
- https://www.nrsc.gov.in/EO_Agr_Objective?language_content_entity=en
- https://www.agrimoon.com
- https://www.agriinfo.in
- https://eagri.org
- https://www.agriglance.com
- https://agritech.tnau.ac.in
- https://loksabhadocs.nic.in/Refinput/New_Reference_Notes/English/Agriculture_and_Digital_India.pdf
- https://www.investindia.gov.in/team-india-blogs/digitalisation-agriculture-india
- http://courseware.cutm.ac.in/wp-content/uploads/2020/06/Session-11-Preparation-of-Contingent-Crop-Planning-and-Crop-Calendars-Using-IT-Tools.pdf
- https://optimizeias.com/indias-digital-ecosystem-for-agriculture/
- https://www.igi-global.com/chapter/introduction-to-agricultural-information-systems/266572#:~:text=Agricultural%20Information%20Systems%3A%20Information%20system,knowledge%20utilization%20by%20agricultural%20producers.
- https://cropcalendar.apps.fao.org/#/home
- http://www.irdindia.in/journal_ijrdmr/pdf/vol4_iss1/7.pdf
- https://learn.microsoft.com/en-us/office365/servicedescriptions/office-applications-service-description/office-applications
- https://ebooks.inflibnet.ac.in/hsp16/chapter/application-of-software-in-statisticalanalysis-i-microsoft-excel/
- http://eagri.org/eagri50/STAM102/index.html
- https://edu.gcfglobal.org/en/internetbasics/using-a-web-browser/1/
- https://www.javatpoint.com/what-is-world-wide-web
- https://www.mdpi.com/journal/agriculture/special_issues/Decision_Support_Systems_Application
- https://apps.gov.in/ministry/ministry-agriculture
- http://courseware.cutm.ac.in/wp-content/uploads/2020/06/Session-11-Preparation-of-Contingent-Crop-Planning-and-Crop-Calendars-Using-IT-Tools.pdf
- https://apps.mgov.gov.in/apps_by_category;jsessionid=8206D0DAE69F48FB50962462A8922C23?name=Agriculture

Tools available for Student for Academic Purpose only: (COMP-111)

1. DSSAT (Decision Support System for Agrotechnology Transfer)
   - Purpose: A comprehensive crop modeling tool.
   - Use: Simulates plant growth, development, and yield for various crops under different management and environmental conditions.
   - Download: https://dssat.net/
2. APSIM (Agricultural Production Systems Simulator)
   - Purpose: A powerful plant simulation tool.
   - Use: Models the effects of environmental variables like soil, climate, and management strategies on plant growth and crop yield.
   - Download: https://www.apsim.info/
3. Open Sim Root
   - Purpose: A root growth modeling software.
   - Use: Helps understand plant root growth processes, interactions with soil, and how they respond to environmental conditions.
   - Download: Available as open-source software via research platforms like Git Hub. https://gitlab.com/rootmodels/OpenSimRoot
4. Virtual Plant
   - Purpose: A tool for visualizing and modeling plant metabolic and regulatory networks.
   - Use: Helps in understanding complex plant processes such as gene regulation, metabolic pathways, and how they respond to environmental conditions.
     Download: https://sourceforge.net/projects/virtualplant/
5. R Studio (with Bioconductor and Plant Modeling Libraries)
   - Purpose: A programming environment for statistical computing.
   - Use: Using plant modeling libraries like plant and photosynthesis, researchers can model plant growth, carbon assimilation, and nutrient cycling.
   - Download: https://posit.co/downloads/
6. WOFOST (World Food Studies)
   - Purpose: A plant process and crop growth simulation model developed by the FAO.
   - Use: Helps in understanding crop development, photosynthesis, and biomass accumulation under different environmental and management conditions.
   - Download: https://www.wur.nl/en/research-results/research-institutes/environmental-research/facilities-tools/software-models-and-databases/wofost/downloads-wofost.htm
7. Green Lab
   - Purpose: A plant growth model focused on plant architecture and functional growth processes.
   - Use: Simulates plant organ development and growth processes, integrating functional and structural aspects of plant behavior.
   - Download: https://greenlab.cirad.fr/GLUVED/html/P3_Tools/Tool_simul_003.html

Course Curriculum of Second Semester as per the ICAR - Sixth Deans' Committee Report for the Academic Programmes in

AGRICULTURAL ENGINEERING

- UG-Certificate in Agricultural Engineering
- UG-Diploma in Agricultural Engineering
- UG-Degree: B.Tech. (Agricultural Engineering)

Mahatma Phule Krishi Vidyapeeth, Rahuri

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli

Maharashtra Agricultural Universities Examination Board, Pune

Compiled & Submitted by

Dr. P.U. Shahare

Associate Dean, College of Agril. Engineering & Technology, Dr.BSKKV, Dapoli.

UG Degree Syllabus State Coordinator

with

UG Degree Syllabus Discipline Coordinators &

DICC - UG Degree Syllabus Core Committee

Submitted to the

Directors of Instruction Coordination Committee

~ w.e.f. AY, 2024-25 ~

Course Curriculum of Second Semester as per the ICAR-Sixth Deans' Committee Report for Academic Programmes in AGRICULTURAL ENGINEERING

Course Layout

B.Tech. (Agricultural Engineering)

Semester: II (New) ***w.e.f.*** **Academic Year: 2024-25**

Sr. No.	Course No.	Course Title	Credit Hrs.	Remark (if any)
1.	**AEC-122***	Communication Skills	2(1+1)	--
2.	**AEC-123**	National Service Scheme-II (NSS-II)/ National Cadet Corps-II (NCC-II)	1(0+1)	--
3.	**MDC-121***	Farming-based Livelihood Systems	3(2+1)	--
4.	**VAC-121**	Environmental Studies and Disaster Management	3(2+1)	--
5.	**FMPE-122**	Engineering Drawing	2(0+2)	--
6.	**COMP-122**	Computer Programming and Data Structures	2(0+2)	--
7.	**SEC-121**	Skill Enhancement Course-I[#] (*To be offered from the list of SEC Courses*)	4(0+4)	--
8.	**SEC-122**	Skill Enhancement Course-II[#] (*To be offered from the list of SEC Courses*)	4(0+4)	--
		Total Credits Hrs.	**21(5+16)**	**G**
AEC: Ability Enhancement Course, **MDC**: Multidisciplinary Course, **SEC**: Skill Enhancement Course, **VAC**: Value Added Course, **G**: Gradial				
Post-II Semester (Only for Exit option for award of UG-Certificate)				
9.	**INT-121**	Internship (10 Weeks)	10(0+10)	--

* During **AY 2024-25**, **AEC-112** & **MDC-111** are being offered in II-semester as **AEC-122** & **MDC-121**, respectively. However, this layout is subject to change and will be regularized **w.e.f. AY 2025-26**, wherein said courses (**AEC-112** & **MDC-111**) will be offered in I-semester by shifting any 2 courses from I-semester to II-semester.

Semester	**:**	**I / II ***			
Course No.	**:**	**AEC-122**	**Credit Hrs.**	**:**	**2(1+1)**
Course Title	**:**	**Communication Skills**			
		To be offered as* AEC-112 *w.e.f.* *Academic year, 2025-26* *onwards			

SYLLABUS

Objectives : (i) To acquire competence in oral, written and non-verbal communication,
(ii) To develop strong personal and professional communication and
(iii) To demonstrate positive group communication.

THEORY

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and Non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication. Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/Abstracting/Summarizing; Style of technical communication, Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions; Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; Phrases and clauses; Case: subjective case, possessive case, objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

PRACTICAL

Listening and note taking; Writing skills: précis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; Vocabulary building exercises; Interview techniques; Organization of events.

TEACHING SCHEDULE

THEORY [AEC-122]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	**Communication Process: The Magic of Effective Communication**	Elements of Communication process such as, Communicator, Message, Channel treatment of message, Audience and Audience response.	5
2	**Building Self-esteem and Overcoming Fears**	Points to build Self-esteem, Build social connections, Encourage yourself, Focus on solutions and Set realistic goals, Strategies to overcome fears, Practice, Visualise Success, Preparation, Know your audience, Seek feedback and Active listening.	5
3	**Communication**	Concept, Nature and Significance of Communication process	10
4		Meaning, Types and Models of communication	10
5		Verbal and Non-verbal communication, Linguistic and Non-linguistic communication	10
6		Barriers to communication and Reasons behind communication gap/ miscommunication	5
7	**Basic Communication Skills**	Listening, Speaking, Reading, Writing skills	5
8		Précis writing/ Abstracting/ Summarizing- Styles of technical communication, Curriculum Vitae/Resume writing	10
9		Innovative methods to enhance vocabulary, Analogy questions	5
10	**Structural and Functional Grammar**	Sentence structure, Modifiers, Connecting words and verbal; Phrases and Clauses	5
11		Case: Subjective case, Possessive case, Objective case	5
12		Correct usage of nouns, Pronouns and Antecedents	5
13		Adjectives, Adverbs and Articles	5
14		Agreement of verbs with the subject: Tense, Mood, Voice	5
15		Writing effective sentences	5
16		Basic sentence faults	5
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [AEC-122]

Exercise No.	Exercise Topic/ Title
1	Listening and Note taking
2	Writing skills - Précis writing
3	Writing skills - Abstracting
4	Writing skills - Summarizing
5	Reading and Comprehension (written and oral) of general and technical articles
6	Micro-presentations
7	Impromptu presentations
8	Feedback on presentations
9	Stage manners - Grooming
10	Stage manners - Body language
11	Stage manners - Voice modulations and speed
12	Group discussions
13	Public speaking exercise
14	Vocabulary building exercises
15	Interview techniques
16	Organisation of events

Suggested Readings (AEC-122):

1. Allport, G W, 1937. Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele & Gyles Brandreth, 1994, How to Interview and be Interviewed. Sheldon Press, London.
3. Carnegie Dale, 1997. The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter S J, 2012. Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
5. Kumar S and Pushpa Lata, 2011. Communication Skills. Oxford University Press.
6. Neuliep James W, 2003. Intercultural Communication- A Contextual Approach. Houghton Mifflin Co Boston.
7. Pease, Allan, 1998, Body Language. Sudha Publications, Delhi.
8. Raman M and Singh P, 2000. Business Communication. Oxford University Press.
9. Ray G L, 2008. Extension, Communication and Management. Kalyani Publishers, Ludhiana
10. Ray G. Land Mondal Sagar, 2012. Textbook on Rural Development Entrepreneurship and Communication Skills. Kalyani Publishers, Ludhiana.
11. Seely J, 2013, Oxford Guide to Effective Writing and Speaking. Oxford University Press.
12. Thomson A J and Martinet A V, 1977, A Practical English Grammar. Oxford University.

Semester : II		
Course No. : AEC-123	**Credit Hrs. : 1 (0+1)**	
Course Title : National Service Scheme-II (NSS-II)/ National Cadet Corps-II (NCC-II)		
Gradial Common Course across all UG Degrees		

Course No.: AEC-123	**Course Title: National Service Scheme-II (NSS-II)**	**Credit Hrs.: 1(0+1)**

SYLLABUS

Objectives :

(i) To evoke social consciousness among students through various activities viz., working together, constructive and creative social work,

(ii) To be skillful in executing democratic leadership, developing skill in program,

(iii) To be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

PRACTICAL

Importance and role of youth leadership. Meaning, types and traits of leadership, qualities of good leaders; Importance and roles of youth leadership, Life competencies. Definition and importance of life competencies, Problem-solving and Decision-making, Interpersonal communication. Youth development programs Development of youth programs and policy at the national level, state level and voluntary sector; Youth-focused and youth-led organizations Health, hygiene and sanitation. Definition Needs and Scope of health education; Role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; National health programs and reproductive health. Youth health, lifestyle, HIV-AIDS and first aid. Healthy lifestyles, HIV-AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths and misconceptions about yoga; Yoga traditions and its impacts, Yoga as a tool for healthy lifestyle, preventive and curative method.

TEACHING SCHEDULE

PRACTICAL [AEC-123/ NSS-II]

Exercise No.	Title	Sub-topics
1	**Orientation on NSS**	Introduction to NSS, its Objectives, History and Role in community service.
2	**Youth Leadership**	Discuss the importance and role of youth leadership, types and traits of leadership and qualities of good leaders.
3	**Life Competencies**	Understanding life competencies, their importance and Practical exercises in problem-solving and decision-making.
4	**Interpersonal Communication**	Practice exercises to improve interpersonal communication skills, Focusing on active listening and effective communication.
5	**Youth Development Programs**	Overview of youth development programs, Policies at national and state levels and Understanding youth-led organizations.
6	**Health, Hygiene, and Sanitation**	Practical activities on the importance of hygiene and sanitation, including Swachh Bharat Abhiyan tasks.
7	**Nutrition and Health Education**	Discuss the role of food, nutrition, and safe drinking water in health; Explore the impact of waterborne diseases.
8	**National Health Programs**	Introduction to key national health programs and their roles in promoting public health and awareness on reproductive health.
9	**Youth Health and Lifestyle**	Sessions on healthy lifestyle choices including exercise, balanced diet and stress management.
10	**HIV/AIDS Awareness**	Educational activities on HIV/AIDS, its prevention, and reducing stigma; Awareness on reproductive health.
11	**Substance Abuse Awareness**	Discussing the dangers of drug and substance abuse, its impact on health and practical ways to prevent addiction.
12	**First Aid and Home Nursing**	Hands-on training in first aid techniques including handling injuries, CPR basics and home nursing care.
13	**Introduction to Yoga**	Introduction to the History, Philosophy and various Traditions of Yoga as a Holistic health practice.
14	**Yoga Practice**	Practical Yoga Sessions focusing on Asanas, Pranayama and Meditation for a healthy lifestyle.
15	**Yoga as Preventive and Curative Tool**	Understanding and Practicing Yoga as a preventive and curative approach for physical and mental health.
16	**Reflection on NSS and Youth Development**	Group Discussion and Reflection on the role of NSS in community building and personal growth, Focusing on youth leadership.

Course No.: AEC-123	Course Title: National Cadet Corps-II (NCC-II)	Credit Hrs.: 1(0+1)

SYLLABUS

Objectives : (i) To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen,

(ii) To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

PRACTICAL

Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill. Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding. Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG. Introduction to map, scales, and conventional signs. Topographical forms and technical terms. The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs. Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

TEACHING SCHEDULE

PRACTICAL (AEC-123/ NCC-II)

Exercise No.	Exercise Title	Sub-topics
1	**Basic Arms Drill**	Attention, stand at ease, stand easy, getting on parade, dismissing and falling out.
2	**Advanced Arms Drill**	Ground/take up arms, examine arms, shoulder from the order and vice versa.
3	**Saluting with Arms**	Saluting at the shoulder both at a halt and while on the march.
4	**Rifle Handling Techniques**	Short/long trail from the order and vice versa, guard mounting and guard of honor procedures.
5	**Platoon and Company Drill**	Practice and demonstration of platoon and company drill formations.
6	**Rifle Characteristics and Handling**	Characteristics of rifles (.22/.303/SLR), ammunition, firepower, and basic care, cleaning, and sight setting.
7	**Rifle Operations and Safety**	Loading, cocking, unloading, safety procedures; lying position, trigger control, and firing a shot.
8	**Range Procedures and Target Practice**	Range procedures, aiming, sight alteration, theory of groups, snap shooting, and firing at moving targets.
9	**Map Reading Basics**	Introduction to maps, scales, conventional signs, topographical forms, and the grid system.
10	**Advanced Map Skills**	Relief, contours, gradients, cardinal points, bearings, and use of the service protractor.
11	**Field Navigation with Compass**	Use of prismatic compass, setting a map, finding north, positioning, map-to-ground, and ground-to-map.
12	**Field Engineering Skills**	Knots and lashings, camouflage, handling explosives, IEDs, field defenses, obstacles, and mines.
13	**Watermanship and Field Water Supplies**	Bridging techniques, field water supplies, track construction, and distance judgment.
14	**Target Recognition and Indication**	Identifying and describing targets, observing, concealment, field signals, and indication of landmarks.
15	**Section Battle Drills and Movement**	Section formations, fire control orders, fire and movement, movement with/without arms, section battle drill.
16	**Communication Skills and Modern Trends**	Types of communication, media and latest trends in NCC communication.

Semester	**:**	**I / II ***		
Course No.	**:**	**MDC-121**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Farming-based Livelihood Systems**		
To be offered as* MDC-111 *w.e.f.* Academic year, 2025-26 *onwards				

SYLLABUS

Objectives : (i) To make the students aware about farming-based livelihood systems in Agriculture,

(ii) To disseminate the knowledge and skills that how farming-based systems can be a source of livelihood.

THEORY

Status of Agriculture in India and different States, Income of farmers and rural people in India, Livelihood- Definition, Concept and Livelihood patterns in urban and rural areas, Different indicators to study livelihood systems. Agricultural Livelihood Systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming-based livelihood systems, Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems: Crops and cropping systems, Livestock, (Dairy, Piggery, Goatry, Poultry, Duckry etc.), Horticultural crops, Agroforestry systems, Aquaculture, Duck/Poultry-cum-Fish, Dairy-cum-Fish, Piggery-cum-Fish etc.; Small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country; Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Governments; Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing lifestyle.

PRACTICAL

Survey of farming systems and agriculture-based livelihood enterprises, Study of components of important farming-based livelihood models/systems in different agro-climatic zones, Study of production and profitability of crop based, livestock based, processing-based and integrated farming-based livelihood models, Field Visit of innovative farming system models. Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Learning about concept of project formulation on farming-based livelihood systems along with cost and profit analysis, Case study of Start-Ups in agri-sectors.

TEACHING SCHEDULE

THEORY [MDC-121]

Lecture No.	Topic	Sub-topics/Key Points	Weightage (%)
1	Status of Agriculture in India	Historical background, Current status, Role of Agriculture in Indian Economy	4
2	Status of Agriculture in Different States	State-wise scenario, Major crops, Regional diversity	4
3	Income of Farmers and Rural People in India	Factors affecting income, Rural-urban income gap, Government initiatives	4
4	Livelihood: Definition, Concept, and livelihood Patterns in urban and rural areas	Livelihood-Definition and its Concept, Urban vs Rural livelihood patterns, Sources of income	4
5	Different Indicators to Study Livelihood Systems	Economic, Social and Environmental indicators, Measuring livelihood resilience	4
6	Agricultural Livelihood Systems (ALS): Meaning and Approaches	Definition, Significance of ALS, Integrated farming systems, Approaches	4
7	ALS Framework and Case studies	Framework for ALS, Case studies in India	4
8	Definition of Farming Systems and farming based Livelihood Systems	Definition and Role of farming systems in rural livelihoods, Examples of systems	4
9	Prevalent Farming Systems in India contributing to livelihood	Traditional vs. Modern farming systems, Regional differences	4
10	Types of Traditional and Modern Farming Systems	Types; Differences; Strengths, Limitations, Case studies	4
11	Components of farming system/farming-based livelihood systems - Crops and Cropping Systems	Components, Crop diversification, Cropping pattern, Mixed cropping, Importance for rural livelihoods	4
12	Livestock-based Farming Systems	Importance and Management of dairy, piggery, poultry, goatry, duckry, etc.	4
13	Horticultural Crops and Livelihoods	Role of fruits, vegetables and spices in rural income generation	4
14	Agroforestry Systems	Agroforestry- Definition, Combining trees and crops, Agroforestry models in India	2
15	Aquaculture as a Livelihood System	Importance of Aquaculture, Integrated systems (e.g. Duck/Poultry-cum-Fish, Dairy-cum-Fish, Piggery-cum-Fish etc.)	4
16	Challenges in Aquaculture-based Systems	Feasibility, Government support and Market access	2

Continued…

17	Small Enterprises in Farming	Role of small enterprises, Value addition, Local processing	2
18	Medium and Large Enterprises in Farming	Value chains, Secondary enterprises as livelihood components for farmers, Agri-processing.	2
19	Factors affecting Integration of various enterprises of farming for livelihood	Technology, Market access, Credit and infrastructure challenges etc.	4
20	Strategies for Enterprise Integration	Successful integration, Government policies, Examples.	2
21	Overview of Agro-Climatic Zones in India	Characteristics of different zones and their agricultural potential.	2
22	Feasibility of different Farming Systems for different Agro-Climatic Zones	Suitable farming systems for different zones, Climate adaptation.	2
23	Commercial Farming Based Livelihood Models by NABARD, ICAR and other organizations across the country	Role of NABARD, ICAR and other Organizations in promoting commercial models, Successful cases.	4
24	Case studies on different Livelihood Enterprises associated with farming	Analysis of successful enterprises, Dairy Cooperatives etc.	4
25	Risk Factors in Farming-based Livelihood Systems	Climate, Market fluctuations, Input costs; Mitigation strategies etc.	4
26	Success Factors in Farming-based Livelihood Systems	Innovation, Market access, Government support, Social capital etc.	2
27	Schemes and Programmes by the Central Government	Overview of schemes like, PM-KISAN, National Rural Livelihood Mission.	2
28	Schemes and programmes by State Governments	State-specific programs promoting rural livelihoods, Case examples.	2
29	Role of Private Sector in Livelihood Promotion	Public-Private Partnerships, Role of private agribusiness.	2
30	Public-Private Partnerships in Agriculture	Successful collaborations in rural development and farming systems	2
31	Farming-based Livelihoods in the 21st Century	Circular economy, Green economy, Climate change, Sustainability.	2
32	Impact of Digitalization and Changing Lifestyles	Technology in Agriculture, Future prospects for rural livelihoods.	2
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [MDC-121]

Exercise No.	Exercise Topic	Exercise Sub-topics/ Titles
1	Survey of Farming Systems and Agriculture-based Livelihood Enterprises	Methods of data collection; Field survey techniques; Preparing reports on surveyed farms.
2	Study of Components of Farming-based Livelihood Models in Different Agro-Climatic Zones	Components: Crop, livestock, fishery, agroforestry; Identifying models suited to specific zones.
3	Study of Production and Profitability of Crop-based Models	Analysis of input-output relations; Identifying profitable crops
4	Study of Livestock-based Models	Livestock systems: Dairy, poultry, goat farming; Profitability and market access
5	Study of Processing-based Models	Value addition in agriculture; Studying small-scale food processing units
6	Study of Integrated Farming-based Models	Study of crop-livestock-aquaculture integration; Synergies and challenges
7	Field Visit to Innovative Farming System Models	Visit to farms using modern technologies; Documenting practices
8	Visit to Agri-based Enterprises	Enterprises involved in input supply or value addition
9	Study of Functional Aspects: Integration of Production, Processing and Distribution	Backward and forward linkages; Assessing supply chain models
10	Agri-Enterprises in Industry and Service Sectors (Value Chain Models)	Studying value chain enterprises; Evaluating sustainability models
11	Concept of Project Formulation on Farming-based Livelihood Systems	Identifying project objectives; Structuring budgets and timelines
12	Cost and Profit Analysis of Farming-based Livelihood Projects	Developing Cost-Benefit analysis; Identifying Break-Even points
13	Case Study of Start-ups in Agri-sectors	Analysing real-world Start-ups; Identifying success factors
14	Group Project: Develop a Farming-based Livelihood Model	Formulating a working model; Feasibility and sustainability analysis
15	Preparation of Report on Farming Systems Survey and Livelihood Models	Compiling field data; Preparing reports with recommendations
16	Presentation and Evaluation of Practical Project Reports	Group presentations; Internal assessment of reports and participation.

Suggested Readings [MDC-121]:

1. **Ashley, C., & Carney, D. (1999)**. *Sustainable Livelihoods: Lessons from Early Experience.* Department for International Development, London, UK.
   - **Relevance**: This book explores sustainable livelihood frameworks, which are key to understanding livelihood patterns and rural income systems.
2. **Agarwal, A., & Narain, S. (1989)**. *Towards Green Villages: A Strategy for Environmentally Sound and Participatory Rural Development.* Centre for Science and Environment, New Delhi, India.
   - **Relevance**: Provides strategies for participatory rural development, focusing on environmental sustainability—a core concept in farming systems.
3. **Carloni, A. (2001)**. *Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa.* FAO, Rome, Italy.
   - **Relevance**: Offers insights into global farming system challenges, with lessons that can be adapted for Indian contexts in agricultural development.
4. **Dixon, J., Gulliver, A., & Gibbon, D. (2001)**. *Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World.* FAO & World Bank, Rome & Washington, DC.
   - **Relevance**: Focuses on farming systems' role in poverty alleviation and rural livelihood improvement.
5. **Evenson, R.E. (2000)**. *Agricultural Productivity and Production in Developing Countries.* In *FAO, The State of Food and Agriculture.* FAO, Rome, Italy.
   - **Relevance**: Discusses agricultural productivity, a critical factor in sustainable farming and improved livelihoods.
6. **Bhatt, B.P., *et al*. (ICAR Research Complex for Eastern Region)**. *Livelihood Improvement of Underprivileged Farming Community: Experiences from Bihar.* Patna, Bihar.
   - **Relevance**: Case studies on improving livelihoods in rural India, relevant to learning about region-specific agricultural interventions.
7. **Panwar *et al.* (2020)**. *Integrated Farming System Models for Agricultural Diversification, Enhanced Income, and Employment.* Indian Council of Agricultural Research, New Delhi.
   - **Relevance**: Provides models for agricultural diversification and income enhancement, which align with farming system topics.
8. **Reddy, S.R. (2016)**. *Farming System and Sustainable Agriculture.* Kalyani Publishers, New Delhi.
   - **Relevance**: Covers sustainable agriculture principles and farming system models, essential for sustainable livelihood systems.
9. **Singh, J.P. *et al*. (2016)**. *Region Specific Synthesized Integrated Farming System Models for Improved Production, Profitability and Nutrition (Series-1).* Bulletin, ICAR-Indian Institute of Farming Systems Research, Modipuram, Meerut (U.P.).
   - **Relevance**: Discusses integrated farming models tailored to different agro-climatic regions of India, essential for practical learning.
10. **Walia, S.S., & Walia, U.S. (2020)**. *Farming System and Sustainable Agriculture.* Scientific Publishers, Jodhpur, Rajasthan.
    - **Relevance:** Provides insights into sustainable agricultural practices and integrated farming systems with regional focus.

Semester	**:**	**II**	
Course No.	**:**	**VAC-121**	**Credit Hrs. : 3(2+1)**
Course Title	**:**	**Environmental Studies and Disaster Management**	
Gradial Common Course across all UG Degrees			

SYLLABUS

Objectives : (i) To expose and acquire the knowledge on the environment,
(ii) To gain the state-of-the-art skill and expertise on management of disasters.

THEORY

Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of Environmental Studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources, Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of Ecosystems. Biodiversity and its conservation: Introduction, Definition, Types. Biogeographical Classification of India. Importance and Value of Biodiversity. Biodiversity Hotspots. Threats and 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) Light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, Effects and Control measures of urban and industrial wastes. Social Issues and the Environment: 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. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and Human Health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and Human health.

Disaster Management - Disaster: Definition-Types-Natural Disasters: Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves. Man-made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, National disaster management framework; Financial arrangements; Role of NGOs, Community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed Forces in disaster response; Police and other organizations in disaster management.

PRACTICAL

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Energy: Biogas production from organic wastes. Visit to wind mill/hydro power/solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and unpolluted system. Visit to local polluted site- Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of *E. coli* in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystems - Visit to pond/ river/ hills. Visit to areas affected by natural disaster.

TEACHING SCHEDULE

THEORY [VAC-121]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	Introduction to Environmental Studies	Definition, Scope and Importance; Multidisciplinary nature	4
2	Segments of Environment	Spheres of Earth – Lithosphere, Hydrosphere, Atmosphere and Different Layers of Atmosphere.	4
3 - 5	Natural Resources	Classification of resources; Forest, water, mineral, food, energy, land, and soil resources	10
6 - 7	Concept of an Ecosystem	Concept, Structure, Function and Energy flow in ecosystems	5
8 - 9	Types of Ecosystems	Terrestrial, Aquatic, Agroecosystems, Forest ecosystems and Human-modified ecosystems	5
10 - 12	Biodiversity and its Conservation	Importance, Value, Types, Biogeographical classification, Hotspots, Threats, Conservation strategies	8
13 - 16	Environmental Pollution	Definition, Causes, Effects, Control measures: Air, Water, Soil, Marine, Noise, Thermal and Light pollution	12
17 - 18	Solid Waste Management	Classification of solid wastes; Management methods like, Composting, Incineration, Pyrolysis, Biogas production	6
19	Urban and Industrial waste	Causes, Effects and Control measures of Urban and Industrial waste	4
20	Social Issues Related to the Environment	Urban energy problems, Water conservation, Rainwater harvesting, Watershed management	4
21 - 22	Environmental Ethics	Issues, Possible solutions, Climate change, Global warming, Acid rain, Ozone layer depletion, Nuclear accidents and Holocaust.	6

Continued…

23	Environment Protection Laws	Environment Protection Act, Air and Water (Pollution) Acts, Wildlife Protection Act, Forest Conservation Act	4
24 - 25	Human Population and Environment	Environment and human health, Human rights, Value education, Women and child welfare, Role of IT in environment and health	5
26 - 28	Introduction to Disaster Management	Definition, Types of natural and man-made disasters; Floods, Droughts, Cyclones, Earthquakes, Landslides, Fires	10
29 - 30	Disaster Management Framework	National and International strategies, disaster response framework, Financial arrangements, Role of NGOs and media	5
31	Central and Local Administration in Disasters	Role of Central, State, District and Local Administrations; Coordination in disaster response	4
32	Disaster Response Organizations	Central, State, District and Local Administrations in Disaster Control; Role of Armed Forces, Police and Other organizations in disaster response and control	4
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [VAC-121]

Exercise No.	Exercise Title
1	Visit to a local area to document environmental assets: River/Forest/Grassland/Hill/Mountain.
2	Visit to Biogas production, Windmill, Hydro/Solar power generation units
3	To assess floral and faunal diversity in farming systems.
4	Assessment of biodiversity in farming system.
5	Floral and faunal diversity assessment in polluted and unpolluted system.
6	Visit to Local Polluted Site - Urban/Rural/Industrial/Agricultural to study the common plants, insects and birds. Environmental sampling and preservation.
7	Water quality analysis: pH and electrical conductivity (EC) in water samples.
8	Estimation of total dissolved solids (TDS) in water samples
9	Estimation of acidity and alkalinity in water samples.
10	Estimation of water hardness in water samples.
11	Determination of dissolved oxygen (DO) and biological oxygen demand (BOD) in water samples.
12	Performing COD estimation on water samples.
13	Enumeration of *E. coli* in water samples to check for contamination.
14	Assessment of Suspended Particulate Matter (SPM) in an environmental sample.
15	Study of simple ecosystem -Visit to Pond/River/Hills.
16	Visit to areas affected by natural disaster.

Suggested Readings (VAC-121):

1. **De, A.K. 2010.** Environmental Chemistry. Published by New Age International Publishers, New Delhi. ISBN:139788122426175. 384 pp.
2. **Dhar Chakrabarti, P.G. 2011.** Disaster Management - India's Risk Management Policy Frameworks and Key Challenges. Published by Centre for Social Markets (India), Bangaluru. 36 pp.
3. **Erach Bharucha,** Text Book for Environmental Studies. University Grants Commission, New Delhi.
4. **Parthiban, K.T., Vennila, S., Prasanthrajan, M. and Umesh Kanna, S. 2023.** Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi, India.
5. **Prasanthrajan, M. and Mahendran, P.P. 2008.** A Text Book on Ecology and Environmental Science.1st Edn. ISBN 8183211046. Agrotech Publishing Academy, Udaipur - 313 002.
6. **Prasanthrajan, M. 2018.** Objective Environmental Studies and Disaster Management, ISBN 9789387893825. Scientific Publishers, Jodhpur, India. 146 pp.
7. **Sharma, P.D. 2009**. Ecology and Environment, Rastogi Publications, Meerut, India.
8. **Tyler Miller and Scot Spoolman. 2009.** Living in the Environment (Concepts, Connections, and Solutions). Brooks/Cole, Cengage Learning Publication, Belmont, USA.

Semester	**:**	**II**			
Course No.	**:**	**FMPE-122**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Engineering Drawing**			

SYLLABUS

Objectives : (i) To develop student's ability to visualize, interpret and communicate technical designs through graphical representation, ensuring accuracy and uniformity in documentation.

(ii) To enhance student's skills to create detailed assembly drawing of machine components, emphasizing standard conventions, tolerances and specifications required for manufacturing and assembly.

PRACTICAL

Introduction to engineering drawing, practice of different layout drawings; Drawing instruments and their use; Introduction to lines, letterings, single stroke letters and gothic letters; Dimensioning, dimension line, extension line, arrow head, continuous and progressive dimensioning; Introduction of drawing scales, representative fraction; Practice on orthographic projections, reference planes, points and lines in space; Drawing for orthographic projection of points by first angle projection method; Third angle methods of projection; Projection of planes; Projection of solids: polyhedral, cylinder, cone; Projection of solids: Prism and pyramids; Development of surfaces of geometrical solids; Drawing the section of solids: cylinder, cone and sphere; Introduction to isometric scale, isometric view and isometric drawing; Isometric projection of geometrical solids; Preparation of working drawing from models and isometric views; Sectional drawing of simple machine parts; Nomenclature, thread profile, multi start threads, left and right hand threads; Conventional representation of threads; Forms of screw threads like metric thread, Whitworth thread; Square thread: acme thread, knuckle thread, buttress thread; Square headed and hexagonal nuts and bolts; Different types of lock nuts, studs, machine screws, cap screws and woods screws; Processes for producing leak proof joints; Drawing of different types of rivet heads and riveted joints and foundation bolts; Drawing of stud screws, set screws, butt, hexagonal and square; Drawing of keys, taper, rank taper, hollow saddle etc.; Symbols for different types of welded joints.

TEACHING SCHEDULE

PRACTICAL [FMPE-122]

Exercise No.	Exercise Title
1	Study of engineering drawing-meaning, layout; Study of Drawing instruments and their use: Introduction to engineering drawing, practice of different layout drawings, Drawing instruments and their use
2	Study of lines and their representation; Study of lettering methods: Introduction to lines, letterings, single stroke letters and gothic letters
3	Study of dimensioning methods and drawing scales: Dimensioning, dimension line, extension line, arrow head, continuous and progressive dimensioning, Introduction of drawing scales, Representative fraction
4	Study of Projection methods, Study of orthographic projection; Study of Projection of Points: Practice on orthographic projections, reference planes, points and lines in space; Drawing for orthographic projection of points by first angle projection method; Third angle methods of projection
5	Study of Projection of lines
6-7	Study of Projection of planes
8-10	Study of Projection of solids: polyhedral, cylinder, cone
11-12	Study of Projection of solids: Prism and pyramids
13-15	Study of Development of surfaces of geometrical solids
16-18	Study of Drawing the section of solids: cylinder, cone and sphere
19	Study of Introduction to isometric scale, isometric view and isometric drawing
20-21	Study of Isometric projection of geometrical solids
22-23	Preparation of working drawing from models and isometric views
24	Study of Sectional drawing of simple machine parts; Nomenclature Thread profile, multi-start threads, left and right-hand threads; Conventional representation of threads
25-26	Study of forms of screw threads: metric thread, Whitworth thread, Square thread: acme thread, knuckle thread, buttress thread
27	Study of Square headed and hexagonal nuts and bolts
28	Study of different types of lock nuts, studs, machine screws, cap screws and woods screws
29	Study of Drawing of stud screws, sets crews, butt, hexagonal and square
30	Study of Processes for producing leak proof joints; Drawing of different types of rivet heads and riveted joints and foundation bolts
31	Study of drawing of keys, taper, rank taper, hollow saddle etc.
32	Study of symbols for different types of welded joints

Suggested Readings [FMPE-122]:

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

Semester	**:**	**II**			
Course No.	**:**	**COMP-122**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Computer Programming and Data Structures**			

SYLLABUS

Objective : To make the students conversant on computer programming languages, specifically "C" language as well as to make them familiar with programming for simple agricultural engineering applications.

PRACTICAL

Introduction to high level languages; Structure programming, C programming, a simple C programming, execution of a C program, program and instruction; Familiarizing with Turbo C IDE. Building an executable version of C program; Study of different operators such as arithmetic, relational, logical, assignment, increment and decrement, conditional, bitwise and special operators, precedence of arithmetic operators; Debugging a C program; Developing and executing simple programs; Creating programs using decision making statements such as if, go to and switch; Developing program using loop statements while, do and for; Using nested control structures; Familiarizing with one- and two-dimensional arrays; Using string functions; Creating user defined functions; Developing structures and union; Using local, global and external variables; Using pointers. Developing linked lists in C language; Inserting an item in Linked List; Deleting an item in Linked List; Implementing Stacks; Implementing push/pop functions; Creating queues, Insertion/ Deletion in queue.

TEACHING SCHEDULE

PRACTICAL [COMP-122]

Exercise No.	Exercise Topic
1	Introduction to high level languages C: - structure programming, C programming, a simple C programming, execution of a 'C' program, program and instruction; Familiarizing with Turbo C IDE
2	Write a 'C' language program to calculate the sum and average value of given number.
3	Write a 'C' language program for application of if statement a) Write a 'C' language program to find odd and even numbers. b) Write a 'C' language program to read the integer number and find the ratio.
4	Write a 'C' language program to calculate roots of quadratic equation. Ax2+Bx+C=0. Write a 'C' language program to find the largest of three values. Write a 'C' language program to evaluate power series. ex=1+x+x²/2!+x³/3!+……..+xn/n!
5	Write a 'C' language program to find factorial of given number; Write a 'C' language program for power table of 2 to 3.
6	Write a 'C' language program to sort list & find its median.
7	Write a 'C' language program for calculation of standard deviation.
8	Write a 'C' language program to calculate the average of student exam score.
9	Write a 'C' language program for temperature conversion Fahrenheit-Celsius table.
10	Write a 'C' language program for evaluation of binomial coefficient.
11	Write a 'C' language program for matrix. a) Addition c) Subtraction b) Multiplication d) Transpose Inverse
12	Write a 'C' language program for prime number.
13	Write a 'C' language program for creating linear link list.
14	Write a 'C' language program for menu driven sorting techniques: a) Bouble sort c) Quick sort b) Merge sort d) Bucket sort
15	Write a 'C' language program for structure & structure members.
16	Write a 'C' language program for data structure: a) Display Structure c) Addition of Structure b) Deletion of Structure d) Searching of Structure
17	Write a 'C' language program for simulation of craps game.
18	Write a 'C' language program for link list node insertion & node deletion function.
19	Write a 'C' language program for "Calculating and storing the areas of several circles.
20	Write a 'C' language program finds "Binomial coefficient (NCR).
21	Write a 'C' language program "To determine roots of algebraic equation using iterative procedure.

Continued…

22	Write a 'C' language program for "the TOWERS OF HANDI".
23	Write a 'C" language program for "To find the maximum of a function within a specified format.
24	Write a 'C' language program "To sort a list of string alphabetically using a two-dimensional character array.
25	Write a 'C' language program for cox formula.
26	Write a 'C' language program for Elision formula.
27	Write a 'C' language program for adjusting soil loss.
28	Write a 'C' language program to design Bisal formula.
29	Write a 'C' language program to design horizontal interval for bench terrace.
30	Write a 'C' language program for Bycyuos formula for erodibility.
31	Write a 'C' language program for Dickens's formula.
32	Write a 'C' language program to design runoff rate.

Suggested Readings [COMP-122]:

1. Rajaraman V. 1985. Computer Oriented Numerical Methods. Prentice Hall of India. Pvt. Ltd., New Delhi.
2. Balagurusamy E. 1990. Programming in 'C'. Tata McGraw Hill Publishing Co. Ltd., 12/4 Asaf Ali Road, New Delhi.
3. Rajaraman V. 1995. Computer Programming in 'C'. Prentice Hall of India Pvt. Ltd., New Delhi.
4. Bronson G and Menconi S. 1995. A First Book of 'C' Fundamentals of 'C' Programming. Jaico Publishing House, New Delhi.
5. Sahni S. 2006. Data Structures, Algorithms and Applications in C++. University Press (India) Pvt. Ltd / Orient Longman Pvt. Ltd.
6. Goodrich M.T., Tamassia R and Mount D. 2011. Data Structures and Algorithms in C++. Wiley Student Edition, John Wiley and Sons.
7. Weiss M.A. 2007. Data Structures and Algorithm Analysis in C++. Pearson Education.
8. Augenstein L and Tanenbaum. 2003. Data Structures using C and C++. PHI/Pearson Education.
9. Drozdek A. 2012. Data Structures and Algorithms in C++. Vikas Publishing House/ Thomson International Student Edition.
10. Agarwal A. 2005. The Complete Reference Guide: Data Structure through C. ISBN: 8178840448; Publisher: Cyber Tech Publications. C language 60 program (Flow chart, Algorithm, code, o/p)
11. Chapman W.A. J 2018. Workshop Technology (Vol. I and II) Arnold Publishers (India) Pvt. Ltd., New Delhi.
12. Hajra Choudhari, S.K. Roy N, Hajra Choudhary A.K. 2017. Elements of Workshop Technology (Vol. I and II) Media Promoters and Publishers Pvt Ltd, Mumbai.
13. Khurmi R.S. and Gupta J.K. 2018 A test book of Workshop Technology. S. Chand and Company Ltd. New Delhi
14. Raghuwanshi B.S. 2016. A Course on Workshop Technology (Vol. I and II). Dhanpat Rai and Sons, New Delhi.

B.Tech. (Agricultural Engineering)

List/ Bouquet of Skill Enhancement Courses (SECs)

Sr. No.	Course No.	Course Title	Credit Hrs.
Department of Farm Machinery and Power Engineering			
1.	**SEC-xxx**	Operation and Maintenance of Farm Machinery	4(0+4)
2.	**SEC-xxx**	Repair and Maintenance of Tractors and Power Tillers	4(0+4)
3.	**SEC-xxx**	Management of Agricultural Machinery Custom Hiring and Maintenance Facilities	4(0+4)
4.	**SEC-xxx**	Operation and Maintenance of Drones Used for Agricultural Applications	4(0+4)
Department of Renewable Energy Engineering			
5.	**SEC-xxx**	Fabrication, Operation and Maintenance of Renewable Energy Devices	4(0+4)
6.	**SEC-xxx**	Machine Vision, Sensors and Sensors' Architecture	4(0+4)
7.	**SEC-xxx**	Design of Solar PV System using Softwares	4(0+4)
8.	**SEC-xxx**	Installation and Maintenance of On-Grid and Off-Grid Solar Systems	4(0+4)
9.	**SEC-xxx**	Design and Maintenance of Agri-voltaic System	4(0+4)
10.	**SEC-xxx**	Valorization of Agri-biomass and Organic Waste	4(0+4)
11.	**SEC-xxx**	Energy Audit, Energy Conservation and Energy Efficiency	4(0+4)
Department of Irrigation and Drainage Engineering			
12.	**SEC-xxx**	Repair and Maintenance of Pumps and Irrigation Systems	4(0+4)
13.	**SEC-xxx**	Installation and Maintenance of Micro Irrigation Systems	4(0+4)
Department of Soil and Water Conservation			
14.	**SEC-xxx**	Geophysical Survey and Investigations for GW Exploration and Instruction of Tubewell/ Borewell	4(0+4
15.	**SEC-xxx**	Application of Remote Sensing and GIS for Agricultural Water Management	4(0+4)
16.	**SEC-xxx**	Operation and Maintenance of Hydro-meteorological Instruments	4(0+4)
17.	**SEC-xxx**	Installation and Maintenance of Roof Top Rain Water Harvesting Systems (RWHS)	4(0+4)
18.	**SEC-xxx**	Operation and Maintenance of Soil Conservation Structures	4(0+4)

Continued…

Department of Farm Structural Engineering			
19.	**SEC-xxx**	Construction, Management and Maintenance of Protected Cultivation Structures	4(0+4)
20.	**SEC-xxx**	Maintenance of Hydroponic Structures	4(0+4)
21.	**SEC-xxx**	Use of IoT in Agricultural Structures	4(0+4)
22.	**SEC-xxx**	Installation, Repair and Maintenance of Shade Net Houses	4(0+4)
23.	**SEC-xxx**	Maintenance of Aeroponics Structures	4(0+4)
24.	**SEC-xxx**	Role of Bamboo in Agricultural Structures, Value Addition through Product Diversification and Waste Utilization	4(0+4)
25.	**SEC-xxx**	Manufacturing of Cement Blocks and Stone Waste Utilization	4(0+4)
26.	**SEC-xxx**	Testing of Engineering Materials	4(0+4)
27.	**SEC-xxx**	Estimating and Costing of Agricultural Structures	4(0+4)
Department of Process Food Engineering			
28.	**SEC-xxx**	Agro-processing Methods, Equipment Operation and Maintenance	4(0+4)
29.	**SEC-xxx**	Operation and Management of Multi-Commodity Agro-processing Centre	4(0+4)
30.	**SEC-xxx**	Primary Processing and Value Addition and Cold Chain Logistics	4(0+4)
31.	**SEC-xxx**	Food Grain Godown and Warehouse Management	4(0+4)
32.	**SEC-xxx**	Post-harvest Value Chain Management including Logistics	4(0+4)

Note: (i) Skill Enhancement Courses can be added/offered as per the facilities and resources available at the respective universities/colleges based on the relevance to the region and the UG degree subject.

(ii) In case of unavailability of said detailed course-wise syllabus of above SEC courses, the same can be primarily developed and followed at College/ University level in the academic year, 2024-25; However, the same can be obtained from the respective UG Degree Coordinator/ Discipline Coordinators and can be followed w.e.f. AY, 2025-26.

(iii) Above list is an indicative list/bouquet of SEC courses and subject to modification as applicable therein.

B.Tech. (Agricultural Engineering)

Skill Enhancement Courses (SECs): Detailed Syllabi

Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**4(0+4)**
Course Title	**:**	**Operation and Maintenance of Farm Machinery**			

Objective :
(i) To impart knowledge of different farm machineries and its operations to students,
(ii) To make aware the importance of operation and maintenance of farm machinery for efficient and economic farm operations,
(iii) To impart training on hitching of implements and operation with tractors, power tillers and self-propelled farm machinery.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-4	Constructional details, adjustment and working of primary tillage equipments such as, Mould Board plough and disc plough
5-8	Constructional details, adjustment and working of secondary tillage equipments such as, cultivators and harrows
9-12	Constructional details, adjustment and working of weeding equipments, such as manual weeder, power weeder/ dry land weeders/ low land weeders/ interculturing equipments
13-16	Constructional details, adjustment and working of rotary tillage/ active tillage equipments such as, tractor operated/ power tiller operated rotavator
17-20	Constructional details, adjustment and working of sowing equipments, such as seed drills, planters and transplanters, minimum tillage equipments
21-22	Adjustments and calibration of seed drills
23-24	Working with different types of furrow openers with seed drills/ planters
25-26	Constructional details, adjustment and working of metering mechanisms of seed drills and planters
27-30	Study of Precision Farm equipments, such as laser levelers, zero till drills, pneumatic planters etc.
31-34	Constructional details, adjustment and working with earth moving equipments such as bulldozers, trenchers and elevators etc.

Continued…

35-37	Constructional details, adjustment and working of transplanting equipments, such as rice transplanters and vegetable transplanters
38-40	Seedling raising technique for transplanters
41-44	Constructional details, adjustment and working of irrigation equipments, such as different types of pumps, sprinkler irrigation system/ drip irrigation system
45-48	Constructional details, adjustment and working of harvesting equipments, such as root crop harvesters (bullock-drawn as well as tractor-operated groundnut diggers) and grain crop harvesters (self-propelled/ tractor operated/ power tiller operated vertical conveyer reapers) etc.
49-52	Constructional Details, adjustment and working of threshing equipments, such as axial flow paddy threshers, combine harvesters etc.
53-56	Driving practice of tractor, safety rules and precautions, fuel saving tips.
57-58	Hitching and de-hitching of mounted and trailed type implements
59-60	Familiarization with different control of power tiers and driving practices.
61-64	Repair and maintenance of different agricultural equipments and machineries.

Suggested Readings: [SEC-xxx]

1. Element of Farm Machinery by A.C. Srivastava. IBH Publications Co. Pvt. Ltd, New Delhi
2. Farm Machinery Equipment by C.P. Nakara, Dhanpat Rai and Sons, Nai Sarak, Delhi
3. Farm Machinery – An Approach by S.C. Jain and Grace Philip, Standard Publishers, Nai Sarak, Delhi
4. Farm Power and Machinery Management by Donel Hunt, Iowa State University Press, Ames, Iowa 10th Edition
5. The Operation, Care and Repairs of Farm Machinery. Deere and Company.
6. Workbook of Practical Farm Machinery. Vol. I and II. By T.K. Bhattacharya, Saroj Prakashan, 646, Katra, Allahabad.
7. Tractor and Farm Machinery Operation and Maintenance: A Practical Manual by Jagvir Dixit, M. Muzamil, J.N. Khan, SKUAST, Srinagar.

Course No. : SEC-xxx	**Credit Hrs. : 4(0+4)**
Course Title : Repair and Maintenance of Tractor and Power Tillers	

Objective : (i) To enable the students to acquire the practical knowledge and skill to repair and maintain tractor and power tiller for different farm operations,

(ii) To make aware of the importance of repair and maintenance of tractors and power tillers for efficient and economic farm operations.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-4	Study of different systems of tractor and power tiller
5-8	Study of different components of engine: piston, cylinder, rings, fly wheel, firing interval and firing order
9-12	Study of fuel system: Working principle, repair and maintenance. Study of Working of fuel pumps, fuel filters and injectors
13-16	Study of lubrication system: Working principle of lubrication system and repair and maintenance. Study of Working of oil filters, oil pumps etc.
17-20	Study of cooling system: Working principle of cooling system and repair and maintenance. Study of Working of thermostat valve
21-22	Study of tractor/ power tiller engine system
23-24	Study of power transmission system of tractor/ power tiller (different types of clutches/gears/ sliding mesh gear box/ constant mesh gear box/ planetary gear box etc. in tractor; power transmission in power tiller)
25-26	Study of differential, final drive, PTO drive, their working principle/ repair and maintenance
27-30	Study of braking system: Different types of brakes, their components and working principle, adjustment and repair maintenance
31-34	Study of steering system: Types of steering system, steering geometry: caster angle, camber angle, toe-in, toe-out etc. Study of working principle of steering system, adjustments, repair and maintenance
35-37	Steering in power tiller: Dog clutch and other arrangements

Continued…

38-40	Study of hydraulic system of tractor and their working principle and repair and maintenance
41-44	Study of hitching system, their working principle, practical on hitching, repair and maintenance
45-48	Automatic draft and position control, working principle on draft and position control. Practical on draft and position control, repair and maintenance
49-52	Study of tyres, rims, their construction and specification, repair and maintenance
53-56	Daily, weekly and monthly maintenance schedule. Maintenance after each 50, 125, 250 and 500 hours of operation: Visit to local workshops
57-58	Engine overhauling and assembling: Visit to Local Workshops
59-60	Study of implement hitching and detaching from tractor as well as power tillers
61-64	Safety rules and precautions to be taken during operation of tractor and power tiller

Suggested Readings: [SEC-xxx]

1. Farm Tractor, Power Tiller Maintenance & Repair by S.C. Jain & C.R. Rai, Standard Publications Destructors- Delhi
2. Farm Machinery – An Approach by S.C. Jain and Grace Philip, Standard Publishers, Nai Sarak, Delhi
3. Elements of Agricultural Engineering by Dr. Jagdishwar Sahay, Standard Publishers Distributors, 2006
4. Farm Machinery Equipment by C.P. Nakara, Dhanpat Rai and Sons, Nai Sarak, Delhi
5. Tractor and their power units (Fourth Edition) by John B. Liljedahl, Paul K. Turnquist, David W. Smith & Makoto Hoki, CBS Publishers New Delhi
6. Indian Slandered Code IS: 6840-1972- Code of Practice for Preventive Maintenance of Agricultural Wheeled Tractor.
7. Indian Slandered Code IS: 13084-1991(reaffirmed 2000): Power Tillers - Installation and Preventive: Maintenance - Guidelines.
8. Indian Slandered Code IS :8132 1999(reaffirmed 2004): Tractors and Machinery for Agriculture and FORESTRY, powered lawn and garden equipment -, Operator's Manuals - Content and Presentation (Second revision).
9. Indian Slandered Code IS :9939 -1981 (reaffirmed 2000): Glossary of Terms relating to Agricultural Tractors and Power Tillers.
10. Using tractors safely: A step-by-step guide, www.hse.gov.uk/pubns/indg185.htm

Course No.	**:**	**SEC-xxx**	**Credit Hrs.** **:**	**4(0+4)**
Course Title	**:**	**Management of Agricultural Machinery, Custom Hiring and Maintenance Facilities**		

Objectives : (i) To learn Management of Agricultural Machinery,
(ii) To learn Custom Hiring of Agricultural Machinery,
(iii) To learn about Maintenance of Agricultural Machinery.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1	Terms associated with Machinery Management for correct understanding
2	Terms associated with Custom Hiring of Farm Machinery
3	Different ways: Machinery can be obtained for use on the farm
4	To learn procedure for direct purchase of farm machinery
5	To learn procedure for purchase of farm machinery through subside schemes
6	To study factors that affect the purchase of machinery
7	To study operations of two-wheel drive tractors
8	To learn the advantages of two-wheel drive tractors
9	To learn limitations of two-wheel drive tractors
10	To study operation of four-wheel drive tractors
11	To learn the advantages of four-wheel drive tractors
12	To learn the limitations of four-wheel drive tractors
13	Calculation of the theoretical capacity of a farm machine
14	To know the General Rules concerning field efficiency
15	Calculation of field capacity of a farm machines
16	Distinguishing between types of costs of machinery ownership
17	Understanding how cost and machine use are related
18	Calculation of salvage value of a farm machine
19	Calculation of average machine investment of a farm machine
20	Calculation of annual fixed cost of a farm machine
21	Calculation of repair cost for a farm machine
22	Calculation of fuel and lubrication costs for a tractor

Continued…

23	Calculation of labor cost for a farm machine
24	Understanding the causes of fatal tractor accidents
25	Learning of the procedures for safe machine operation
26	Understanding the reasons for efficiency in tractor operation
27	Preventative maintenance of farm machinery
28	To make list of five areas of servicing machinery
29	To calculate: estimated variable cost of a farm machine
30	To calculate: overall cost per acre for farm machinery
31	To calculate: equipment width (size) to match tractor horsepower
32	To study the construction of MB plough
33	To study the operation of tractor with MB plough
34	To study the adjustments of MB plough
35	To calculate the cost of operation of tillage
36	To study the scheduled maintenance of MB plough
37	To study the construction of disc harrow
38	To study the operation of tractor with disc harrow
39	To study the adjustments of MB disc harrow
40	To calculate the cost of operation of disc harrow
41	To study the scheduled maintenance of disc harrow
42	To study the construction of planter
43	To study the operation of tractor with planter
44	To study the adjustments and calibration of planter
45	To calculate the cost of operation of planter
46	To study the scheduled maintenance of planter
47	To study the construction of weeder
48	To study the operation of tractor with weeder
49	To study the adjustments of weeder
50	To calculate the cost of operation of weeding
51	To study the scheduled maintenance of weeder
52	To study the construction of sprayer
53	To study the operation of tractor with boom sprayer
54	To study the adjustments of boom sprayer

Continued…

55	To calculate the cost of operation of spraying
56	To study the scheduled maintenance of sprayer
57	To study the construction of reaper and thresher/ combine harvester
58	To study the operation of tractor with reaper and thresher/ combine harvester
59	To study the adjustments of VCR and thresher/ combine harvester
60	To calculate the cost of operation of harvesting
61	To study the scheduled maintenance of reaper and thresher/combine harvester
62	Visit to Custom Hiring Center
63-64	Visit to Tractor or Farm Machinery Repair Workshop.

Suggested Readings: [SEC-xxx]

1. Farm Power and Machinery Management: Eleventh Edition by Donnell Hunt, David Wilson
2. http://ecoursesonline.iasri.res.in/course/view.php?id=13

Course No.	**:**	**SEC-xxx**	**Credit Hrs. : 4(0+4)**
Course Title	**:**	**Operation and Maintenance of Drones Used for Agricultural Applications**	

Objectives : (i) To learn and make a Drone handling operational system with maintenance practices,

(ii) Hands-on skill development practices on Agri Drone applications.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-4	Overview of drone technology, Importance of drones in agriculture. Types of agricultural drones (fixed-wing, rotary-wing, multi-rotor), Regulatory framework and compliance requirements for agricultural drone operations.
5-9	Understanding the components of a drone (frame, motors, propellers, flight controller, sensors, etc.), functionality of each component and its role in drone operation, basics of drone aerodynamics and flight principles. Drone component design in CAD Software and 3-D printing basic operations
10-15	Introduction to various sensors used in agricultural drones; RGB cameras, Multispectral cameras, Thermal cameras, LiDAR, Hyperspectral Camera Sensors
16-19	Applications of different sensors in Agriculture: Crop monitoring, pest detection, irrigation management, etc., Payload integration and compatibility considerations.
20-26	Principles of flight planning for agricultural drone missions; Selection of appropriate flight parameters (altitude, speed, overlap, etc.); Use of mission planning software and tools, Pre-flight checks and safety protocols; Mission planer and google map allocation for drone operation; manual spraying operation; Automated spraying operation.
27-30	Techniques for data acquisition during drone flights; Post-flight data processing and analysis; Interpretation of aerial imagery and sensor data, Software tools for data processing and visualization.
31-33	Applications of drones in crop monitoring (plant health assessment, yield estimation, disease detection, etc.); Integration of drone data with precision agriculture techniques; Decision support systems for crop management based on drone data.
34-36	Using drones for early pest and disease detection, Identification of common pests and diseases in crops; Monitoring strategies for pest infestations and disease outbreaks.

Continued…

37-39	Role of drones in assessing soil moisture levels and irrigation needs, Optimizing irrigation scheduling with drone data, Water resource management and conservation using drone technology.
40-43	Preventive maintenance procedures for agricultural drones, Diagnosing and troubleshooting common issues (motor failure, GPS signal loss, sensor calibration, etc.); Battery management and care, break down maintenance.
44-46	Safety protocols for drone operations in agricultural settings; Understanding airspace regulations and restrictions; Emergency procedures and risk mitigation strategies.
47-50	Real-world examples of successful drone applications in agriculture; Hands-on exercises and Field demonstrations.
51-55	Challenges and opportunities for the widespread adoption of Drone Technology in Agriculture, Ethical and societal implications of drone use in farming.
56-60	Crop-wise spraying SOP determination by field operations.
61-64	Preparation of charts, tables, graphs and overall report by individual students.

Suggested Readings: [SEC-xxx]

1. Handbook of Unmanned Aerial Vehicles by Kimon P. Valavanis George J. Vachtsevanos by A.C. Srivastava. IBH Publications Co. Pvt. Ltd, New Delhi.
2. Participant Handbook by NSDC Skill India.
3. UAS (Drone) Operations Manual by University of Bristal USA https://bristol.ac.uk/safety/media/gn/ops-manual-gn.pdf
4. Drone Design by Ruben Antuna Herreo Dumlupinar Universitesi.
5. Drone Data Book https://dronecenter.bard.edu/files/2019/10/CSD-Drone-Databook-Web.pdf
6. Drone Applications in Agriculture.
7. Theory, Design, and Applications of Unmanned Aerial Vehicles- by A. R. Jha Ph.D. (Author), 2016.
8. Handbook of Unmanned Aerial Vehicles- Editors: Valavanis, K., Vachtsevanos, George J. (Eds.), 2014.
9. Jane's Unmanned Aerial Vehicles and Targets by Kenneth Munson (Editor), 2010.
10. Guidance of Unmanned Aerial Vehicles- by Rafael Yanushevsky (Author), 2011.
11. Research papers on drone applications.
12. Online references and tutorials like~
    - https://oscarliang.com/build-a-quadcopter-beginners-tutorial-1/
    - https://blog.owenson.me/build-your-own-quadcopter-flight-controller/
    - http://www.starlino.com/imu_guide.html
    - https://www.intorobotics.com/accelerometer-gyroscope-and-imu-sensors-tutorials
    - http://droneinsider.org/the-aerodynamics-of-multirotors/
    - https://blog.owenson.me/build-your-own-quadcopter-flight-controller/
    - https://challenge.toradex.com/projects/10078-autopilot-quadcopter
    - http://andrew.gibiansky.com/blog/physics/quadcopter-dynamics/
    - http://blog.owenson.me/build-your-own-quadcopter-flight-controller/

Course No. : SEC-xxx	Credit Hrs. : 4(0+4)
Course Title : Fabrication, Operation and Maintenance of Renewable Energy Devices	

Objective : To enable the students to acquire the knowledge and skills for fabrication, operation and maintenance of Renewable Energy Device.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-2	To get acquaintance with different renewable energy sources (Solar, Wind, Hydro, Biomass, Geothermal).
3-4	Study of fabrication, operation, utilization, and maintenance of solar dryers (Tunnel/ Cabinet/Hybrid).
5-6	Study of fabrication, operation, utilization and maintenance of solar water heating system (Natural/Forces convection).
7-8	Principle, components and working of box type and parabolic dish solar cooker.
9	Principle, components and working of solar desalination unit.
10-11	Principle, components and working of solar concentrating system for the processes heat and steam generation.
12-13	Study of routine maintenance and fault detection of solar thermal devices.
14	Principles of Photovoltaic (PV) technology.
15-16	Study of different types of Solar panels and their fabrication processes.
17-18	Study of installation and maintenance of Grid tied solar power systems.
19-20	Study of installation and maintenance of Off-grid solar power systems.
21-22	Study of components, working and operation and routine maintenance of Solar water pumping system.
23-24	Study of operation, utilization and routine maintenance of SPV devices, like solar lamps, solar streetlight, solar sprayer, solar chargers, solar home lights, solar insect traps and other SPV operated agricultural tools.
25	Overview of Wind turbine technology and components.
26-27	Study of fabrication and installation of Wind turbines.
28-29	Operation and maintenance practices for Wind farms.
30	Concept, components, operation and utilization of Pico hydro unit.
31	To study construction and maintenance of Pico hydro technology.
32-33	Study of biomass sources and conversion technologies (combustion, gasification, anaerobic digestion),
34-35	Study of operation, component fabrication and maintenance of biomass improved chulla's for heat generation.
36-37	Study of operation, component fabrication and maintenance of biomass gasifier for energy production.
38-39	Study of operation, component fabrication maintenance of biomass carbonization unit for charcoal and biochar production.

Continued…

40-41	Study of operation, component fabrication maintenance of biomass pyrolysis unit for energy production.
42-43	Study of operation, component fabrication maintenance of biomass fired dryer for crop drying.
44-45	Study of operation, component fabrication maintenance of biomass briquetting/ palletizing for fuel production.
46-47	Study of operation, component fabrication and maintenance of family size biogas plant for fuel production.
48-49	Study of operation, component fabrication and maintenance of biogas-engine plant for energy production.
50-51	Study of routine maintenance procedures and troubleshooting common issues for renewable energy systems
52-53	Study of safety protocols for maintenance tasks, monitoring and performance optimization of renewable energy systems.
54-56	Exploration of real-world examples of successful renewable energy projects in India and Abroad.
57-58	Hands-on projects to reinforce learning evaluation of renewable energy for technical-economic evaluation.
59	Acquaintance with the emerging trends in renewable energy technologies for domestic, industrial and agricultural applications
60	Exploration of innovative technologies (tidal, wave, solar thermal, etc.) for alternate energy option
61	Study of renewable energy policies and incentives in India and Maharashtra.
62	Study of regulatory compliance for renewable energy projects.
63	Study of environmental considerations and permitting processes of renewable energy projects.
64	Site visits and SEC Report preparation

Suggested Readings: [SEC-xxx]

1. G.D. Rai 2012. Non-Conventional Energy Sources, Khanna Publishers.
2. G.D. Rai 2012. Solar Energy Utilization, Khanna Publishers.
3. Chetan Singh Solanki 2015. Solar Photovoltaics Fundamentals Technologies and Applications, PHI learnings Private Limited, New Delhi.
4. Chetan Singh Solanki 2013.Solar Photovoltaic Technologies and Systems, A Manual for Technicians, Trainers and Engineers, PHI Learning Private Limited New Delhi.
5. Rathore N.S., Kurchania A.K., Panwar N.L. 2006, Renewable Energy Theory and Practice., Himanshu Publications.
6. Augustin McEvoy, Tom Markvat, Luis Castaner, 2011 Practical Handbook of Photovoltaics Fundamental and Applications, Academic Press, Second Edition
7. Sanjay Kumar, 2013. Fundamental of Renewable Energy Resources and Technology, Kalyani Publisher, Noida.
8. Banhi D. Shukla, 2018. Engineering of Wind Energy, Jain Brothers, New Delhi.
9. Mathur A. N., Rathore N. S. 1992. Biogas Production, Management & Utilization. Himanshu Publications.

Course No. : SEC-xxx	**Credit Hrs. : 4(0+4)**
Course Title : Machine Vision, Sensors and Architecture	

Objective : To enable the students to acquire the skill for utilizations of Machine Vision and Sensors in Agriculture and Allied Sciences.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1	To study the overview of machine vision systems and their applications.
2	To study the importance of sensors in machine vision.
3	To study the basic principles of image processing and analysis.
4	To explore the classification of sensors based on various criteria- (Type of measurement, Operating principle, etc.)
5	Study and application of common optical sensors.
6	Study and application of common proximity sensors.
7	Study and application of common temperature sensors.
8	Study and application of common pressure sensors.
9-10	Comparative study of different sensor technologies in terms of accuracy, response time, cost, and suitability for specific applications.
11-12	To study the principle, components, and operational mechanism of a sensor system. (sensor element, signal conditioning circuitry, interface electronics, etc.).
13	To study the static and dynamic characteristics of Sensor (sensitivity, resolution, linearity, hysteresis, etc.)
14	To identify and select the sensor for specific applications and integration in the application.
15-16	To study the principle and operational mechanism of Image acquisition with sensors; To study the principle and operational mechanism lenses, lighting in image processing
17-20	To study the Image processing techniques for Filtering; Edge detection; Segmentation; Feature extraction.
21	To study the role of algorithms in image analysis and interpretation.
22	To study the components and architecture of a typical machine vision system.
23	To Integrate sensors and vision systems for industrial automation and quality control.
24-26	Practical applications of machine vision in different manufacturing industries: Food storage and supply chain Fruits and Vegetables Agro-processing
27-28	To study the principle of 3D vision and depth sensing technologies.
29-31	To study the mechanism of different 3D sensors stereo vision 3D sensor, structured light 3D sensor, time-of-flight 3D sensor

32-34	To study the practical Applications of 3D vision in Robotics; Metrology; Object recognition.
35	Practical application of multisensory systems in real-world.
36	To study overview of Smart Sensors and their capabilities. (Self-calibration, self-diagnosis, etc.)
37-38	To study integration of sensors into IoT (Internet of Things) platforms with Case study of IoT Applications in Agriculture.
39-42	Introduction of sensor networks and to study communication protocols for sensor networks with Bluetooth Zigbee LoRaWAN.
43-44	To study the concept of embedded vision systems and integration of sensors and vision processing capabilities into embedded systems.
45-47	To explore the applications of embedded vision in Vehicles Drones Consumer Electronics
48	Study of real-world examples of sensor systems and machine vision applications
49-55	Hands-on exercises and projects involving sensor integration and image processing.
56-61	Visit to industries to experience sensor systems and machine vision applications
62-64	To study the emerging trends in sensor technology and machine vision; To identify challenges in advanced sensor systems and societal implications of sensor employment and data collection; SEC Report preparation and submission.

Suggested Readings: [SEC-xxx]

1. Machine Vision Algorithms and Applications by Carsten Steger, Markus Ulrich, Christian Wiedemann
2. Machine Vision: Theory, Algorithms, Practicalities by E.R. Davies
3. Machine Vision for Industry 4.0 by Roshani Raut, Salahddine Krit, Prasenjit Chatterjee
4. Sensors Handbook by Sabrie Soloman
5. Introduction to Sensors by John Vetelino, Aravind Reghu
6. Advances in Modern Sensors by G R. SINHA. 2020
7. Instrument measurement analysis by B.C. NaKra and K.K Choudhari
8. Industrial instrumentation by S. K. Singh
9. Understanding Smart Sensors by Randy Frank
10. Introduction to Sensors in IoT and Cloud Computing Applications by Ambika Nagaraj
11. Embedded Vision: An Introduction by S. R. Vijayalakshmi, S. Muruganand
12. Fundamentals of Computer Vision by Wesley E. Snyder, Hairong Qi.
13. Sensor Systems Simulations: From Concept to Solution by Willem Dirk van Driel, Oliver Pyper, Cornelia Schumann.
14. Annals of Scientific Society for Assembly, Handling and Industrial Robotics 2021 by Annika Raatz, Kirsten Tracht, Thorsten Schüppstuhl Springer Publication.
15. Embedded Vision: An Introduction by S. R. Vijayalakshmi, S. Muruganand.
16. Embedded Computer Vision by Branislav Kisacanin, Shuvra S. Bhattacharyya, · Sek Cha 2008
17. Computer Vision and Applications by Bernd Jahne
18. Handbook of Research on Developments and Trends in Wireless by Jin, Hai, Jiang, Wenbin
19. Emerging Trends in IoT and Integration with Data Science by Taser, Pelin Yildirim.

Course No. : SEC-xxx	Credit Hrs. : 4(0+4)
Course Title : Design of Solar PV Systems using Softwares	

Objectives : (i) To enhance the student's skill for designing of Solar PV systems using softwares,
(ii) To pertain knowledge about planning, project implementation, operation and financial analysis of solar PV power generation using softwares.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-5	To study different software tools commonly used to design solar PV system for installation and setup instructions. a) PVSyst b) PV*SOL c) Helioscope d) SAM e) Other softwares
6-12	To study the generation of preliminary input data using different software tools for Site location Solar irradiance Electrical load profile System specifications Shading analysis Financial analysis
13-17	To study the site analysis for assessment of Solar potential Space for PV system installation Shading analysis Potential obstructions
18	To determine the appropriate size of the solar PV system to maximize energy production and efficiency of PV modules.
19	To determine the appropriate size of the solar PV system to maximize energy production and efficiency of Inverters.
20	To determine the appropriate size of the solar PV system to maximize energy production and efficiency of mounting structures.
21-22	To create a layout for the solar PV array using the software design tools to optimize orientations and configurations for placing PV modules on roof.
23-24	To create a layout for the solar PV array using the software design tools to optimize orientations and configurations for placing PV modules on ground.
25-28	To design the electrical wiring and connection scheme for PV array, Inverters and BoS, utilities etc.
29-32	To estimate the performance and energy yield of the proposed PV system by running simulations.
33-35	To optimize the performance and maximize energy output by fine-tuning the different parameters of system.
36-40	To assess the economic feasibility of the solar PV project, Off-Grid system; On-Grid systems.

Continued…

41-46	To conduct sensitivity analysis to evaluate the impact of variations in module type, module efficiency, system size and electrical tariffs on project economics for different solar PV projects.
47-50	Generating detailed reports and documentation summarizing the design process, simulation results and project economics of different types of solar PV projects.
51-54	Case studies based on real-world projects to design grid connected PV system.
55-58	Case studies based on real-world projects to design standalone PV system.
59-62	Case studies based on real-world projects to design PV Water pumping system
63-64	To study common challenges and troubleshooting issues encountered during the design process.

Suggested Readings: [SEC-xxx]

1. Deambi, S. (2016). Photovoltaic System Design: Procedures, Tools and Applications. CRC Pr I Llc; 1st edition, 2020
2. Bhatia, A., 2018. Design and Sizing of Solar Photovoltaic Systems. Contin. Educ. Dev. Inc, (877), pp.2-125.
3. E-Book on Standard Operating Procedure for Installation of Grid Connected Rooftop Solar Photovoltaic Systems- A Handbook for Engineers & Developers Prepared by GSES India Sustainable Energy Pvt. Ltd. for The World Bank – SUPRABHA TA Program
4. PV*SOL® Expert Version 6.0 Design and Simulation of Photovoltaic Systems Manual
5. PVsyst Version 7 Grid Connected Systems User Manual
6. HelioScope User Manual © 2016
7. IS 12834:2013. Indian Standard Solar Photovoltaic Energy Systems- Terms, Definitions and Symbols (First Revision)
8. IS 17018 (Part 1): 2022. Solar Photovoltaic Water Pumping Systems Part 1- Centrifugal Pumps Specification.
9. Chetan Singh Solanki 2013.Solar Photovoltaic Technologies and Systems, A Manual for Technicians, Trainers and Engineers, PHI learning Private Limited New Delhi.
10. G. Divya Teja, N Mahesh Kumar and G. Vishnu Pramod Teja (2021) "Experimental Investigation of Standalone PV System Using PVsyst Software". *International Journal of Trend in Scientific Research and Development (IJTSRD*), ISSN: 2456- 6470,6,1249-1254,
11. https://indianinstituteofsolarenergy.com/software/helioscope-step-by-step-guide-for-solar-pv-design/

Course No. : SEC-xxx	**Credit Hrs. : 4(0+4)**
Course Title : Installation and Maintenance of On-Grid and Off-Grid Solar Systems	

Objectives : (i) To enable the students to acquire the skill for installation of On-Grid and Off-Grid Solar Systems in domestic and industrial sectors,

(ii) To impart the hands-on skills for maintenance of On-Grid and Off-Grid Solar Systems

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-2	To study the overview, system concepts, types and applications of Solar Photovoltaic Technology.
3-4	Study of commercial On-grid and Off-grid PV Solar system.
5-9	Identification and study of technical specifications of key components of Solar PV system Solar panels, Inverters Charge controllers. Batteries, Wiring
10-11	To study differences between On-grid and Off-grid SPV systems in terms of Types, Circuit diagram, Working and Application Suitability
12-14	To study the components of On-grid and Off-grid solar PV system; To study suitability of On-grid and Off-grid solar PV system; To design system layout of On-grid and Off-grid solar PV system.
15-16	Study of site assessments protocol to determine potential and suitability for PV system installation.
17-18	To study design considerations for System sizing, orientation and tilt angle.
19-20	Planning of layout of Solar panels, Mounting structures and Electrical components.
21-22	To practise installation of Solar panels, Inverters and other components for On-grid PV systems.
23-24	To study mounting Solar panels on rooftops or ground-mounted structures.
25	To study wiring and connection of components to the Electrical grid
26-27	To practice the setting up Off-grid solar systems, including battery-based energy storage.
28-29	To practise installation of Charge controllers, Batteries and DC loads.
30-31	To design and configure Off-grid systems for reliable and efficient operation.
32	To practise electrical wiring for solar PV systems.
33-34	To study the safety precautions and regulations related to electrical installations.
35-37	To practise of wiring of Solar panels; Inverters Charge Controllers, Battery banks

Continued…

38	To study the solar PV systems to ensure proper functionality.
39	To study the performance tests and verifying system parameters of PV system.
40-41	To study the troubleshooting common issues and installation errors in PV system.
42-44	To demonstrate routine maintenance tasks for On-grid solar PV systems – Cleaning, Inspection, Performance monitoring. To diagnose and troubleshoot of grid-connected system components.
45-47	To demonstrate specialized maintenance requirements for Off-grid solar systems, including Battery maintenance, Charge controller.
48-51	To discuss the techniques for integrating additional Solar panels, Batteries, Other components into existing systems.
52-53	To study and identify the system modification and expansion techniques.
54-56	To study remote monitoring of PV system using data analytic tools; Performance monitoring of PV system using remote analytic tools to diagnose issues and optimization.
57-60	Hands-on practice in accessing system data and interpreting performance metrics of PV system.
61-64	Site Visits and SEC Report preparation.

Suggested Readings: [SEC-xxx]

1. G.D. Rai 2012. Non-Conventional Energy Sources, Khanna Publishers.
2. G.D. Rai 2012. Solar Energy Utilization, Khanna Publishers.
3. Chetan Singh Solanki 2011. Solar Photovoltaics Fundamentals Technologies and Applications, PHI Learnings Private Limited, New Delhi.
4. Chetan Singh Solanki 2013.Solar Photovoltaic Technologies and Systems, A Manual for Technicians, Trainers and Engineers, PHI Learning Private Limited, New Delhi.
5. Rathore N.S., Kurchania A.K., Panwar N.L. 2006, Renewable Energy Theory and Practice, Himanshu Publications.
6. Augustin McEvoy, Tom Markvat, Luis Castaner, 2011. Practical Handbook of Photovoltaics Fundamental and applications, Academic press, Second Edition
7. E-Book on Participant Handbook- Solar Panel Installation Technician, Electronics Sector Skill Council of India.
8. E-Book on Standard Operating Procedure for Installation of Grid Connected Rooftop Solar Photovoltaic Systems A Handbook for Engineers and Developers Prepared by GSES India Sustainable Energy Pvt. Ltd. for The World Bank.

Course No. : SEC-xxx	Credit Hrs. : 4(0+4)
Course Title : Design and Maintenance of Agri-voltaic System	

Objectives : (i) To enhance the student's skill in designing, operation and maintenance of Agri-voltaic system to cater ever rising demands of both food and energy using the same land,

(ii) To pertain knowledge about planning, project implementation, operation and financial analysis of solar power plant in order to cultivate the plants below the panel.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-2	To study Agri-voltaic systems and their benefits with Synergistics of solar power generation and agriculture.
3-5	To study different parameters for selection of site for Agri-PV System
6-7	Measurement of solar radiation available on surface of solar panel
8	Measurement of reflected solar radiation
9-10	To study different types of solar panel (Mono facial/ bi facial)
11-15	To study different design parameters for erecting solar panels with respect to Size of plot, Spacing between two panels, Heights of panel inclination and Direction of panel.
16-17	Study of different parameters for shadow tolerant crops selection under Agri-voltaic system
18	To study the management practices suitable for Agri-voltaic systems.
19-21	To study and monitor soil moisture, nutrient levels and crop health under Agri-voltaic system
22-26	Measurement of weather parameters for Agri-voltaic system: Ambient Temperature, Relative Humidity, Wind Velocity, Sunshine hours, Surface temperature of panel
27-30	To study installation of solar panels on support structures (ground-mounted or elevated) with proper panel orientation and tilt angle for maximum energy capture.
31-32	To study safety protocols, safety kits and best practices for working with solar panel arrays.
33-34	To design irrigation and fertigation system for an Agri-voltaic system.
35	Preparation of pest management model for an Agri-voltaic system.
36-37	To design the electrical layout for connecting solar panels to the on-grid or off-grid systems
38-39	To study installation of wiring, inverters, combiner boxes and other electrical components for Agri-voltaic system.

Continued…

40	To study electrical codes and safety standards for Agri-voltaic system.
41-43	To get acquainted with maintenance of solar panels, support structures and electrical components of Agri-voltaic system.
44-45	To monitor Agri-voltaic system performance, equipment inspection, cleaning and maintenance.
46-50	Interpretation of data to optimize system performance and agricultural productivity, using data analytics tools to identify trends and patterns.
51-52	Overview of regulations, permits and incentives related to Agri-voltaic installations.
53-54	Overview of zoning laws, land use regulations and environmental regulations for adoption of Agri-voltaics.
55	To study rainwater harvesting system in Agri-voltaic system.
56	Measurement of Photosynthetically Active Radiation (PAR).
57	To study different systems for cleaning of PV module used in Agri-voltaic system.
58	To study different tracking systems for solar PV panels
59	To study land equivalent ratio of Agri-voltaic system in field.
60	To study energy output of solar PV arrays installed in Agri-voltaic system
61-64	Visit to nearby Agri-voltaic Project; SEC Report preparation and submission.

Suggested Readings: [SEC-xxx]

1. Design and Test of Agri-Voltaic System; Turkish Journal of Computer and Mathematics Education Vol.12 No.8(2021), 2395-2404.
2. Agrivoltaics in India; 'Overview of Projects and relevant Policies, Report by National Solar Energy Federation of India (NSEFI) Version: v3.0, 22 July 2023 New Delhi.
3. Solanki C.S. 2011. Solar Photovoltaics: Fundamentals, Technologies and Applications, PHI Learning Pvt. Ltd.
4. Rathore N.S., Kurchenia A.K., Panwar N.L. Renewable Energy Theory and Practices, Himanshu Publication, 2007.
5. E-Book on Participant Handbook- Solar Panel Installation Technician, Electronics Sector Skill Council of India.
6. E-Book on Standard Operating Procedure for Installation of Grid Connected Rooftop Solar Photovoltaic Systems; A Handbook for Engineers & Developers Prepared by GSES India Sustainable Energy Pvt. Ltd. for The World Bank – SUPRABHATA Program.
7. E-Book on Participant Handbook- Solar Panel Installation Technician, Electronics Sector Skill Council of India.

Course No. : SEC-xxx	**Credit Hrs. : 4(0+4)**
Course Title : Valorisation of Agri-biomass and Organic Waste	

Objectives : (i) To enable the students to acquire the knowledge and skills for efficient utilizations of agriculture biomass and organic waste,

(ii) To acquainted with advance biomass conversion technologies for energy and fuel production.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-2	To study the basic concept of valorisation and its role in waste-to-value processes.
3-4	Introduction to the sources, classification and types of agri-biomass and organic waste generated in agriculture and food production.
5-6	Study of methods for characterizing agri-biomass and organic waste (composition, moisture content, calorific value, etc.).
7-8	Estimation of agricultural waste by remote sensing and field method.
9-11	Determination of physical properties of solid fuels (like size, shape, bulk density, particle density, durability etc.).
12-14	Determination of physical properties of liquid fuels (Boiling point, cloud point, and pour point, viscosity).
15-17	Determination of properties of gaseous fuels (Molecular weight, Boiling point, Freezing point, Density, Compressibility etc.).
18-20	Understanding the properties and potential uses of different types of biomass and waste materials.
21-22	Overview of sample collection, preparation and analysis of properties of waste material.
23-24	Determination of fire point and flash point of liquid fuel
25-26	Study of gas analysis by Orsat apparatus
27-28	Determination of Volatile solids of agrowaste/ organic waste
29-30	Estimation of calorific value of biomass and its byproducts
31-32	Determination of lignin, cellulose and hemicellulose in agri-biomass and waste
33-34	Study of ultimate analysis of agri-biomass and organic waste
35-36	Study of Thermogravimetric analysis (TGA) of agri-biomass and organic waste
37-38	Introduction to biological conversion methods such as anaerobic digestion and composting.

Continued…

39-40	To study the principles of microbial decomposition and fermentation in biomass conversion.
41	Study of various biogas plants for microbial decomposition.
42	Study of mechanism and components of fermentation process.
43	Study of chemistry of bio-ethanol/methanol production.
44-45	Overview of thermochemical conversion techniques including pyrolysis, gasification, and hydrothermal processing.
46	Understanding the principles of heat transfer, chemical reactions, and product formation in thermochemical processes.
47-48	Study and evaluation of different biomass gasifier systems for heat and power generation.
49	Study pyrolysis of agri-biomass and organic waste.
50	Performance evaluation of gasifier-engine system for power generation.
51	Introduction to biochemical and biotechnological approaches for valorising biomass and organic waste.
52	Studies on utilization of enzymes, microorganisms, and fermentation processes in bioconversion.
53-55	Study of methods for producing biofuels from agri-biomass and organic waste (biogas, biodiesel, bioethanol, etc.).
56-57	Studies on valorization of agri-biomass and organic waste into value-added products such as biochar, biobased chemicals, and biomaterials.
58	Biochar production from agri-biomass and organic waste.
59	Bio-oil production from agri-biomass and organic waste.
60	Development of strategies for waste minimization, reuse and recycling in agricultural and food production systems.
61	Study of emerging trends such as agri-biomass and organic waste valorisation technologies, precision biomass conversion and integrated bio-refinery concepts.
62	Overview of regulations, standards, and policies governing the valorisation of agri-biomass and organic waste.
63-64	Visit to site of waste to wealth projects and SEC Report preparation.

Suggested Readings: [SEC-xxx]

1. Markel, I.A. 1981. Managing Livestock Waste, AVI Publishing Co.
2. Pantastico, ECB. 1975. Post Harvest Physiology, Handling and utilization of Tropical and Sub-tropical fruits and vegetables, AVI Pub. Co.
3. USDA 1992. *Agricultural Waste Management Field Hand book*. USDA, Washington DC.

4. Weichmann J. 1987. Post Harvest Physiology of vegetables, Marcel and Dekker Verlag.
5. Joshi V K and Sharma S K. 2011. *Food Processing Waste Management: Treatment & Utilization Technology*. New India Publishing Agency.
6. VassoOreopoulou and Winfried Russ (Edited). 2007. Utilization of By-products and Treatment of waste in the Food Industry. Springer Science & Business media, LLC 233 New York.
7. Prashar, Anupama and Bansal, Pratibha. 2007-08. Industrial Safety and Environment. S.K. Kataria and sons, New Delhi
8. Garg, S.K. 1998. Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering. Khanna Publishers, New Delhi
9. Bhatia, S.C. 2001. Environmental Pollution and Control in Chemical Process Industries. Khanna Publishers, New Delhi.
10. Mathur A.N., Rathore N.S. 1992. Biogas production, management & utilization. Himanshu Publications.
11. Joshi V.K. and S.K. Sharma. Food Processing Waste Management; Treatment and Utilization, New India Publishing Agency, New Delhi.
12. Jaidev Singh, 2012. Effluent Treatment Plant; Design, operation and Analysis of Waste Water.
13. Kalbande S.R. Agricultural Waste Logistics: Theory and Practices, 2024. Narendra Publishing House Delhi, India.
14. Relevant ICAR online e-resources.

Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**4(0+4)**
Course Title	**:**	**Energy Audit, Energy Conservation and Energy Efficiency**			

Objectives :

(i) To enhance the student's skill in promoting sustainable practices and reducing energy consumption in various sectors,

(ii) To pertain knowledge to the students to provide actionable recommendations to reduce energy consumption, improve system performance and lower operating costs,

(iii) To impart the advance knowledge to students to make them capable for integration of renewable energy sources by reducing demand on traditional power grids.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1	Concept of energy, their types, units, low of conservation.
2-3	To study the principles of energy auditing and analysis.
4-5	To study the techniques of energy audits.
6-9	To collect and analyse energy consumption data for different utilities.
10-12	To interpret energy bills, utility data and meter readings.
13-15	To conduct the energy audits for residential, commercial, and industrial facilities.
16-17	To study the energy auditing tools and equipments - (e.g. Power meters, data loggers, thermal imaging cameras, sensors, etc.).
18-19	Energy data analysis and visualization with the use of software tools
20-21	To identify potential areas for energy savings and efficiency improvements.
22-23	Evaluation of building systems, equipment, and operations in ECOs.
24-27	To identify ECOs through site inspections and data analysis of different energy consuming utilities.
28-29	To study the energy-efficient technologies and best practices in lighting, HVAC, insulation, appliances, etc.
30-33	Demonstration of energy-saving devices and equipments.
34-38	To study case studies of successful energy efficiency projects.

Continued…

39-44	Analysis of building energy performance using energy modelling software.
45-47	To study the possibilities of integration of renewable energy systems (Solar PV, Wind, Geothermal, etc.) with energy conservation and efficiency measures
48-50	To study the energy efficiency policies, regulations, and incentives at local, national, and international levels.
51-53	To study the energy efficiency standards, labeling programs, and building codes
54-56	To study the cost-benefit analysis, return on investment (ROI) calculations and lifecycle cost analysis.
57-59	To study the use of measurement and verification (M&V) protocols.
60-64	To visit energy efficient industries/utilities and SEC Report preparation.

Suggested Readings: [SEC-xxx]

1. Guidebook: 1-4, Bureau of Energy Efficiency, New Delhi
2. Fluck R. C. and Baired C.D. 1984. Agricultural Energetics, AVI Publ.
3. Kennedy W.J. Jr. and Wayne C Turner 1984. Energy Management, Prentice Hall.
4. Pinental D. 1980. Handbook of Energy Utilization in Agriculture, CRC Press.
5. Rai G.D., Non-conventional Sources of Energy, Khanna Publications, New Delhi.
6. http://www.gcekjr.ac.in/pdf/lectures/2020/2688I_5th%20Semester_Electrical%20Engineering.pdf
7. https://vishwavishwani.ac.in/pdf/7.1.3/Energy-Audit-F.pdf
8. https://beeindia.gov.in/sites/default/files/1Ch3.pdf
9. https://www.teachmint.com/tfile/studymaterial/class-5th/eca/energyconservationauditunit1to5pdf/e8795ada-98cb-4170-a041-f3b4523cfd2f
10. https://egyankosh.ac.in/bitstream/123456789/26354/1/Unit-3.pdf

Course No. : SEC-xxx	Credit Hrs. : 4(0+4)
Course Title : Repair and Maintenance of Pumps and Irrigation Systems	

Objectives : (i) To acquire knowledge in irrigation pumps and motors,
(ii) To enable the students to have basic idea about the installation and maintenance of irrigation pumps and motors.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-3	Study of various water lifting devices, their advantages and limitations
4-6	To study different pumps used in irrigation system
7-9	To study different electric motors used in irrigation system
10-12	Study of components of centrifugal pump
13-15	Study of components of submersible pump
16-18	Study of components of reciprocating pump
19-21	Dismantling and assembling of centrifugal pumps
22-24	Dismantling and assembling of reciprocating pumps
25-27	Dismantling and assembling of submersible pumps
28-30	Performance testing of centrifugal pumps in series and parallel
31-32	Performance testing of reciprocating pumps
33-35	Design and preparation of pump housing
36-38	To study pump alignment and its troubleshooting
39-42	Winding of 3-phase and single-phase electric motor
43-45	To study trouble shooting in electrical pump set and their remedial measures
46-48	To study dismantling and assembling of diesel pump set
49-51	To study maintenance and troubleshooting of diesel pump set
52-54	Regular maintenance and overhauling of pumps
55-57	Study of solar pump set and its components.
58-60	Installation and maintenance of solar pump set
61-62	Selection of suitable pumps for irrigation
63	Visit to Pump Factory
64	Visit to Motor Rewinding Workshop

Suggested Readings [SEC-xxx]

1. A.M. Michael and S.D. Khepar. Water Wells and Pump, Tata McGraw Hill Education Pvt., New Delhi.
2. A.M. Michael Irrigation: Theory & Practice, Vikas Publishing, New Delhi.

Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**4(0+4)**
Course Title	**:**	**Installation and Maintenance of Micro Irrigation Systems**			

Objectives : (i) To give broad view and application areas of subject,

(ii) To enable the student to have basic idea about the subject, applications and different instruments involved in installation and maintenance of micro irrigation systems.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-2	To study different components of micro irrigation system and their functions.
3-6	To study different types of filters used in micro-irrigation system and their adoptability Gravel filters or Media filters, Screen filters, Disc filters and Hydrocyclone filters.
7	Study of different types of pipes used in micro irrigation systems.
8	Study of different types of drippers and their hydraulics.
9-10	Determination of pressure discharge relationship of micro irrigation system.
11	Study of different types of micro sprinklers & their hydraulics.
12	Study of spray distribution patterns of micro sprinklers.
13-14	To study different methods of estimating evapotranspiration.
15-16	To study different methods of computation of crop water requirement.
17-18	To study the different softwares for determining crop water requirement.
19-20	Design of drip irrigation system for field crops.
21-22	Design of drip irrigation system for orchard crops.
23-24	Design of micro-sprinkler irrigation system for vegetable crops/ field crops/ floriculture.
25-26	Design of micro-sprinkler irrigation system for orchards.
27	Estimation of power requirement and selection of pump.
28-31	To study of different types of equipments for Fertigation Venturi, Fertilizer Tank Pressure bypass, Tank Injection Pumps.
32	To study the operation and maintenance of fertigation equipments.
33	Determination of fertilizer injection rate.
34	Determination of capacity of fertilizer tank.
35-36	Computation of fertilizer quantities and doses for different crops.
37-38	Application of liquid fertilizers through micro irrigation.

Continued…

39-40	Application of water-soluble fertilizers through micro irrigation.
41-42	Installation of head unit of micro irrigation system.
43-44	Installation of drip irrigation system.
45-46	Installation of micro sprinkler system.
47	Performance evaluation of drip irrigation system.
48	Performance evaluation of micro sprinkler system.
49	Weekly schedule of maintenance of drip & micro sprinkler irrigation systems.
50	Monthly schedule of maintenance of drip & micro sprinkler irrigation systems.
51	Seasonal schedule of maintenance of drip & micro sprinkler irrigation systems.
52-53	Automation in drip and micro sprinkler irrigation system.
54-57	Study and operation of different components of automation in drip and micro sprinkler irrigation system.
58-59	Study of different IOT-based drip and micro sprinkler irrigation systems.
60-61	Operation of different IOT-based drip and micro sprinkler irrigation systems.
62-64	Field Visit to automated micro irrigation system.

Suggested Readings [SEC-xxx]

1. M.S. Mane, B.L. Ayare, S.S. Magar. Principles of Drip Irrigation, Jain Brothers, New Delhi
2. M.S. Mane, B.L. Ayare. Principles of Sprinkler Irrigation Jain Brothers, New Delhi
3. K.N. Tiwari T.B.S. Rajput. Micro Irrigation System Designs Agrimoon website of ICAR
4. A.M. Michael. Irrigation: Theory & Practice, Vikas Publishing, New Delhi
5. K.N. Tiwari N.S. Raghuwanshi, Irrigation Engineering, Agrimoon website of ICAR.

Course No. : SEC-xxx	Credit Hrs. : 4(0+4)
Course Title : Geophysical Survey and Investigations for GW Exploration and Instruction of Tubewell/ Borewell	

Objectives : (i) To give a broad view and application areas of subject,

(ii) To enable the student to have basic idea about the subject, applications and different instruments involved in field operations and allied activities.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1	Study of different types of water bearing formations.
2	Study of different hydro-geological formations.
3	To study the electric resistivity method.
4	To study the seismic refraction method.
5	To study the other methods of geophysical survey.
6	To study the different components of resistivity meter.
7-8	To study the electric resistivity survey using Wenner method.
9	To study the electric resistivity survey using Schlumberger method.
10-11	Comparison of Wenner and Schlumberger method.
12-14	To study the field process for identification of bore pots (point) (2 pin method).
15-17	To study the geological formation using 4 pin method.
18-20	Analysis of the survey data of electrical resistivity meter and its interpretation.
21-22	Study of different types of well log.
23	Study of test drilling and geological log.
24-25	Study of resistivity logging and other miscellaneous logging techniques.
26-27	Study of different types of water.
28-29	Study of different types of open wells.
30-31	Study on different types of tube well-based construction method depth entry of water and types of aquifer.
32-33	Study of different components of tube well (housing pipe, casing pipe, screen, gravel pack).
34-35	Study of different tube well drilling equipments and methods.

Continued…

36-37	Study of precession drilling methods and their components (Hand Boring, Mechanical Percussion boring).
38-39	Study of different hydraulic rotary drilling methods (Direct circulation & Reverse circulation).
40-41	Study of drilling problems in Reverse rotary.
42-43	Study of miscellaneous Drilling methods.
44-45	Study of different types of screen wells and their desirable features.
46-47	Study of plastic pipes for tube well casing strainers and accessories.
48-49	Study of practice size distribution of the aquifer.
50	To study the design of gravel pack and design criteria for gravel pack.
51	Study of different gravel pack material and screening of gravel.
52	To study the objectives of well development.
53	To study the different methods of well development.
54	Study of over pumping methods of well development.
55	Study of surging (Surger block and bailing) methods of well development and adoptability.
56	Study of surging (pumping with compressed air) methods of well development and adoptability.
57	Study of back washing method of well development.
58	Study of high velocity jetting method of well development.
59	Study of fracturing and chemical treatments of well development.
60	Studies on choice of well development method and testing.
61	Common cause of contamination and their remedies.
62	Sanitary protection of wells and pollution travel in soils and aquifers.
63	Location and design of wells with sanitary protection.
64	Study of disinfection of wells.

Suggested Readings [SEC-xxx]

1) David Keith Todd. Ground Water Hydrology, Second Edition, Published by John Wiley & Sons.
2) A.M. Michael, S.D. Khepar, S.K. Sondhi. Water, Wells and Pumps, Second Edition, Published by Tata McGraw – Hill Education Pvt. Ltd., New Delhi.
3) Manual of Soil Resistivity Meter (*Available online*).

Course No. : SEC-xxx	Credit Hrs. : 4(0+4)
Course Title : Application of Remote Sensing and GIS for Agricultural Water Management	

Objectives :

(i) To gain a solid understanding of the principles, technologies, and methodologies used in Remote Sensing (RS) and Geographic Information Systems (GIS),

(ii) To learn how to extract, analyze and visualize geospatial data,

(iii) To develop the skills to collect, down load, and process Remote Sensing data (e.g. satellite imagery) for agricultural applications,

(iv) To analyze and interpret remote sensing data to assess key vegetation and water-related parameters such as soil moisture, vegetation health and irrigation efficiency,

(v) To delineate watershed, preparation of drainage map, contour map using Digital Elevation Model (DEM) in GIS.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1	Understanding of basics of Remote Sensing.
2	Understanding of different types of Remote Sensing sensors and platforms.
3	Understanding of basics of GIS and its components.
4	Study of different types of projection systems.
5	Study of image resolution and coordinate system.
6	Study of different sources for acquiring remote sensing data.
7-8	To familiarize with the main modules of ArcGIS software and Data Input.
9-10	To familiarize with the main modules of QGIS software and Data Input.
11-12	Hands-on experience in downloading Survey of India (SOI) toposheets.
13-14	To assign spatial reference or georeference and projection to given Toposheet or Map.
15-16	Understanding raster data and vector data operations.
17-18	To digitize Toposheet using ArcGIS. Creating point, line and polygon layer in ArcGIS. Creation of shape file in ArcGIS.
19-20	Preparation of watershed and base map from SOI toposheets.
21-22	Preparation of contour map from SOI toposheets.
23-24	Preparation of drainage map from SOI toposheets.
25-26	Preparation of Rainfall Thiessen polygon map.

Continued…

27-28	To compose the map by adding map components, layout and Exporting Map.
29-30	Hands-on experience in downloading DEM data (SRTM, Cartosat).
31-32	To mosaic two or more raster images in ArcGIS.
33-34	Delineation of watershed from DEM using ArcGIS.
35-36	Preparation of drainage map from DEM using ArcGIS.
37-38	To add attribute data to the shapefile or layer and querying on attribute data.
39-40	Preparation of contour map from DEM using ArcGIS.
41-42	Hypsometric analysis of watershed using ArcGIS.
43-44	Hands-on experience in downloading administrative and watershed boundary.
45-46	Morphometric analysis of watershed using ArcGIS.
47-48	To perform Vector Analysis using Geoprocessing Tools (Buffer, Clip, Intersect, Dissolve, Merge, Union) using ArcGIS.
49-50	To convert raster map to vector layer and vector layer to raster by using ArcGIS.
51-52	Hands-on experience in downloading and processing remote sensing images (e.g., Landsat, Sentinel data).
53-54	Preparation of Normalized Difference Vegetation Index (NDVI) map in ArcGIS.
55-56	Preparation of Green Normalized Difference Vegetation Index (GNDVI) map in ArcGIS.
57-58	Preparation of Soil-Adjusted Vegetation Index (MSAVI) map in ArcGIS.
59-60	Preparation of Modified Soil-Adjusted Vegetation Index (MSAVI) map in ArcGIS.
61-62	Preparation of Normalized Difference Water Index (NDWI) map in ArcGIS.
63-64	Preparation of Enhanced Vegetation Index (EVI) map in ArcGIS.

Suggested Readings [SEC-xxx]

1. Reddy Anji, M. 2006. Textbook of Remote Sensing and Geographical Information Systems. 4th Edition, BS Publications, Hyderabad.
2. George Joseph. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad
3. Lillesand, T., R.W. Kiefer and J. Chipman. 2015 Remote Sensing and Image Interpretation. 6 th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.
4. Sabins, F. F. 2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA.
5. Suresh, R. (1997). Soil and Water Conservation Engineering, Second edition, Standard Publisher Distributors, Delhi, India.
6. https://vardhaman.org/wp-content/uploads/2021/03/GeographicalInformation-Lab-1.pdf
7. https://eos.com/blog/vegetation-indices/
8. https://www.cropin.com/blogs/vegetation-index-for-precision-agriculture

Course No. : SEC-xxx	Credit Hrs. : 4(0+4)
Course Title : Operation and Maintenance of Hydro-meteorological Instruments	

Objective : To enhance the skill in management and maintenance of hydro meteorological instruments used in monitoring hydrological and meteorological parameters needed in watershed management, monitoring and climate change studies etc.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-3	Visit to Agro-meteorological Field Laboratory.
4-5	Study and operation of Barometer to measure atmospheric pressure.
6-7	Study and operation of hygrometer (Steven's screen) to measure relative humidity.
8-9	Study and operation to measure soil temperature.
10-11	Study and operation of Anemometer (Wind speed, direction, etc.).
12-13	Study and operation of Pyranometer.
14-15	Study and operation to measure dew.
16-18	Components of an automatic weather station (AWS).
19-20	Installation of AWS and its maintenance.
21-23	Study of rainfall measuring instruments i.e. Automated rain gauges, manual rain gauge and data analysis.
24-25	Calibration and installation of Tipping bucket rain gauge.
26-27	Installation of open pan evaporimeter and periodic maintenance.
28-29	Study of infiltration process using ring infiltrometer and data analysis.
30-31	Measurement of flow in open channels using notches (V-notches, Trapezoidal notch and Orifice).
32-33	Measurement of flow in partial flume and H flumes.
34-35	Study of different weirs and flumes for flow measurement.
36-37	Installation and measurement of flow from weirs and flumes in the channel.
38-39	Measurement of soil moisture using gravimetric method.
40-41	Measurement of soil moisture using field methods (Calcium carbide, Alcohol methods).

Continued…

42-44	*In-situ* measurement of soil moisture using different soil moisture sensors, TDR.
45-46	Installation of digital water level recorder (DWLR).
47-49	Measurement of groundwater level using ground water level recorder.
50-51	Study of multi-slot divisor silt sampler for measurement of soil loss.
52-54	Study of Coshocton wheel silt sampler for measurement of soil loss.
55-56	Measurement of flow velocity using digital current meter.
57-58	Procedure for recording field observations.
59-60	Troubleshooting of hydro-meteorological instruments.
61-64	Visit to Field Laboratories related to hydrological instruments in the watershed.

Suggested Readings [SEC-xxx]

1. Gadekar S R., 2008. Agricultural Meteorology, Agromet Publishers, Nagpur, ISBI No. 819220734X, 9788192207346 Pp: 143
2. Wasi Ulha, S K Gupta and S S Dalal, 1972. Hydrological Measure for Watershed Research, Published by Jugal Kishor and Company, Deharadun (India),
3. Anonymous. 2020. Hand Book Hydro Meteorological Observation. Published by Ministry of Jal Shakti. New Delhi. Pp: 213.
4. Murti V V N and M K Jha 2011. Land and Water Management. Engineering, Kalyani Publisher, New Delhi. Sixth Edition.
5. Zante P and U R Ambre. 2002. The TDR Technology for Soil Moisture Measurement. INRA-ENSAM, Montpellier, France.
6. Harry Diamond and Wilbur S. Hinman. 1940. An Automated Weather Station. National Bureau of Standards. Part of Journal of Research of the National Bureau of Standards, Vol. 25.

Course No. : SEC-xxx	Credit Hrs. : 4(0+4)
Course Title : Installation and Maintenance of Rooftop Rainwater Harvesting System (RWHS)	

Objectives :

(i) To enhance the necessary skills to design, implement and maintain rainwater harvesting systems (RWHS),

(ii) To promote sustainable practices and reducing water consumption in various sectors,

(iii) To assess roof top water harvesting,

(iv) To evaluate roof top water harvesting system,

(v) To encourage conservation efforts that complement the integration of roof top water harvesting system.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-2	Introduction to Water Resources of India, Rain/ rooftop Water Harvesting-Concepts.
3-5	Computation of additional recharge to ground water.
6-9	Advantages of rainwater harvesting, need for roof top rainwater harvesting.
10-12	Rain water Harvesting Regulations as per DCR/ building byelaws in different Cities of India.
13-14	Survey and site selection for RWHS.
15-16	Computation of rooftop RWH potential and runoff coefficient.
17-18	Study of components of RWH System.
19-21	Study of Catchments: Grading and plastering of rooftop.
22-23	Study of Coarse mesh, gutters; roofing materials.
24-27	Study of Conduit: material, size of conveyance pipe.
28-29	Study of types of filter system used in RWH system and material used.
30-33	Study of storage tank: capacity, overflow pipe, uses.
34-38	Study of suitable recharge structure for ground water and techniques.
39-44	Study of constructional details of recharge pits, recharge trench and trench.
45-47	Study of types of contaminants in RWH system, Analysis etc.
48-50	Study of Hand pumps and its application in RWH system.
51-53	Case study of roof top water harvesting system.
54-58	Preparation of Detailed Project Report with cost estimation.
59-61	To visit roof top water harvesting systems- household buildings.
62-64	Policy issues on Rainwater Harvesting in India.

Suggested Readings [SEC-xxx]

1. Manual on Artificial Recharge of Groundwater, Government of India, Ministry of Water Resources Central Ground Water Board, September 2007, Page No. 102 to 131.
2. Rooftop Rainwater Harvesting – An Innovative Approach toward Resource Conservation, Indian Farming, 73(07) July-2023.
3. Manual for Rooftop Rainwater Harvesting Systems- in the Republic of Yemen.
4. Water Harvesting and Recycling: Indian Experiences (2002) J.S. Samra, Central Soil and Water Conservation Research & Training Institute.
5. https://www.raincentre.net/downloads/pdf/RAIN_HARVESTIN_1.pdf
6. https://nwm.gov.in/sites/default/files/IS-15797-Rainwater_Haresting_Roof_Top.pdf
7. https://www.hyderabadwater.gov.in/en/themes/HMWS/downloads/rainwaterharvesting.pdf
8. https://jsactr.mowr.gov.in/Public_Dash/download/Rain_Water_Harvesting_Conservation_Manual_2019-CPWD_compressed.pdf
9. https://www.bebuffered.com/downloads/Rain%20Water%20Harvesting%20Manual%20-%20WEC-1.pdf
10. https://cwas.org.in/resources/file_manager/module_3-3_1_rwh_guidelines.pdf
11. Kumari, P. (2009). Design & Policy Issues on Rainwater Harvesting in India. Retrievable from Academia: http://www.academia.edu/242362/Design_and_Poliy_Issues_on_Rainwater_Harvesting_in_India

Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**4(0+4)**
Course Title	**:**	**Operation and Maintenance of Soil Conservation Structures**			

Objectives :

(i) To preserve topsoil and reduce weakening in soil fertility and the water holding capacity, thus sustaining productivity,

(ii) To increase the groundwater recharge by sustaining the soil moisture retention capacity of the soil,

(iii) To maintain the land productivity and prevent shrinkage of arable area,

(iv) To reduce the dredging work due to sedimentation in creeks, rivers, lakes and reservoirs,

(v) To minimize the flooding risk that affects the sustainability and livelihoods of humans, animals and plants,

(vi) To control ecosystems' deterioration due to soil loss.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-3	To conduct contour survey, Preparation of contour map.
4-6	To study stream order; land use and land cover.
7-9	To study the selection of suitable sites for various soil and water conservation structures based on survey.
10-12	Ground truthing of various soil conservation structures.
13-16	To study different location specific soil conservation structures.
17-18	To study CCT and SCT and diversion drains.
19-22	To study contour bunds, graded bunds and their features.
23-26	To study types of terraces and their features.
27-29	To study drop spillway, its components, functions and site suitability.
30-32	To study drop inlet spillway, its components, functions and site suitability.
33-35	To study chute spillway, its components, functions and site suitability.
36-40	To study various check dams, site suitability and their construction.
41-44	To study construction material of various soil conservation structures.
45-50	Cost estimation of various soil conservation structures.

Continued…

51-52	Planning for outline of detailed Project Report.
53-54	Preparation for location and related information compilation for Detailed Project Report (DPR).
55-56	Compilation of Participatory Rural Appraisal (PRA) for Project Report.
57-58	Tabulation of data sets for detailed Project report.
59-60	Preparation of graphs and mapping for detailed Project Report.
61-62	Capacity building, Phasing of programme and Budgeting for DPR.
63-64	Preparation of brief information/ summary related to socio-economic feasibility and expected outcome.

Suggested Readings [SEC-xxx]

1. Mal, B.C. (1995). Introduction to Soil and Water Conservation Engineering, Kalyani Publishers, New Delhi
2. Michael, A.M. and Ojha, T.P. (1978). Principles of Agricultural Engineering, Vol. II, Jain Brothers, New Delhi, India.
3. Morgan, R.P.C. (2005). Soil Erosion and Conservation, 3rd edition, Blackwell Publishing, UK.
4. Murthy, V.V.N. (1994). Land and Water Management Engineering, Kalyani Publishers, New Delhi. Schwab, Glenn O., Frevert, Richard K., Edminster, Talcott W., and Barnes, Kenneth K. (1981). Soil and Water Conservation Engineering, Third edition, John Wiley and Sons, New York.
5. Suresh, R. (1997). Soil and Water Conservation Engineering, Second edition, Standard Publisher Distributors, Delhi, India.
6. Sharda, V.N., Juyal, G.P., Prakash, C. and Joshi, B.P. (2007). Training Manual on Soil Conservation and Watershed Management, Vol. II: Soil and Water Conservation Engineering, CSWCRTI, Dehradun, Saraswati Press, Dehradun, India.

Course No. : SEC-xxx	Credit Hrs. : 4(0+4)
Course Title : Construction, Management and Maintenance of Protected Cultivation Structures	

Objectives :

(i) Understanding the concept and importance of protected cultivation,

(ii) Learning about different types of protected structures, such as greenhouses, polyhouses and shade net houses,

(iii) Learning about the design, construction, and management of protected structures,

(iv) Learning: how to optimize plant growth and yield.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-4	Visit to Commercial greenhouse complex/ Protected structure.
5-10	Layout of protected structure as per requirement (500 sq m, 1000 sq m).
11-15	Selection of construction material with standard specifications.
16-20	Quality evaluation of standard material (covering material, pipes, purlins, uv film, mulching paper) using various instruments.
21-24	Cost estimation for construction of protected structure/ greenhouse.
25-28	Estimation of material requirement for preparation of root media.
29-34	Measurement of greenhouse environmental parameters (Temp., RH, Solar radiations, CO_2, Air velocity etc.) and prepare profiles of these parameters.
35-36	Measurement of greenhouse environmental parameters such as, Soil temperature, pH and EC.
37-42	Study of different greenhouse environment control instruments.
43-48	To design the fan and pad system in greenhouse.
49-54	Cultivation of Tomato, Capsicum and Cucumber: Bed preparation and Support system.
55-58	Economic analysis of protected structures.
59-64	Design of 500 sq m and 1000 sq m protected structures.

Suggested Readings: [SEC-xxx]

1. Vilas M. Salokh and Ajay K. Sharma Greenhouse Technology and Applications, Agrotech Publishing Academy, Udaipur (Raj.)
2. G. N. Tiwari. Greenhouse Technology for Controlled Environment, Narosa publishing house, New Delhi/ Mumbai.
3. Paul V. Nelson Greenhouse operation and management Prentice Hall, New Jersey – 07458.
4. Singh Brahma and Balraj Singh Advances in Protected Cultivation, New India Publishing Company, New Delhi.
5. Sharma P., Precision Farming, Daya Publishing House, New Delhi.

Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**4(0+4)**
Course Title	**:**	**Maintenance of Hydroponic Structures**			

Objectives : (i) To develop the ability to make informed decisions about managing hydroponic crops,

(ii) To gain expertise in Hydroponics,

(iii) To equip students with a deep understanding of hydroponics and the skills required to effectively manage and maintain hydroponic systems, securing employment opportunities as Hydroponics Consultants and Growers.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-5	To study the preparation of root chamber for plants and optimal conditions for root development.
6-10	To study how to prepare the nutrient solution, maintaining the recommended ratio of water, nutrients and hormones essential for plant growth.
11-15	To study the importance of regular repair and maintenance tasks to ensure the proper functioning of the Aeroponic farm system.
16-20	To study the importance of regular repair and maintenance tasks to ensure the proper functioning of the Hydroponic farm system.
21-25	To study the NFT channel slope by maintaining uniformity of nutrient solution.
26-30	To study the application of nutrient solution to trays and pots in recommended quantities.
31-35	To study the creation of holes in PVC pipes and insert plants in plastic net pots for DFT systems.
36-40	To study the process of suspending plants in growing tubes within the Hydroponic system.
41-45	To study the drainage techniques to prevent water-logging and regular maintenance of motors, pumps and trays.
46-50	To study how to monitor and adjust pH levels using recommended treatments to maintain water quality.
51-55	To study misting techniques for temperature control and the use of shade nets for aeration and protection against pests.
56-60	Visit to different Hydroponic structures.
61-64	Designing the Hydroponic system.

Suggested Readings: [SEC-xxx]

1. P.S. Naik and Tanuja Buckseth. 2018. Recent Advances in Virus Elimination and Tissue Culture for Quality Potato Seed Production. In: Biotechnologies of Crop Improvement (SS Gosal Eds.). Springer International Publishing Volume 1, pp.131-158.
2. Seed Potato Production Techniques (Principles & Applications) URL: http://14.139.61.83/Ebook_SeedProductionTechniques/Main_Page.htm
3. Singh, R.K., Buckseth, Tanuja, Tiwari, J. K., Sharma, Ashwani K., Singh, Vinay, Kumar, Dhruv, Venkatsalam, E. P., Singh, Raj Kumar, Sadawarti, Muralidhar, Challam, Clarissa & Swarup K. Chakrabarti. 2019. Seed Potato (*Solanum tuberosum* L.) Production System in India: A Chronological Outlook. Indian Journal of Agricultural Sciences, 89 (4): 578-87
4. Tanuja Buckseth, A.K. Sharma, K.K. Pandey, B.P. Singh and R. Muthuraj, 2016. Methods of Pre-basic Seed Potato Production with Special Reference to Aeroponics - A Review. Scientia Horticulturae, 204: 7987.
5. Tanuja Buckseth, Singh RK, Sumita Sharma, Ashwani K Sharma and Chakrabarti, SK (2017) Training-cum-Laboratory Manual on Hi-tech Seed Potato Production. ICAR-Central Potato Research Institute, Shimla, Himachal Pradesh, India. 46 p.
6. Training Manual on Advancement in Potato Production Technology and its Future Prospects‖. By Dr. S.K. Chakrabarti Course Director Dr. Manoj Kumar Course Coordinators Dr. Anuj Bhatnagar Dr. Mehi Lal Organized By ICAR-Central Potato Research Institute Regional Station, Modipuram, Meerut– 250110 (UP).
7. Training Manual on Protected Cultivation, Post-Harvest Technology, Value Addition and Supply Chain Management in Potato‖. By Vijay Kumar Dua NK Pandey Pooja Mankar SK Chakrabarti Sponsored by Directorate of Extension, Ministry of Agriculture and Farmers Welfare Government of India, New Delhi, Organized by ICAR - Central Potato Research Institute, Shimla- 171 001, Himachal Pradesh.

Course No. : SEC-xxx	Credit Hrs. : 4(0+4)
Course Title : Use of IoT in Agricultural Structures	

Objectives :

(i) Skill enhancement to monitor crop fields using sensors and automating irrigation systems,

(ii) To sense, transmit and calculate various environmental information,

(iii) To improve crop quality and quantity, reduce expenses and increase farm efficiency,

(iv) To identify and solve the problems quickly, increasing crop quantity, while maintaining efficiency,

(v) To collect real-time data on weather conditions: temperature, rainfall, humidity, light, pH and soil moisture to improve crop yield and output.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-5	Identification and selection of various types of sensors used in Smart Agriculture.
6-10	Positioning the appropriate sensors and collection of the information required in Smart Agriculture.
11-15	Identification and installation of the devices used in green house.
16-20	Monitoring soil moisture, pH, temperature, relative humidity, etc. & record data.
21-25	Selection of plant health monitoring system and application of proper water, fertilizer, etc.
26-30	Identification, selection and operation of drone in various applications.
31-35	Measurement of CO_2, solar radiation/oxygen for green house/ protected structures.
36-40	Industrial visit for the applications of IoT.
41-45	Application of IoT in Agriculture structures.
46-50	Study of applications of Arduino programming.
51-55	Development of Smart App for measuring environmental parameters in agricultural structures.
56-60	Application of Sensor-based IoT in Dairy barn structure.
61-64	Application of IoT in Poultry house structure.

Suggested Readings: [SEC-xxx]

1. Singh Nirmal, A.K. Suwaika, G. Gugalia. 2023. Trends in Agriculture using IoT. Akinik Publications, New Delhi.
2. Tofael Ahamed. 2023. IoT and AI in Agriculture. Springer.

Course No. : SEC-xxx	Credit Hrs. : 4(0+4)
Course Title : Installation, Repair and Maintenance of Shade Net Houses	

Objectives : (i) Understanding the concept and importance of cultivation in shade net structures,
(ii) Learning about different types of shade net structures,
(iii) Learning about the design, construction and management of shade net structures,
(iv) Learning how to optimize plant growth and yield.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-5	Visit to different types of Shade net structures.
6-10	Layout of Shade net house structure as per requirement (100 sq m, 500 sq m, 1000 sq m).
11-15	Selection of site as per cropping pattern.
16-20	Selection of Shade net house material with standard specifications.
21-25	Cost estimation of Shade net house (100 sq m, 500 sq m, 1000 sq m).
26-30	Quality evaluation and specification of standard material (Shade net, pipes, purlins, UV film, mulching paper) using various instruments.
31-35	Excavation procedure for foundation and erection of the Shade net structure.
36-40	Fixing of cladding/ covering material, UV film during erection of Shade net structure.
41-45	Measurement of greenhouse environmental parameters (Temp., RH, Solar radiations, CO_2, Air velocity etc.) and prepare profiles of these parameters.
46-50	Measurement of Greenhouse environmental parameters such as soil temperature, pH and EC.
51-55	Cultivation of high value vegetables in Shade net structures.
56-60	Economic analysis of Shade net structures.
61-64	Design of 500 sq m and 1000 sq m Shade net structure.

Suggested Readings: [SEC-xxx]

1. Singh Brahma and Balraj Singh, Advances in Protected Cultivation, New India Publishing Company, New Delhi.
2. Sharma P. Precision Farming. Daya Publishing House New Delhi.

Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**4(0+4)**
Course Title	**:**	**Maintenance of Aeroponics Structures**			

Objectives : (i) To develop the ability to make informed decisions about managing Aeroponics crops,

(ii) To gain expertise in Aeroponics,

(iii) To equip students with a deep understanding of Aeroponics and the skills required to effectively manage and maintain Aeroponics systems, securing employment opportunities as Aeroponics Consultants and Growers.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-4	To study the preparation of root chamber for plants and optimal conditions for root development.
5-10	To study how to prepare the nutrient solution, maintaining the recommended ratio of water, nutrients and hormones essential for plant growth.
11-15	To study the importance of regular repair and maintenance tasks to ensure the proper functioning of the Aeroponics Farm System.
16-20	To analyze the impact of environmental factors and system calibration on the efficiency of an Aeroponics Farm System. Or ?
21-24	To study the placement of nozzles for uniform spread of spray.
25-28	To study applying the nutrient solution to trays and pots in recommended quantities.
29-34	To study the creation of holes and insert plants in plastic net pots.
35-36	To study the process of suspending plants within the aeroponics system.
37-42	To study drainage techniques to prevent waterlogging and regular maintenance of motors, pumps and trays.
43-50	To study how to monitor and adjust pH levels using recommended treatments to maintain water quality.
51-55	To study misting techniques for temperature control and the use of shade nets for aeration and protection against pests.
56-64	Visit to different Aeroponics and Hydroponic structures.

Suggested Readings: [SEC-xxx]

1. P.S. Naik and Tanuja Buckseth. 2018. Recent Advances in Virus Elimination and Tissue Culture for Quality Potato Seed Production. In: Biotechnologies of Crop Improvement (SS Gosal Eds.). Springer International Publishing, Volume 1, pp.131-158
2. Seed Potato Production Techniques (Principles & Applications) URL: http://14.139.61.83/Ebook_SeedProductionTechniques/Main_Page.htm
3. Singh, R.K., Buckseth, Tanuja, Tiwari, J.K., Sharma, Ashwani K., Singh, Vinay, Kumar, Dhruv, Venkatsalam, E.P., Singh, Raj Kumar, Sadawarti, Muralidhar, Challam, Clarissa & Swarup K. Chakrabarti. 2019. Seed Potato (*Solanum tuberosum* L.) Production System in India: A Chronological Outlook. Indian Journal of Agricultural Sciences 89 (4): 578-87.
4. Tanuja Buckseth, A.K. Sharma, K.K. Pandey, B.P. Singh and R. Muthuraj, 2016. Methods of Pre-basic Seed Potato Production with Special Reference to Aeroponics - A Review. Scientia Horticulturae, 204: 7987.
5. Tanuja Buckseth, Singh R.K., Sumita Sharma, Ashwani K. Sharma and Chakrabarti, S.K. (2017). Training-cum-Laboratory Manual on Hi-tech Seed Potato Production. ICAR-Central Potato Research Institute, Shimla, Himachal Pradesh, India. 46 p.
6. Training Manual on Advancement in Potato Production Technology and its Future Prospects. By Dr. S.K. Chakrabarti Course Director Dr. Manoj Kumar Course Coordinators Dr. Anuj Bhatnagar Dr. Mehi Lal organized By ICAR-Central Potato Research Institute Regional Station, Modipuram, Meerut - 250 110 (UP).
7. Training Manual on Protected Cultivation, Post-Harvest Technology, Value Addition and Supply Chain Management in Potato. By Vijay Kumar Dua, N.K. Pandey, Pooja Mankar, S.K. Chakrabarti. Sponsored by Directorate of Extension, Ministry of Agriculture and Farmers' Welfare, Government of India, New Delhi Organized by ICAR-Central Potato Research Institute, Shimla - 171 001, Himachal Pradesh.

Course No. : SEC-xxx	Credit Hrs. : 4(0+4)
Course Title :	**Role of Bamboo in Agricultural Structures, Value Addition through Product Diversification and Waste Utilization**

Objectives : (i) To gain hands-on training on bamboo processing and value-added products for undergraduate students in Agricultural Engineering,

(ii) To cultivate capabilities of marketing and sale of bamboo products and build entrepreneurship spirit and business management competence among the students.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-4	To study the methods of sap removal from bamboo.
5-8	Chemical treatment of bamboo for preservation.
9-12	Bamboo harvesting problems and solutions.
13-16	Study of Bamboo Handicrafts.
17-20	Study of Bamboo Furniture.
21-24	Study of Bamboo Resorts.
25-28	Study of Bamboo Structures.
29-32	Demonstration of bamboo charcoal and vinegar preparation.
33-36	To study the medicinal properties of bamboo vinegar.
37-38	Preparation of briquettes from bamboo and other waste material.
39-40	Demonstration of edible products of bamboo.
41-42	Bamboo reinforcement in cement concrete for rural housing.
43-44	Preparation of Bamboo Nursery.
45-46	Bamboo green house for nursery for hardening.
47-48	Bamboo green house for vegetables.
49-50	Bamboo fibre extraction and its utilization.
51-52	Demonstration of bamboo processing machineries.
53-56	Manufacturing of decorative bamboo pieces.
57-58	Bamboo grain storage structures.
59-60	Low-cost bamboo dryers for grain drying.
61-62	Visits to Bamboo Factories.
63-64	Visits to Bamboo Nurseries/ Research Stations.

Suggested Readings: [SEC-xxx]

1. www.bambus\new\eng\reports\buildingmaterial\buildingmaterial.html
2. Performance evaluation of bamboo reinforced concrete by Leena Khare. An Unpublished Thesis submitted to The University of Texas at Arlington. December 2005.
3. IS: 875 (Part I, II, III) – 1987. Code of Practice for Design Loads for Buildings and Structures. Bureau of Indian Standards, New Delhi
4. Anonymous (2004). Structural Design Manual. National Greenhouse Manufacturers Association, Harrisburg, PA. www.ngma.com Lekshmi S. Sukumaran (2022). Bamboo Housing. Laurie Baker Centre, COSTFORD 2022
5. IS: 1902–2006. Preservation of Bamboo and Cane for Non-structural Purposes- Code of Practice. Bureau of Indian Standards, New Delhi.

Course No. : SEC-xxx	Credit Hrs. : 4(0+4)
Course Title : Manufacturing of Cement Blocks and Stone Waste Utilization	

Objectives : (i) To conduct hands-on training on Manufacturing of cement blocks and stone waste utilization for undergraduate students in Agricultural Engineering,

(ii) To cultivate capabilities of marketing and sale of cement blocks and build entrepreneurship spirit and business management competence among students.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-4	Study of Water-Cement ratio.
5-8	Proportioning of ingredients for block making.
9-12	Mixing of ingredients for cement block preparation.
13-16	Curing of cement blocks.
17-20	Test for normal consistency of cement.
21-24	Test for soundness of cement.
25-28	Test for setting times of cement.
29-32	Test for quality of sand.
33-36	Coarse aggregate impact test.
37-40	Slump cone apparatus test.
41-44	Compaction factor apparatus test.
45-48	Compression test of blocks.
49-52	Yield calculation of blocks.
53-56	Bureau of Indian Standards for construction with block.
57-60	Cost estimation of cement blocks.
61-64	Preparation of Test Reports.

Suggested Readings: [SEC-xxx]

1. Veegese P.C. 2005. Building Materials. PHI Learning P. Ltd., 97, Connaught Circus, New Delhi.
2. Rangwala S.C. 1994. Engineering Materials. Charotar Publishing House, Anand.
3. Rangwala S.C. 2007. Building Construction. Charotar Publishing House, Anand.
4. Chakraborti, M. 2012. Estimating, Costing, Specification and Valuation in Civil Engineering. Monojit Charaborti, 21 B, Bhabananda, Kolkata.

Course No. : SEC-xxx	Credit Hrs. : 4(0+4)
Course Title : Testing of Engineering Materials	

Objectives : (i) To conduct hands-on training on testing procedure for various materials,
(ii) To create awareness regarding quality of material among stakeholders.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-4	Study of different types of rocks.
5-10	Study of water absorption of stone and brick materials.
11-15	Determination of soundness of cement by Lechatelier apparatus.
16-20	To determine fineness of cement.
21-24	Test of adhesiveness of mortar to building units.
25-28	To determine standard consistency of cement.
29-34	To determine initial setting time of cement.
35-39	To test workability of cement by Slump cone method.
40-45	To test workability of cement by Compaction factor method.
46-49	Determination of Bulking of sand and silt content in the sand.
50-54	To determine void ratio and bulk density of cement.
55-58	To determine void ratio and bulk density of fine aggregate.
59-64	To determine void ratio and bulk density of coarse aggregates.

Suggested Readings: [SEC-xxx]

1. Veegese P.C. 2005. Building Materials. PHI Learning P. Ltd., 97, Connaught Circus, New Delhi.
2. Rangwala S.C. 1994. Engineering Materials. Charotar Publishing House, Anand.
3. Rangwala S.C. 2007. Building Construction. Charotar Publishing House, Anand.
4. Chakraborti M. 2012. Estimating, Costing, Specification and Valuation in Civil Engineering. Monojit Chakraborti, 21 B, Bhabananda, Kolkata.

Course No. : SEC-xxx	Credit Hrs. : 4(0+4)
Course Title : Estimating and Costing of Agricultural Structures	

Objectives : (i) To study various types of estimates regarding Agricultural Structures,
(ii) To study of SSR,
(iii) To find total cost of the project including rate analysis and SSR rates.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-4	To workout estimate of residential building.
5-10	To workout estimate of dairy barn.
11-15	To workout estimate of poultry/ goat house.
16-20	To workout estimate of godowns.
21-24	To workout estimate of greenhouse/ shed net house.
25-28	To workout estimate of water conservation structure: cement plug.
29-34	To workout estimate of water conservation structure: earthen plug.
35-36	To workout estimate of water conservation structure: gulley plugs.
37-42	To workout estimate of bunding (contour bunding, graded bunding, compartmental bunding).
43-48	To workout estimate of wells/ RCC wells.
49-54	To workout estimate of lift irrigation scheme, sprinkler irrigation system and drip irrigation system.
55-58	To workout estimate of surface and subsurface drainage.
59-64	To workout estimate of truss (wooden and steel).

Suggested Readings: [SEC-xxx]

1. Chakraborti, M. 2012. Estimating, Costing, Specification and Valuation in Civil Engineering. Monojit Charaborti, 21 B, Bhabananda, Kolkata.
2. Veegese P.C. 2005. Building Materials. PHI Learning P. Ltd., 97, Connaught Circus, New Delhi.
3. Rangwala S.C. 1994. Engineering Materials. Charotar Publishing House, Anand.
4. Rangwala S.C. 2007. Building Construction. Charotar Publishing House, Anand.

Course No.	**:**	**SEC-xxx**	**Credit Hrs.**	**:**	**4(0+4)**
Course Title	**:**	**Agro-Processing Methods, Equipment Operation and Maintenance**			

Objectives : (i) To develop entrepreneurship among students through Agro-processing,
(ii) To enhance the skill for operation and maintenance of agricultural processing machineries,
(iii) To enable the students to have the knowledge of packaging of agricultural commodities.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-3	Study on cleaning of cereals, pulses and oilseeds.
4-5	Study on cleaning of fruits and vegetables.
6-7	Operation and maintenance of different types of grain cleaner.
8	Study on grading of agricultural commodities.
9-10	Operation and maintenance of different types of grader.
11	Operation and maintenance de-stoner.
12	Operation and maintenance specific gravity separator.
13	Operation and maintenance of double roll rice mill.
14	Operation and maintenance of de-huller.
15	Operation and maintenance of centrifugal dehusker.
16	Operation and maintenance of degermer.
17	Operation of maintenance of grain/ seed dryer.
18	Study on unit operation of rice milling.
19-20	Operation and maintenance of different rice polishers.
21-22	Operation and maintenance of different types of rice grader.
23-24	Study on unit as operations of pulse processing.
25-26	Operation and maintenance of dal mill.
27-29	Operation and maintenance of different types of dal polisher.
30-31	Operation and maintenance of different types of oil mill.
32-33	Operation and maintenance of different types of oil filter.

Continued…

34-35	Operation and maintenance of different types of flour mill.
36	Operation and maintenance of pulveriser.
37-38	Study on different types boiler.
39-40	Operation and maintenance of different types of boiler.
41	Study on different methods of pulveriser.
42-43	Operation and maintenance of hammer mill.
44-45	Operation and maintenance of sterilizer and pasteurizer.
46-47	Operation and maintenance different types of peeler.
48	Study on different types of slicer.
49	Operation and maintenance of slicer.
50-51	Study on different types of pulper.
52-53	Operation and maintenance of pulper.
54-55	Study on different types of juicer.
56-57	Operation and maintenance of different types of juicer.
58	Study on unit operations of canning process.
59-60	Operation and maintenance of canning machineries.
61	Study on different packaging material.
62	Operation and maintenance of milk packaging machinery.
63	Operation and maintenance of vacuum packaging of milk.
64	Operation and maintenance of spray dryer.

Suggested Readings: [SEC-xxx]

1. Sahay K.M. and K.K. Singh Unit Operation of Agricultural Processing, Vikas Publishing, New Delhi.
2. A. Chakravarti Post Harvest Technology of Cereals, Pulses & Oilseeds, Oxford & IBH Publishing Co., New Delhi.
3. Earle R. L. Unit Operation in Food Processing, Pergemon Press, Newyork, USA.

Course No.	**:**	**SEC-xxx**	**Credit Hrs.** **:**	**4(0+4)**
Course Title	**:**	**Operation and Management of Multi-Commodity Agro-Processing Centre**		

Objectives : (i) To enable the students to acquire basic skills in operation and management of Agro-Processing centre,

(ii) To enable the students for self-employment or start their Agro-Processing center,

(iii) To enhance the skill development of students for entrepreneurship through Agro-Processing.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1-3	Study of different Cereal Pulse and Oilseed Processing Models.
4	Site selection for Grain Processing Plant.
5	Site selection for Fruits/Vegetables Processing Plant.
6	Preparation of Project Report of Agro-Processing Centre.
7	Visit to grain processing plant to study the management and operation of primary processing of grains.
8	Study of manufacturing and specification of grain processing machineries.
9-11	Study of Market survey of cereals, pulses and oilseeds-based products.
12-14	Study of primary operations for cereal pulses and oilseeds grains processing.
15-17	Preparation of process products from cereals. (Papad, Puffed and Popped products, Shevaya, Savory etc.)
18	Study of Dal milling operations.
19-20	Preparation of Soy-based different products: a) Soyamilk b) Soyapaneer c) Soyanuts d) Soyachikki.
21-22	Preparation of processed products from Green gram and Black gram: a) Papad b) Savory (Wadi making)
23	Preparation of processed products from Pigeon pea and Chick pea.
24	Preparation of processed products from Jowar/ Bajra.
25	Preparation of processed products from Wheat.
26	Preparation of processed products from Rice.
27	Preparation of processed products from Corn.
28	Visit to Oilseed Industry.
29-30	Study of different processed products from Oilseeds.

Continued…

31-32	Study of operation of different equipments used for grain processing.
33	Study of operation of different equipments used for oilseeds processing (Hydraulic press, Screw press)
34	Study of operation of different equipments used for Pulses processing (Dal mill/ flowchart)
35	Market survey for different flours available in market including multigrain.
36	Study of different flour mills.
37-38	Preparation of different RTE & RTC products by using Flour. (Extruded snacks/ Multigrain atta/ Traditional snacks)
39	Study of chilli processing with operation of different equipments.
40	Study of turmeric processing with operation of different equipments.
41	Visit to Spice Processing Plant/ Industry.
42	Preparation of different Spice powder (Ready mixes/ Curry spices).
43	Preparation of dehydrated products from Onion.
44	Preparation of dehydrated products from Garlic.
45	Preparation of dehydrated products from Curry leaves.
46	Preparation of dehydrated products from Ginger-Garlic paste.
47	Preparation of dehydrated products from Cumin and Coriander seed powder.
48	Visit to Pack house.
49	Study of different unit operations in Pack house.
50	Study of different equipments used in Pack house.
51	Study of waxing operation for Fruits.
52	Preparation of Jam.
53	Preparation of Jelly.
54	Preparation of Squash/ Sharabat etc.
55-57	Preparation of Dehydrated fruits' products (Candy, Powder, Leather, Raisin, Awala Supari, Dried Fig, etc).
58	Preparation of Pickles (Mango, Lemon).
59	Study of different equipment used in Fruit processing plant (Operation of washer, peeler, blanchers, cutters, grader).
60	Visit to Vegetable-based Product Industry.
61	Study of different Quality Control Systems.
62	Study of different hygiene practices (GMP/GAP) and different Certification Agencies.
63	Study of record keeping and inventory management for Agro-Processing Industry.
64	Study of record of finance and human resource management for Agro-Processing Industry.

Suggested Readings: [SEC-xxx]

1. Unit Operations of Agricultural Processing - K.M. Sahay and K.K. Singh, 1994, ISBN 978-8125911425
2. Post Harvest Technology of Cereals, Pulses and Oil seeds - A. Chakraverty, 1988, ISBN 978-8120409699
3. Agro-processing and Food Engineering: Operational and Application Aspects - Harish Kumar Sharma and Navneet Kumar, 2022, ISBN 978-9811672910
4. Agro-processing and The Food Industry - R.N. Singh, R.L.S. Sengar, 2020, ISBN 978-9389480070
5. Postharvest Technology of Horticultural Crops - K.L. Chadha, J.S. Choudhury, 2007, ISBN 978-8190610590
6. Handbook of Cereal Science and Technology - Karel Kulp, K.F. McDonald, 2003, ISBN 978-0824707802
7. Oilseeds Processing and Utilization - R.R. Sharma, R.T. Yadav, 2015, ISBN 978-9382138779
8. Cereal Grain Processing and Technology - R.G. Ziegler, 2018, ISBN 978-0813821142
9. Fundamentals of Food Process Engineering - Romeo T. Toledo, 2017, ISBN 978-1493951623
10. Food processing: Principles and Applications - N.L.M. Tiwari, S.D.P. Mehta, 2014, ISBN 978-9350250422
11. Engineering Aspects of Cereal and Cereal-based Products - V.S.K. Vijayan, V.G. Jayashree, 2019, ISBN 978-0367339894
12. Agro-processing in Developing Countries - John E. Williams, 2012, ISBN 978-0195384160
13. Handbook of Food Processing Equipments - M.R. Raghavendra, R.R. Garg, 2021, ISBN 978-0367422183

Semester	**:**	**II**		
Course No.	**:**	**SEC-xxx**	**Credit Hrs. :**	**4(0+4)**
Course Title	**:**	**Primary Processing and Value Addition and Cold Chain Logistics**		

Objectives : (i) To understand the primary processing techniques for fruits and vegetables,

(ii) To learn the operation and maintenance of cold chain systems,

(iii) To explore cold chain technologies, cold transport logistics,

(iv) To study the supply chain management and logistics for food.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1	Study the maturity indices of fruits and vegetables.
2	Study of different methods of fruits and vegetables cleaning.
3	Study the different methods of sorting and grading for fruits and vegetables.
4	Study the operation and maintenance of washers and graders.
5	Study the waxing treatment and its role in extending shelf life of fruits and vegetables.
6	Study the different types of peelers and slicer.
7	Study the different methods of blanching for processing of fruits and vegetables.
8	Study of juicer and pulper for fruits and vegetables.
9	Study the different methods of filtrations for fruit and vegetable juices.
10	Study of commonly used packaging materials for fresh fruits and vegetables.
11	Demonstration of shrink-wrapping packaging techniques for fruits and vegetables.
12	Demonstration of vacuum packaging techniques for fruits and vegetables.
13	Study of modified atmosphere packaging on the quality of fresh produce.
14	Study of controlled atmosphere storage on the quality of fresh produce.
15	Study the aseptic packaging used for pulp and juice.
16	To study the working principles and components of a vapour compression refrigeration system.
17	Study of domestic household refrigeration system.
18	To study the working principles and components of a vapour absorption refrigeration system.
19	Assessment of refrigerants based on environmental and thermodynamic properties.

Continued…

20	Measurement of energy consumption and coefficient of performance (cop) in refrigeration systems.
21	Study of psychometric chart and various psychometric processes.
22	Study on repair and maintenance on refrigeration system.
23	To study the freezing methods and equipments.
24	To study the various precooling methods for fruits and vegetables.
25	Survey of existing precooling facilities in local agricultural markets.
26	Identification of suitable precooling methods for different horticultural crops.
27	Study the cold storage for fruits and vegetables.
28	Design of cold storage.
29	Assessment of energy efficiency in cold storage systems.
30	Study the solar-powered cold storage systems for fruits and vegetables.
31	Assessment of energy efficiency in solar-powered cold storage systems.
32	Application of IoT sensors for monitoring and controlling cold storage conditions.
33	Preparation of a maintenance checklist for efficient cold storage operations.
34	Study of the operational parameters of ripening chambers for optimal fruit ripening.
35	Measurement of ethylene gas concentration and its impact on fruit ripening.
36	Study of low-cost ripening chamber for different fruits.
37	Survey of ripening chamber technology usage in local fruit processing units.
38	Identification of factors affecting the performance of semi-chilled transport systems for food products.
39	Assessment of temperature and relative humidity fluctuations in refrigerated van systems during long-distance transport.
40-41	Measurement of energy consumption in different cold transport systems (Chilled vs. Semi-chilled vans).
42	Estimation of the shelf life of perishable goods during transport using refrigerated vans.
43-44	Survey of cold chain logistics in the food industry: challenges and best practices.
45	To study the effectiveness of gel pack as a cooling agent in cold chain transportation.
46	Identification of temperature variations in cold chain systems using dry ice and liquid nitrogen.
47	Standards and regulations for cold chain management system.

Continued…

48-49	Preparation of a cold chain protocol for ensuring safe transport of food products.
50-51	Survey of cold chain infrastructure in the agricultural sector for fruits and vegetables.
52-53	Study of supply chain management systems in global industries: Planning, sourcing, manufacturing, delivering and returning.
54	Study the types of SCM models.
55	Assessment of inventory management systems in contract logistics.
56	Study the different preservation methods for extending the shelf life of fruits and vegetables and its products.
57	Study the beverages prepared from different fruits and vegetables.
58	Preparation of fruits and vegetables-based jams and jellies and their evaluation for quality parameters.
59-60	Studies on dehydration of fruits and vegetables using different drying techniques.
61	To develop novel food products from fruits and vegetables.
62	Visit to supply chain management logistic system for different agricultural commodities.
63	Visit to a Commercial precooling plant, Ripening chamber facility and Cold storage facility to understand operational challenges and solutions.
64	Visit to a Fruit and Vegetable Processing Plant to understand Post-harvest operations.

Suggested Readings: [SEC-xxx]

1. Post Harvest Technology of Horticultural Crops by Dr. S.R.S.S. Chhabra (2017, ISBN: 978-9386408957)
2. Principles of Food Preservation by Dr. P.G. Rao (2004, ISBN: 978-8171414602)
3. Food Processing and Preservation by S.R.S. Chhabra (2015, ISBN: 978-9385567601)
4. Postharvest Management of Horticultural Crops by K.M.K. Usha Rani (2014, ISBN: 978-9350250177)
5. Cold Chain Management and Food Safety by P. G. A. S. R. Rao (2012, ISBN: 978-8175950513)
6. Packaging Technology for Horticultural Crops by D. S. S. R. D. R. Rao (2018, ISBN: 978-9380913300)
7. Food Refrigeration and Cold Storage by Rajeev Ranjan & R. C. Chaurasia (2011, ISBN: 978-8120335266)
8. Technology of Fruit and Vegetable Processing by R. S. Singhal (2007, ISBN: 978-8187072966)
9. Supply Chain Management in Food Industry by S. S. S. R. Rao (2016, ISBN: 978-9384058721)
10. Food Processing and Engineering by Shalini Puri (2008, ISBN: 978-8120338892).

Course No. : SEC-xxx	Credit Hrs. : 4(0+4)
Course Title : Food Grain Godown and Warehouse Management	

Objectives : (i) To develop Expertise in Grain Preservation and Quality Control,

(ii) To enhance Operational Efficiency in Warehouse Management,

(iii) To strengthen Compliance with Food Safety and Regulatory Standards,

(iv) To promote Sustainable and Climate-Resilient Warehouse Practices.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1	To study the Technical Terms used in Grain Storage.
2	To study the Principles of Food Grain Storage.
3	To measure the Temperature in Grain Storage Units using Thermometers and Digital Sensors.
4	To determine the Relative Humidity in Storage Environments using Hygrometers.
5	To study the Grain Sampling Techniques.
6	Determination of Grain Moisture Content using Moisture meters.
7	Assessment of Grain Quality through Visual Inspection and Grading
8	To study the calibration of instruments for Temperature and Humidity measurement.
9	Determination of contaminants and foreign matter in grain samples.
10	To analyse Results from Grain Quality Tests for Storage Suitability.
11	Identification and Familiarization with Common Warehouse Equipment.
12	To study Inspection and Functionality Testing of Grain Storage Structures.
13	Study of Loading and Unloading Equipment for Grain Storage.
14	Study of Bulk Storage Systems and Bagged Storage Setups.
15	To study Maintenance and Safety Checks of Warehouse Tools and Equipments.
16	To study Cleaning Procedures for Grain Storage Units.
17	To study the different Grain Cleaning Equipments.
18	To study the different Grain Drying Techniques.
19	To study Aeration Practices for Maintaining Grain Quality.
20	Study of proper techniques for Bag Stacking in Warehouses.
21	To measure and calculate the Floor Area Requirements for Bag Storage.

Continued…

22	To study the Layout Design for Bagged Storage in Warehouses.
23	Study of different numericals on Layout Design for Grain Godowns.
24	Estimation of Space Utilization Efficiency in Bag Storage.
25	Understanding the constructional features of warehouses.
26	Inspection and Maintenance of Warehouse Structures.
27	Sanitation Practices for Pest and Rodent Control.
28	Hygiene Protocols for Grain Storage Areas.
29	Study of Waste Management in Warehouse Premises.
30	Introduction to Integrated Pest Management (IPM) for Grain Storage.
31	Study of different Application of Chemical Pest Control Methods.
32	Study of Non-Chemical Pest Control Methods in Grain Storage.
33	Study of Rodent Control Measures in Grain Warehouses.
34	Study of Monitoring and Evaluation of Pest Control Measures.
35	Study of Visual Inspection for Signs of Infestation.
36	Determination of Pest Detections by using Sieves and Grain Probes.
37	Detection of insect activity in stored grain facilities using pheromone traps.
38	Detection of Insect Eggs and Larvae using Light Microscopes.
39	Detection of Fungal Infestation through Visual and Odor Assessment.
40	Study of Moisture Content Measurement to prevent fungal growth.
41	Study of Application of Aeration and Ventilation Techniques.
42	Study of Use of Safe Chemical and Non-Chemical Fungicides.
43	Understanding Inventory Classification in Warehouses.
44	Hands-on experience with Inventory Recording Systems.
45	Study of FIFO (First in First Out) and FEFO (First Expire First Out) Techniques for Inventory Rotation.
46	Study of Planning and Optimizing Grain Transportation.
47	Study of Warehouse Layout Design for Logistics Efficiency.
48	Study of Loading and Unloading Operations.
49	Study of Role of Collateral Management in Grain Storage.
50	Identify the Risk Assessment in Collateralized Grain Storage.
51	Study of Quality Standards for Grain Procurement.
52	Study of Inspection and Sampling Techniques for Procurement.
53	Study of Documentation and Record Keeping for Procurement.
54	Study of Disposal Methods for Spoiled Food Grains.

Continued…

55	Study of Legal and Environmental Compliance in Grain Disposal.
56	Determination of Grain Weight and Bulk Density measurement during storage.
57	Study of Detection of Infestation and Contamination.
58	Study of Germination Test for Seed Grains.
59	Study of Identification of Fungal or Mold growth in Grains.
60	Study of Analysis of Grain Nutritional Composition.
61	Study of Fumigation Techniques for Stored Grains.
62	Study of AI and Machine Learning in Warehouse Management.
63	Study of Repair and Maintenance of Storage Equipment.
64	Study of Fire Safety in Grain Godowns.

Suggested Readings: [SEC-xxx]

1. K.M. Sahay and K.K. Singh, Unit Operation of Agricultural Processing (2007), Vikash Publishing House Pvt. Ltd., A-22, Sector-4, Noida – 201 301 (U.P.).
2. B.K. Bala, Drying and storage of cereal grains, Oxford and IBH Publishing Co. Pvt. Ltd., 66, Janpath, New Delhi – 110 001.
3. J.L. Multon, Preservation and Storage of Grains, Seeds and their By-products. CBS Publishers and Distributors, 485, Jain Bhavan, Bhola Nath Nagar, Shahadara, Delhi – 110 032.
4. Reimbert M. and A. Reimbert, Silos – Theory and Practice, AVI Publication.
5. T.P. Ojha & A.M. Michael, Principles of Agricultural Engineering- VolumeI., Jain Brothers, 873, East Park Road, Karol Baug, New Delhi – 110 005.
6. Chakravarty A., Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford & IBH Publishing Co. Pvt. Ltd., 66, Janpath, NEW DELHI – 110 001
7. Khetarpaul Neelam. 2005. Food Spoilage and its Causes. CH4. In: Food Processing and Preservation. Ed. Khetarpaul, N. Publ. by Daya Publishing Co., Delhi-110035. India. P. 43-53.
8. Singh, P. K. A Decentralized and Holistic Approach for Grain Management in India, Current Science, Vol. 99, No. 9, 10 November 2010, 1179-1180
9. Traditional storage practices, Kartikeyan, C., Veeraraghavantham, D., Karpagam, D., Firdouse, S.A. (2009). Indian Journal of Traditional Knowledge, 8(4), 564-568.
10. Patil, R.T., and Shukla, B.D. Overview of Grain Drying and Storage Problems in India. In: Research and Development Issues in Grain Post Harvest Problems in Asia. GASGA, Executive Series Seminar, no.2.
11. Sashidhar, R. B. Ramakrishna, Y. and Bhat, R.V. (1992). Moulds and Mycotoxins in Sorghum Stored in Traditional Containers in India. Journal of Stored Products Research, 28(4), 257-260.
12. Sinha, A.K. Sinha, K.K. (1990). Insect Pests, *Aspergillus flavus* and Aflatoxin Contamination in Stored Wheat: A Survey at North Bihar (INDIA). Journal of Stored Products Research, 26(4), 223-236.
13. Greeley, M. (1978). Recent Indian Experience with Farm-level Food Grain Storage Research. Food Policy, 39-49.
14. IoT and AI in Agriculture Smart Automation Systems for Increasing Agricultural Productivity to Achieve SDGs and Society 5.0. Editor. Tofael Ahamed. Published by Springer Nature Link, 2024.

Course No. : SEC-xxx	Credit Hrs. : 4(0+4)
Course Title : Post-Harvest Value Chain Management including Logistics	

Objectives : (i) To enable the students to acquire the skills in supply chain of agricultural commodities,

(ii) To enhance the skill of students in post-harvest management of agricultural commodities,

(iii) To develop entrepreneurship among the students through supply chain of agricultural commodities.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Title
1	Study on post-harvest value chain of agricultural commodities (Cereals, Pulses and Oilseeds).
2	Study on supply chain of Pulses.
3	Study on supply chain of Oil seeds.
4	Study on supply chain of Cereals.
5-6	Case study and analysis of value chain of Pulses.
7-8	Case study and analysis of value chain of Oil seeds.
9-10	Case study and analysis of value chain of Cereals.
11	Study on post-harvest value chain of Horticultural crops.
12	Case study and analysis of value chain of Orange.
13-14	Case study and analysis of value chain of Grapes.
15-16	Case study and analysis of value chain of Pomegranate.
17-18	Case study and analysis of value chain of Mango.
19-20	Case study and analysis of value chain of Cashew nut.
21-22	Case study and analysis of value chain of Turmeric.
23-24	Case study and analysis of value chain of Onion.
25-26	Case study and analysis of value chain of Tomato.
27-28	Case study and analysis of value chain of Custard apple.
29	Case study and analysis of value chain of Jamun.
30-31	Case study and analysis of value chain of Chilli.
32	Study on storage of Fruits and Vegetables.

Continued…

33	Study on controlled and modified atmospheric storage of Fruits and Vegetables.
34	Study on packaging of different processed products of fruits.
35	Packaging of different processed products of cereals and its products.
36	Study on warehouse management for Cereals.
37	Study on warehouse management for Pulses.
38	Study on warehouse management for Oilseed.
39-43	Study on management of cold storage for different Fruits and Vegetables.
44-45	Study on management of cold storage for Frozen products.
46-47	Quality management of processed products of Fruits.
48-49	Quality management of processed products of Vegetables.
50-51	Quality management of Cereals and its products.
52-53	Quality management of Pulses and its products.
54-55	Study on different types packaging of Cereals and its products.
56-57	Study on different types packaging of Pulses and its products.
58-59	Study on different types packaging of Oilseeds and its products.
60-62	Study on different material handling machineries for Cereals, Pulses and Oilseeds.
63-64	Quality management and tracking different of Food Supply Chain.

Suggested Readings: [SEC-xxx]

1. Earle R.L. Unit Operation in Food Processing, Pergemon Press Newyork, USA
2. Sahay K.M. and K.K. Singh Unit Operation of Agricultural Processing, Vikas Publishing, New Delhi.
3. Chakravarti A. Post Harvest Technology of Cereals, Pulses and Oilseeds, Oxford & IBH Publishing Co., New Delhi.
4. Pande P.H. Principles and Practices of Post Harvest Technology Kalyani Publishers, Ludhiana
5. P.S. Phirke, Processing and Conveying Equipment Design, John Brothers, New Delhi.
6. Srivastav R.P. and Kumar S. and S. Kumar, Fruits and Vegetable Preservation- Principles and Practices, International Book Distributor.

Course Curriculum of Third Semester

as per the ICAR - Sixth Deans' Committee Report for the Academic Programmes in

AGRICULTURAL ENGINEERING

- UG-Certificate in Agricultural Engineering
- UG-Diploma in Agricultural Engineering
- UG-Degree: B.Tech. (Agricultural Engineering)

Mahatma Phule Krishi Vidyapeeth, Rahuri

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli

Maharashtra Agricultural Universities Examination Board, Pune

Compiled & Submitted by

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UG Degree Syllabus State Coordinator

with

UG Degree Syllabus Discipline Coordinators &

DICC - UG Degree Syllabus Core Committee

Submitted to the

Directors of Instruction Coordination Committee

~ w.e.f. AY, 2025-26 ~

Course Layout

B.Tech. (Agricultural Engineering)

Semester: III (New) ***w.e.f.*** **Academic Year: 2025-26**

Sr. No.	Course No.	Course Title	Credit Hrs.	Remark
1.	**AEC-234**	Physical Education, First Aid, Yoga Practices and Meditation	2(0+2)	--
2.	**AE-MATH-232**	Engineering Mathematics-I	3(3+0)	--
3.	**PHY-231**	Engineering Physics	3(2+1)	--
4.	**REE-232**	Engineering Chemistry	3(2+1)	--
5.	**FS-231**	Engineering Mechanics	3(2+1)	--
6.	**SWCE-232**	Soil Mechanics	2(1+1)	--
7.	**IDE-231**	Fluid Mechanics and Open Channel Hydraulics	3(2+1)	--
8.	**PFE-231**	Engineering Properties of Agricultural Produce and Food Science	3(2+1)	--
9.	**FMPE-233**	Farm Machinery and Equipment-I	3(2+1)	--
10.	**OC-1/ OC-2/ ...**	Online Course(s)/ MOOCs†	As opted by student	**NG**
		Total Credits Hrs.=	**25(16+9)**	**G**

AEC: Ability Enhancement Course, **OC**: Online Course, **G**: Gradial, **NG**: Non-gradial

†**Note:** It is mandatory for each Student to complete **total 6 credits** (Non-gradial) of **Online Courses** from available resources across III to VIII semesters under the guidance of assigned Faculty/Advisor.

Course-wise Syllabus with Teaching Schedules

Semester : III		
Course No. : AEC-234	**Credit Hrs. : 2(0+2)**	
Course Title : Physical Education, First Aid, Yoga Practices and Meditation		
Gradial Common Course across all UG Degrees		

SYLLABUS

Objectives :
(i) To make the students aware about Physical Education, First Aid and Yoga Practices,
(ii) To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga.

PRACTICAL

Physical Education; Training and Coaching- Meaning and concept; Aerobic and Aerobic exercises; Calisthenics, Weight Training, Circuit Training, Interval Training, Fartlek Training; Effect of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition- Effect of Diet on Performance; Physiological Changes due to ageing and Role of exercise on ageing process; Personality, its dimensions and types, Role of Sports in Personality Development; Motivation and Achievements in Sports; Learning and Theories of Learning; Adolescent Problems and its Management; Posture; Postural Deformities, Exercises for Good Posture.

Yoga: History of Yoga, Types of Yoga, Introduction to Yoga.

- Asanas (Definitions and Importance)- Padmasan, Gaumukhasan, Bhadrasan, Vajrasan Shashakasan, Pashchimothasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan- left & right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Shawasan.
- Suryanamaskar, Pranayama (Definitions and Importance)- Omkar, Suryabhedan, Chandrabhedan, Anulom, Vilom, Shitali, Shitkari, Bhastrika, Bhramari.
- Meditation (Definitions and Importance)- Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh Mudras (Definitions and Importance)- Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Prutvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra.
- Role of Yoga in Sports.
- Teaching of Asanas- Demonstration, Practice, Correction and Practice.

History of Sports and Ancient games, Governance of Sports in India; Important Sporting events-Awards in sports, History, Latest rules, Measurement of playfield, Specifications of equipment, Skill, Technique, Style and Coaching of major games (Cricket, Football, Table tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho and Athletics).

Need and Requirement of First Aid: First Aid techniques, Equipment and Upkeep First Aid techniques; First aid-related with respiratory system; First aid-related with Heart, Blood and Circulation; First Aid-related with wounds and injuries; First Aid-related with Bones, Joints muscles related injuries; First Aid-related with Nervous system and Unconsciousness; First Aid-related with Gastrointestinal Tract, Skin Burns; First Aid-related with Bites and stings, poisoning; First Aid-related with Sense organs; Handling and transport of injured traumatized persons- Sports injuries and their Treatments.

TEACHING SCHEDULE

PRACTICAL [AEC-234]

Exercise No.	Topic	Exercise Title / Sub-topics
1	**Physical Education**	To study the training and coaching- Meaning and concept of Physical Education
2 - 7	**Methods of Training**	To study the method of training - Aerobic and Aerobic exercises
		To study the method of training - Calisthenics
		To study the method of training - Weight Training
		To study the method of training - Circuit Training
		To study the method of training - Interval Training
		To study the method of training - Fartlek Training
8	**Effect of Exercise**	To study the effect of exercise on Muscular, Respiratory, Circulatory and Digestive systems
9	**Balanced Diet and Nutrition**	To study the Balanced Diet and Nutrition- Effect of diet on performance
10	**Physiological Changes**	To study the physiological changes due to ageing and role of exercise on ageing process
11	**Personality Development**	To study the dimensions and types - Role of sports in personality development

Continued…

12	**Motivation and Achievements in Sports**	To study the Motivation and Achievements in Sports
13	**Learning and Theories of Learning**	To study the Learning and Theories of Learning
14	**Adolescent Problems and its Management**	To study the Adolescent Problems and its Management
15	**Posture**	To study the Postural Deformities, Exercises for Good Posture
16 - 22	**Yoga**	To study the Introduction, History and Types of Yoga
		To study the Asanas: Padmasan, Gaumukhasan, Bhadrasan, Vajrasan Shashakasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan- left leg- right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Shawasan
		To study the Suryanamaskar, Pranayama, Omkar, Suryabhedan, Chandrabhedan, Anulom, Vilom, Shitali, Shitkari, Bhastrika, Bhramari
		To study the Meditation, Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
		To study the Mudras: Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Prutvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
		To study the Role of Yoga in Sports
		To study the Demonstration, Practice, Correction and Practice of Asanas
23 - 26	**Sports**	To study the History of Sports and Ancient games
		To study the Governance of Sports in India
		To study the Awards in Sports, History, Latest rules, Measurement of playfield, Specifications of equipment in important sporting events
		To study the Skill, Technique, Style and Coaching of major games (Cricket, Football, Table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho and Athletics)

Continued…

27 - 32	**First Aid**	To study the Need and Requirement of First Aid-First Aid techniques, Equipment and Upkeep
		To study the First aid related with Respiratory system, Heart, Blood and Circulation
		To study the First aid related with Wounds and Injuries, Bones, Joints muscles related injuries
		To study the First aid related with Nervous system Unconsciousness, Sense organs
		To study the First aid related with Gastrointestinal Tract, Skin Burns, Bites and Stings, Poisoning
		To study the Handling and Transport of Injured Traumatized Persons- Sports Injuries and their Treatments

Semester	**:**	**III**		
Course No.	**:**	**AE-MATH-232**	**Credit Hrs.**	**: 3(3+0)**
Course Title	**:**	**Engineering Mathematics - I**		

SYLLABUS

Objectives : To make the students acquainted with the Basic Mathematics applied in Engineering and their applications in solving engineering problems

THEORY

Differential Equations: first order differential equations, exact and reducible to exact form by integrating factors, linear differential equation and Bernoulli's equation, equations of first order and higher degree, Clairaut's equation.

Higher order differential equations: methods/rules of finding complementary functions and particular integrals, methods of variation of parameters, Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients.

Differential calculus: Taylor's and Maclaurin's expansions, Maxima and minima for function of one variable, functions of two or more variables, partial derivative and total derivative, homogeneous functions and Euler's theorem.

Partial differential equations: Formation of PDE, higher order linear PDE with constant coefficients, solution of non-linear PDE, Charpit's method.

Integral calculus: Double integrals, change of order of integration, triple integrals, application of double and triple integrals to find area and volume.

Matrices: Elementary transformations, Gauss-Jordan method to find the inverse of a matrix, rank of a matrix, solution of linear equations, Gauss elimination Method, linear transformation, Eigen values and Eigen vectors, Cayley Hamilton Theorem- it's use to find inverse of the matrix, diagonalization of matrices.

Suggested Readings [AE-MATH-232]:

1. Grewal B.S., 2015; Higher Engineering Mathematics. Khanna Publishers Delhi. (43rd Edn.)
2. Narayan, S. 2016. A Text Book of Vector. S. Chand and Co. Ltd. New Delhi.
3. Narayan, S. 2016. Differential Calculus. S. Chand and Co. Ltd. New Delhi.
4. Narayan, S. 2016. Integral Calculus. S. Chand and Co. Ltd. New Delhi.

TEACHING SCHEDULE

THEORY [AE-MATH-232]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 10	Differential Equations	First order differential equations	20
		Linear differential equation	
		Bernoulli's differential equation	
		Exact differential equation: Definition, Necessary and sufficient condition for exactness and solution of exact equation	
		Equations reducible to exact form by Integrating factor	
		Equations of the first order and higher degree: Clairaut's form	
11 - 17	Higher Order Differential Equations	Linear differential equations with constant coefficients: Methods / Rules for finding complementary functions	15
		Method / Rules for finding the Particular integral	
		Methods of variation of parameters	
		Cauchy's and Legendre's linear equations	
		Simultaneous linear differential equations with constant coefficients	
18 - 27	Differential Calculus	Maclaurin's and Taylor's Expansion	20
		Maxima and minima	
		Partial Differentiation: functions of two or more variables	
		Partial derivatives	
		Homogeneous function & Euler's Theorem	
		Total derivative	
28 - 32	Partial Differential Equations	Formation of PDE,	10
		Higher order linear PDE with constant coefficient	
		Solution of non-linear PDE	
		Charpit's method	
33 - 38	Integral Calculus	Double integrals,	15
		Change of order of integration	
		Triple integrals,	
		Application of double and triple integrals to find area and volume	
39 - 48	Matrices	Rank of a Matrix	20
		Elementary transformations	
		Gauss-Jordan method to find the inverse of a matrix	
		Solution linear equations	
		Gauss elimination Method	
		Linear transformation,	
		Eigen values and Eigen vectors	
		Cayley Hamilton Theorem - it's use to find inverse of the matrix	
		Diagonalization of matrices	
		Total =	**100**

*[**Note**: In some topics, re-arrangement of points is done for smooth teaching as per the books suggested.]*

Semester	**:**	**III**		
Course No.	**:**	**PHY-231**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Engineering Physics**		

SYLLABUS

Objectives : (i) To make the students acquainted with applications of Physics in engineering and different physical processes in Agricultural Engineering.

(ii) To be skilful in the study of the Magnetism, Quantum Mechanics, Spectroscopy, Solid state Physics, Semiconductors, Superconductivity, LASERS and MASERS, Holography and Optical fibre with emphasis to learn advancements in quantum computing, sensors, resource management and environmental sustainability, that will supportive for learning advanced digital techniques, which are valuable for cutting-edge Agriculture.

THEORY

Magnetism: Dia-, para- and ferro-magnetism- classification; Langevin theory of dia- and para-magnetism, adiabatic demagnetization, Weiss molecular field theory; **Introduction to Quantum Mechanics**: wave particles duality, de Broglie concept uncertainty principle, time dependent and time independent Schrodinger equation. **Spectroscopy**: Qualitative explanation of Zeeman effect, Stark effect and Paschen back effect, Raman spectroscopy; **Solid state Physics**: statement of Bloch function, bands in solids, effective mass, distinction between metals, insulators and semi-conductors. **Semiconductors**: Intrinsic and extrinsic semi-conductors, law of mass action, determination of energy gap in semi-conductors, donors and acceptor levels; **Superconductivity**: super conductivity, critical magnetic field, Meissner effect, isotope effect, Type I and II superconductors, Josephsons effect, DC and AC squids, introduction to high Tc superconductors. **LASERS and MASERS**: Spontaneous and stimulated emission, Einstein A and B coefficients, population inversion, He, Ne and Ruby lasers, Ammonia and Ruby masers; **Holography and optical fiber**: optical fiber- physical structure, basic theory, type of modes, characteristics of optical fiber and applications; **Illumination:** laws of illumination, luminous flux, luminous intensity, candle power, brightness.

PRACTICAL

To verify law of transverse vibrations along a string using electrical tuning fork; To determine e/m of electron using magnetron valve method; Determine dielectric constant of material using De-Sauty's bridge; Study the variation of magnetic field with distance along the axis of a current carrying circular coil and to determine the radius of the coil; Determine the energy band gap in a semi-conductor using a p-n junction diode; Study the LCR circuit; Find the wave length of light by using prism and spectrometer; Determine the low resistance using Carey Foster bridge without calibrating the bridge wire.

TEACHING SCHEDULE

THEORY [PHY-231]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 4	Magnetism	Introduction, Properties of magnetic materials, Classification of Magnetism, Dia-, para- and ferro-magnetism; Langevin theory of dia- and para-magnetism, adiabatic demagnetization, Weiss molecular field theory	10
5 - 8	Quantum Mechanics	Introduction to Quantum Mechanics: Wave particles duality, De-Broglie concept Uncertainty principle, Time-dependent and Time-independent Schrodinger equation.	10
9 - 12	Spectroscopy	Qualitative explanation of Zeeman effect, Stark effect and Paschen-Back effect, Raman spectroscopy and its applications.	15
13 - 16	Solid State Physics	Introduction to Bravais Lattice, Band structure of solids, Effective mass, Distinction between (ICAR) Classification of Solids on the basis of band structure-Metals, insulators and semi-conductors. Statement of Bloch function.	10
17 - 20	Semiconductors	Definition of Intrinsic and Extrinsic semi-conductors, Law of mass action, Determination of energy gap in semi-conductors, donors and acceptor levels.	15
21 - 24	Superconductors	Superconductivity, Critical magnetic field, Meissner effect, Isotope effect, Type I and II superconductors, Josephsons effect, DC and AC squids, Introduction to high Tc superconductors.	15
25 - 28	Lasers and Masers	LASERS and MASERS: Spontaneous and Stimulated emission, Einstein A and B coefficients, Population inversion, He-Ne and Ruby lasers, Ammonia and Ruby masers.	10
29 - 32	Holography, Optical Fiber and Illumination	Introduction and Principle of Holography, Recording of the Hologram, Reconstruction of the image. Applications of Holography. Optical Fibre – Physical Structure, Basic theory, Types of modes, Characteristics of optical fibre and applications; Laws of Illumination, Luminous flux, Luminous intensity, Candle power, Brightness.	15
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [PHY-231]

Exercise No.	Exercise Title
1 - 2	To verify law of transverse vibrations along a string using electrical tuning fork
3 - 4	To determine e/m of electron using magnetron valve method
5 - 6	To determine dielectric constant of material using De-Sauty's bridge
7 - 8	To study the variation of magnetic field with distance along the axis of a current carrying circular coil and to determine the radius of the coil
9	To estimate the energy band gap in a semiconductor using a p-n junction diode
10 - 11	To study the LCR circuit
12 - 13	To study the frequency response of the parallel resonance circuits
14 - 15	To determine the Wavelength of laser light using prism and spectrometer
16	To determine the low resistance using Carey Foster bridge without calibrating the bridge wire

Suggested Readings [PHY-231]:

1. Avadhanulu, M.N. 2013. An Introduction to Lasers Theory and Applications. S. Chand Publication.
2. Chattopadhyay, D. and Rakshit, P.C. 2011. Electricity and Magnetism. S. Chand Publication.
3. Ghatak, A.K. and Lokanathan, S. 2022. Quantum Mechanics, Theory and Application. Trinity Press.
4. Griffiths, D.J. and Schroeter. 2018. Introduction to Quantum Mechanics. Cambridge University Press.
5. Khandelwal, D.P. 1985. A Laboratory Manual of Physics. Vani Publications.
6. Kittel, C. 2005. Introduction to Solid State Physics. Wiley Eastern Pvt. Ltd.
7. Laud, B.B. 2011. Lasers and Non-linear Optics. New Age International Publishers.
8. Mani, H.S. and Mehta, G.K. 2022. Modern Physics. Affiliated East-West Press.
9. Omar, M.A. 2002. Elementary Solid-State Physics. Pearson.
10. Prakash, S. 2011. Optics. Pragati Prakashan, Meerut.
11. Saraf, B. and Khandelwal, D.P. 1982. Physics through Experiments. Vol. I & II. Vikas Publication, New Delhi.
12. Subramanyam, N., Lal, B. and Avadhanulu, M.N. 2012. A Textbook of Optics. S. Chand Publ.
13. White, H.E. 2019. Introduction to Atomic Spectra. Mc-Graw Hill Publication.
14. Worsnop, B.L. and Flint, H.C. 1951. Advanced Practical Physics. Littlehampton Book Services Ltd.
15. Mehta, V.K. 1980. Principles of Electronics, S. Chand Publication.

Semester	**:**	**III**	
Course No.	**:**	**REE-232**	**Credit Hrs. : 3(2+1)**
Course Title	**:**	**Engineering Chemistry**	

SYLLABUS

Objectives : (i) To make the students acquainted with applications of Chemistry in Engineering,
(ii) To study different chemical processes in Agricultural and Food Engineering.

THEORY

Phase rule: Phase, component, degree of freedom, Application to one component system, viz. Water system, Sulphur system, Two component system, viz. Pb-Ag system, Desilverisation of Pb; **Colloids:** Classification, Properties like Optical activity- Tyndall effect, Brownian movement, Electrical properties-electrophoresis, Causes, Types and Methods of prevention- Proper designing. **Corrosion:** Cathodic protection using pure metal and metal alloys, Use of inhibitors. **Water:** Temporary and permanent hardness, Disadvantages of hard water, Scale and sludge formation of boilers, Boiler corrosion, Basic idea on thermo-gravimetric analysis, Polarographic analysis, Nuclear radiation, Detectors and Analytical applications of radio-active materials, Discovery of isotopes and new elements, release of atomic energy, radio-active tracer, and carbon dating; **Fuels:** Classifications, Calorific value and its determination by bomb calorimeter. **Principles of Food Chemistry:** Lipids, Proteins, Carbohydrates and their Classifications, Vitamins and their Importance. Enzymes and Co-enzymes Importance in Food processing and storage, their use in manufacturing of ethanol and acetic acid by fermentation method; Introduction to food preservatives, definition, Types: Natural and Artificial preservative and its use, Colouring and flavoring reagents of foods. **Lubricants:** Classifications, Properties- Viscosity, flash point and fire point mechanism, thick film, thin film and extreme pressure, neutralization point, saponification number and mechanical stability. Type of Polymerization with Examples (addition, free radical); Different Properties of Polymers- Chemical resistance, Crystallinity. **Polymers:** Effect of heat on polymers, General use, Basic principles of determination of molecular weight by viscosity methods, Basic principles of determination of molecular weight by light scattering methods. **Introduction to IR spectroscopy:** Basic principles of Spectroscopy, Beer-Lambart's law, Types of vibration, symmetric, asymmetric vibration, Absorbances of different functional group in IR.

PRACTICAL

To determine temporary and permanent hardness of water by EDTA method; To estimate chloride in water sample; To estimate dissolved oxygen in water sample; To study the different types of fuels and compare their characteristics; To study different types of foods and their ingredients; To study the different types of food preservatives and their active principles; To study the different properties of lubricants; To determine λmax and verification of Beer-Lambert law.

TEACHING SCHEDULE

THEORY [REE-232]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 3	Phase Rule	• Definition - • Explanation of Terms Phase Rule- • Component & Degree of freedom- • Application to: - One component system viz; Water system and Sulphur System - Two component System viz; Lead-Silver System (Pb-Ag) • Desilverisation of Pb-	15
4 - 5	Colloids	• Classification- • Optical properties- Optical activity, Tyndall effect, Brownian movement • Electrical properties- Electrophoresis, Causes, Types, and Methods of prevention- Proper designing	15
6	Corrosion	• Cathodic protection using pure metal and metal alloys, • Use of inhibitors.	
7 - 8	Water	• Hardness of water; Temporary and Permanent hardness; Disadvantages of hard water • Scale and sludge formation in boilers; Boiler corrosion	20
9 - 10	Thermo-gravimetric & Polarographic Analysis	• Basic idea on thermo-gravimetric analysis and Polarographic analysis	
11 - 13	Nuclear Chemistry	• Nuclear radiation, Detectors and Analytical applications of radio-active materials • Discovery of isotopes and new elements, Release of atomic energy, Radio-active tracer and Carbon dating	
14 - 15	Fuels	• Classifications of Fuels • Calorific value and its Determination by Bomb calorimeter	20
16 - 18	Principles of Food Chemistry	• Lipids, Proteins, Carbohydrates and their Classifications, Vitamins and their importance	
19 - 20	Enzymes and Co-enzymes	• Important in Food processing and storage, • Use in manufacturing of ethanol and acetic acid by fermentation method	
21 - 22	Food Preservatives	• Introduction of Food Preservatives- • Definition, Types- • Natural and Artificial preservatives and its use, Colouring and flavoring regents of foods.	

Continued…

23 - 25	Lubricants	• Function • Mechanism of lubrication- fluid film or thick film, boundary lubrication of thin -film and extreme pressure lubrication. • Classification • Properties of lubricating oils viz., Viscosity, flash point and fire point mechanism, thick film, thin film and extreme pressure neutralization point, saponification number and mechanical stability	15
26 - 27	Polymerization	• Type of Polymerization with Examples (Addition, Free radical); • Different properties of Polymers- Chemical resistance, Crystallinity	15
28 - 30	Polymers	• Effect of heat on polymers, General use, • Basic principles of determination of molecular weight by viscosity methods, • Basic principles of determination of molecular weight by light scattering methods	
31 - 32	IR Spectroscopy	• Introduction to IR spectroscopy • Basic principles of spectroscopy, Beer-Lambart's law, • Types of vibration: Symmetric, Asymmetric vibration, • Absorbances of different functional group in IR.	
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [REE-232]

Exercise No.	Exercise Title
1 - 2	To determine the temporary and permanent hardness of water by EDTA method
3	To estimate chloride in water sample.
4	To estimate dissolved oxygen in water sample.
5 - 6	To study the different types of fuels and compare their characteristics.
7 - 8	To study of Proximate and Ultimate analysis of selected biomass.
9 - 10	To study of calorific value of solid and gaseous fuel.
11	To study the different types of food preservatives and their active principles.
12	To study different types of foods and their ingredients.
13 - 14	To study the different properties of lubricants.
15 - 16	To determine λ_{max} and verification of Beer-Lambert's Law.

Suggested Readings [REE-232]:

1. Jain P.C. and Jain Monika. 2016. *Engineering Chemistry*. Dhanpat Rai Publication.
2. Jain P.C. and Jain Monika.1994. *Engineering Chemistry*. Dhanpat Rai publishing company Pvt. Ltd., Delhi.
3. Bahl B.S., Bahl A. and Tuli B.D. 2007. *Essentials of Physical Chemistry*. S. Chand and Co. Ltd., New Delhi.
4. Finar I.L. 2002. *Organic Chemistry*, *Vol I and II*. Pearson.
5. Glasstone S. *Elements of Physical Chemistry*. The Macmillan Company of India Limited.
6. Morrison R.T., Boyd R.N. and Bhattacharjee S.K. 2010. *Organic Chemistry*. Pearson.
7. Sharam Y.R. 2013. *Elementary Organic Spectroscopy*. S. Chand Publishing.

Semester	**:**	**III**		
Course No.	**:**	**FS-231**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Engineering Mechanics**		

SYLLABUS

Objectives : (i) To make the students acquainted with the Principles of Engineering Mechanics.
(ii) To make the students acquainted with the calculation of different stresses to be helpful for design of engineering structures.

THEORY

Basic concepts of Engineering Mechanics, Statics, Dynamics, Kinetics, Scalar quantities, Vector quantities, Systems of units; Composition and resolution of forces, Analytical method, Graphical method; Laws of Forces, Moments and their Application, Levers, Parallel forces and Couples; Equilibrium of Forces, Free body diagrams. Centre of gravity (CG) of simple geometrical figures, CG by moments, plane figures, Axis of references, CG of symmetric sections, Unsymmetrical sections, Solid bodies and Cut sections; Moment of inertia: methods of finding out M.I., Methods of integration, M.I. of different sections, Theorem of perpendicular axes, parallel axes, M.I. of composite sections and cut sections, Frictional forces, Static friction, Dynamic friction, Limiting friction, Normal reaction, Angle of friction, Coefficient of friction, Laws of friction, Equilibrium of a body lying in horizontal and inclined planes, Ladder friction; Wedge friction, Screw friction, Screw jack; Analysis of simple framed structures, Methods of sections, Force table, Methods of joints, Hinged joints, Roller support, Vertical and Inclined loads; Simple stresses and strain, Hooke's Law, Poisson's ratio, Modulus of elasticity, Strain related problems. Shear force and bending moment, Fundamentals of shear force and bending moment, SFD and BMD of cantilever and simply supported and overhanging beams, Point of contra-flexture; Torsion of circular shaft, Torsional effect, Hoop stress, Power transmitted by a shaft; Principal stresses and strain, Analysis of plane and complex stress, Principal planes and Principal stresses, Mohr's circle, Finding out principal stresses, Different analysis.

PRACTICAL

Problems on composition and resolution of forces; Study the moments of a force; Problems related to resultant of a concurrent- coplanar force system; Problems related to non-concurrent coplanar force system; Systems of couples in space; Problems related to centroids of composite areas; Problems on Moment of Inertia, radius of gyration of composite areas; Analysis of equilibrium of concurrent coplanar and non-concurrent coplanar force system; Problems involved with frictions; Analysis of simple trusses by methods of joints and methods of sections; Analysis of simple trusses by graphical method; Problems on simple stress and strains; Problems on shear and bending moment diagrams. Problems on stresses on beams. Problems on torsion of the shafts; Analysis of plane and complex stresses.

TEACHING SCHEDULE

THEORY [FS-231]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	Introduction	Basic concepts of Engineering Mechanics, Static, dynamic, kinetic, scalar quantities, Vector quantities, Systems of unit	25
2 - 3	Composition and Resolution of Forces	Composition and resolution of forces, Analytical method, Graphical method	
4 - 7	Moments, Equilibrium of Forces, Parallel Forces and Couples	Laws of forces, Moments and their application, levers, Parallel forces and couples; Equilibrium of forces, Free body diagrams	
8 - 11	Centre of Gravity	Centre of gravity (CG) of Simple geometrical figures, CG by moments, plane figures, axis of references, CG of symmetric sections, Unsymmetrical sections, Solid bodies and Cut sections	25
12 - 14	Moment of Inertia	Methods of finding out M.I., Methods of integration, M.I. of different sections, Theorem of perpendicular axes, parallel axes, M.I. of composite sections and cut sections	
15 - 18	Friction	Frictional forces, static friction, dynamic friction, limiting friction, normal reaction, angle of friction, coefficient of friction, laws of friction, equilibrium of a body lying in horizontal and inclined planes, ladder friction; wedge friction, screw friction, screw jack	25
19 - 21	Analysis of Perfect Frames	Analysis of simple framed structures, Methods of sections, force table, methods of joints, hinged joints, roller support, vertical and inclined loads	
22 - 25	Simple Stresses and Strain	Simple Stresses and Strain, Hooke's Law, Poisson's ratio, Modulus of elasticity, Strain related problems	25
26 - 28	Shear Force and Bending Moment	Shear force and Bending moment, Fundamentals of shear force and Bending moment, SFD and BMD of cantilever and simply supported and overhanging beams, Point of contra-flexture	
29 - 30	Torsion	Torsion of circular shaft, torsional effect, hoop stress, power transmitted by a shaft	
31 - 32	Principal Stresses and Strain	Principal stresses and strain, Analysis of plane and complex stress, Principal planes and Principal stresses, Mohr's circle, Finding out Principal stresses, Different analysis	
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FS-231]

Exercise No.	Exercise Title
1	Problems on composition and resolution of forces
2	Study the moments of a force
3	Problems related to resultant of a concurrent-coplanar force system
4	Problems related to resultant of a non-concurrent coplanar force system
5	Problems on systems of couples in space
6	Problems related to centroids of composite areas
7	Problems on Moment of Inertia, radius of gyration of composite areas
8	Analysis of equilibrium of concurrent coplanar and non-concurrent coplanar force system
9	Problems involved with frictions
10	Analysis of simple trusses by methods of joints and methods of sections
11	Analysis of simple trusses by graphical method
12	Problems on simple stresses and strains
13	Problems on shear and bending moment diagrams
14	Problems on stresses on beams
15	Problems on torsion of the shafts
16	Analysis of plane and complex stresses.

Suggested Readings [FS-231]:

1. Bansal R.K. 2005. A Text Book of Engineering Mechanics. Laxmi Publishers, New Delhi.
2. Khurmi R.S. 2006. Strength of Materials. S. Chand Publishing.
3. Khurmi R.S. 2018. A Text Book of Engineering Mechanics. S. Chand Publishing.
4. Prasad I.B. 2004. Applied Mechanics and Strength of Materials. Khanna Publishers, New Delhi.
5. Prasad I.B. 2004. Applied Mechanics. Khanna Publishers, New Delhi.
6. Sundarajan V. 2002. Engineering Mechanics and Dynamics. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
7. Timoshenko S. and Young D.H. 2003. Engineering Mechanics. McGraw Hill Book Co., New Delhi.

Semester	**:**	**III**			
Course No.	**:**	**SWCE-232**	**Credit Hrs.**	**:**	**2(1+1)**
Course Title	**:**	**Soil Mechanics**			

SYLLABUS

Objectives : To make the students acquainted with the Principles of Soil Mechanics and the calculation of different stresses in soil, which will be helpful in designing the retaining walls and other engineering structures.

THEORY

Introduction to Soil Mechanics, Field and scope of Soil Mechanics; Phase diagram, Physical and index properties of soil, Particle size distribution, Grain size distribution curve, Soil indices; Plastic limit, liquid limit, shrinkage limit; Classification of soils, Effective and neutral stress, Boussinesq and Wester-guard's analysis, New-mark's influence chart, Stress distribution and diagrams; Shear stress, Mohr's circle, Direct shear stress, Triaxial test and Vane shear test; Mohr coulomb failure theory, Effective stress principle, Determination of shear parameters by direct shear test, Triangle test and vane shear test. Numerical Exercise based on various types of tests Compaction of soils, Standard and modified protector test, Abbot's compaction and Jodhpur mini compaction test, Field compaction method and Control; Consolidation of soils, Terzaghi's theory of one-dimensional consolidation, Spring analogy, Laboratory consolidation test, Calculation of void ratio and coefficient of volume change, Taylor's and Casagrande's method. 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, Friction circle method.

PRACTICAL

Determination of moisture content of soil sample; Determination of specific gravity of soil sample; Study of field density by core cutter; Study of bulk density, dry density by sand replacement method; Determination of grain size distribution of coarse grained soil by sieving; Determination of grain size by hydrometer method; Determination of liquid limit by Casagrande apparatus; Determination of liquid limit by cone penetrometer; Determination of plastic limit of soil specimen; Determination of shrinkage limit of soil; Determination of optimum moisture content of saturated soil by Abbot's compaction test; Determination of optimum moisture content of saturated soil by Proctor's mould; Consolidation characteristics of soil; Shear strength of soil by direct shear test; Shear strength of soil by tri-axial shear test.

TEACHING SCHEDULE

THEORY [SWCE-232]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	Soil Mechanics	Introduction to Soil Mechanics, Field and Scope of Soil Mechanics	5
2	Soil Properties	Soil as a three-phase system or diagram, Physical properties of soil (void ratio, porosity and degree of saturation, functional relationships and numerical)	5
3		Index properties of soil: Water content, Specific gravity, Particle size distribution, Consistency limits, *In-situ* density and Density index.	5
4		Particle size distribution, Grain size distribution curve, soil indices; Plastic limit, Liquid limit, Shrinkage limit	5
5		Classification of soils: Particle size classification, Textural classification Highway Research Board classification and Unified Classification	5
6	Soil Stresses	Effective and natural stress: Modes of water, capillarity and stress condition in soil	5
7		Boussinesq and Wester-guard's analysis, New-mark's influence chart	5
8 - 9		Mohr's circle, direct shear stress, triaxial test and vane shear test; Mohr coulomb failure theory, Effective stress principle, Determination of shear parameters by direct shear test, triangle test and vane shear test	10
10 - 11	Compaction of Soils	Standard Proctor Test, Modified Proctor Test, Abbot Compaction Test, Jodhpur Mini Compaction test, Field compaction methods and Field compaction control	15
12 - 13	Consolidation of Soil	One-dimensional consolidation, Spring analogy, Tergazi's theory of one-dimensional consolidation, Laboratory consolidation test, Calculation of voids ratio and coefficient of volume change, Taylor's and Casagrande's method.	15
14 - 15	Earth Pressure	Plastic equilibrium in soils, Active and passive states, Rankine's theory of earth pressure, Active earth pressure for cohesive soils, Passive earth pressure for cohesive soils. Simple Numerical Exercises.	15
16	Stability of Slopes	Introduction to Stability analysis of infinite slopes, Finite slope. Friction circle methos, Taylor's stability number, Friction circle method.	10
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [SWCE-232]

Exercise No.	Exercise Title
1	Determination of moisture content of soil sample.
2	Determination of specific gravity of soil sample.
3	Study of field density by core cutter.
4	Study of bulk density, dry density by sand replacement method.
5	Determination of grain size distribution of coarse-grained soil by sieving.
6	Determination of grain size by hydrometer method.
7	Determination of liquid limit by Cassagrande apparatus.
8	Determination of liquid limit by cone penetrometer.
9	Determination of plastic limit of soil specimen.
10	Determination of shrinkage limit of soil.
11	Determination of optimum moisture content of saturated soil by Abbot's compaction test.
12	Determination of optimum moisture content of saturated soil by Proctor's mould.
13	To study the Consolidation characteristics of soil.
14	Determination of hydraulic conductivity of soil by constant head methods.
15	Shear strength of soil by direct shear test.
16	Shear strength of soil by tri-axial shear test.

Suggested Readings [SWCE-232]:

1. Punmia B.C., Jain A.K. and Jain A.K. 2005. Soil Mechanics and Foundations. Laxmi Publications (P) Ltd., New Delhi.
2. Ranjan G. and Rao A. S. R. 1993. Basic and Applied Soil Mechanics. Welley Easters Ltd., New Delhi.
3. Singh A. 1994. Soil Engineering. Vol. I. CBS Publishers and Distributions, New Delhi.

Semester	**:**	**III**		
Course No.	**:**	**IDE-231**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Fluid Mechanics and Open Channel Hydraulics**		

SYLLABUS

Objectives : To make the students acquainted with the behaviour of fluids at rest and in motion and to enable them to apply the principles to design simple fluid mechanical systems in engineering

THEORY

Properties of fluids: Ideal and real fluid units; Pressure and its measurement, Pascal's law, pressure forces on plane and curved surfaces, center of pressure, pressure diagram, application of hydrostatics in engineering structures; Buoyancy, Archimedes' principle, metacenter 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 pitot tube, siphon.

Flow through orifices (Measurement of Discharge, Measurement of Time), Flow through Mouthpieces, Flow over Notches, Flow over weirs, end contraction of rectangular weir, ventilation of weirs, various types of nappes.

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, Chezy's formula for loss of head in pipes, Flow through simple and compound pipes, Transmission of power through pipes.

Open channel design and hydraulics: Chezy's formula, Bazin's formula, Kutter's Manning's formula, Best hydraulic section, Velocity and Pressure profiles in open channels, Hydraulic jump, Discharge measurement in open channel: Current meter;

Dimensional analysis and similitude: Rayleigh's method and Buckingham's `Pi' theorem, Types of similarities, Dimensionless numbers. Introduction to fluid machinery.

PRACTICAL

Study of manometers and pressure gauges; Study of transmissibility of liquid pressure; Study of various types of flow such as laminar flow, uniform flow, steady flow, vertex flow rotational flow; Determination of meta centric height; Verification of Bernoulli's theorem; Determination of coefficient of discharge of venturimeter and orifice meter; Determination of coefficient of friction in pipeline; Determination of coefficient of discharge for rectangular notch 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.; Determination of efficiency of hydraulic ram; Measurement of velocity by current meter.; Study of open channel flow.; Velocity distribution in open channels and determination of Manning's coefficient of Rugosity and Chezy's roughness coefficient; Study of various types of models and prototypes: geometrical, kinematic and dynamic similarities; Study on non-dimensional constants such as Froud's number and Reynold's number; Study of various types of pumps and its components.

TEACHING SCHEDULE

THEORY [IDE-231]

Lecture No.	Topic	Sub- topics/ Key Points	Weightage, (%)
1	Properties of Fluids	Introduction, Properties of fluid, Types of fluids: Ideal and Real fluid.	15
2 -7	Pressure and its Measurement	Fluid pressure at point, Pascal's law, Absolute, Gauge, Atmospheric and Vacuum pressure. Piezometer, U-tube manometer, Single column manometer, U-tube differential manometers, Inverted U-tube differential manometer, Mechanical gauges.	
8 - 10	Pressure Forces on Plane and Curved Surfaces	Total pressure and center of pressure, Pressure diagram, Vertical plane surface submerged in liquid, Horizontal plane surface submerged in liquid, Inclined plane surface submerged in liquid, Curved surface sub-merged in liquid. Application of hydrostatics in engineering structures.	15
11 - 13	Buoyancy and Floatation	Archimedes's Principle, Introduction, Buoyancy, Center of buoyancy, Meta-centre, Metacentric height, Analytical method for metacentric height.	
		Conditions of floatation and stability of submerged and Floating bodies.	

Continued…

14 - 15	Kinematics of Fluid Flow	Lagrangian and Eulerian description of fluid motion.	10
16	Description of the Flow Pattern	Path lines, streak lines and stream lines, stream tube, Types of fluid flow, Translation, Rotation, Circulation and Vorticity, Vortex motion. Velocity potential function and Stream function, Vorticity, Flow net.	
17 - 18	Dynamics of Fluid Flow	Venturimeter, Bernoulli's equations; Orifice meter, Nozzle (Pitot-tube), Siphon.	
19 - 21	Flow through Orifices and Mouth Pieces; Flow through Notches, Weirs	Introduction, Classifications of orifices, Classifications of mouthpieces, Measurement of discharge, measurement of time. Classification of notches and weirs, Discharge over a rectangular notch or weir, Ventilation of weirs, Various types of nappe.	10
22 - 24	Laminar and Turbulent Flow in Pipes	General equation for head loss, Darcy equation, Moody's diagram; Major and minor hydraulic losses through pipes and fittings. Chezy's formula for loss of head in pipes. Flow through simple and compound pipe. Flow through network of pipes, Power transmission through pipes. Hydraulic gradient and energy gradient.	10
25 - 28	Open Channel Design and Hydraulics	Chezy's formula and Manning's formula, Bazin's formula, Ganguillet-Kutter's formula, Best hydraulic section, velocity and pressure profiles in open channels, Hydraulic jump, Discharge measurement in open channels; Current meter.	30
29 - 31	Dimensional Analysis and Similitude	Rayleigh's method, Buckingham's π – theorem, Types of similarities (Similitude), Dimensionless numbers.	10
32	Introduction of Fluid Machinery	Fluid machinery; Hydraulic ram.	
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [IDE-231]

Exercise No.	Exercise Title
1	Study of manometers and pressure gauges.
2	Study of transmissibility of liquid pressure.
3	Study of various types of flow such as laminar flow, uniform flow, steady flow, vertex flow, rotational flow.
4	Determination of meta centric height.
5	Verification of Bernoulli's theorem.
6	Determination of coefficient of discharge of venturimeter.
7	Determination of coefficient of discharge of orifice meter.
8	Determination of coefficient of friction in pipeline.
9	Determination of coefficient of discharge for rectangular notch and triangular notch.
10	Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice.
11	Determination of coefficient of discharge for mouth piece.
12	Determination of efficiency of hydraulic ram.
13	Study of open channel flow and measurement of velocity by current meter.
14	Velocity distribution in open channels and determination of Manning's coefficient of Rugosity and Chezy's roughness coefficient.
15	Study of various types of models and prototypes: geometrical, kinematic and dynamic similarities.
16	Study on non-dimensional constants such as Froude's number and Reynold's number and Study of various types of pumps and its components.

Suggested Readings [IDE-231]:

1. Bansal R.K. A Text Book of Fluid Mechanics and Hydraulic Mechanics (10th edition). Laxmi Publications (P) Ltd., New Delhi.
2. Modi P.N and Seth S.M. 2017. Hydraulics and Fluid Mechanics (including Hydraulic Machines) (16th Edition). Standard Book House, Delhi-6.
3. Garg S.K. Irrigation Engineering and Hydraulic Structures. Khanna Publisher, New Delhi.
4. Jagdish Lal. Fluid Mechanics. Metropolitan Books CI. Pvt. Ltd. New Delhi.
5. Ramanuthan S. 2011. Hydraulics, Fluid Mechanics and Hydraulic Machines. Dhanpat Rai and Sons, New Delhi.
6. Khurmi R.S. and Khurmi N.S. 1987. Hydraulics, Fluid Mechanics and Hydraulic Machines. S. Chand & Co. Ltd., New Delhi.

Semester	**:**	**III**		
Course No.	**:**	**PFE-231**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Engineering Properties of Agricultural Produce and Food Science**		

SYLLABUS

Objectives : To make the students acquainted with the different engineering properties of agricultural produce and to help them to understand the importance of these properties in handling, processing and storage.

THEORY

Different engineering properties of food and their importance; Application of engineering properties in handling, processing and storage; Physical properties, viz. shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area; Colour properties, CIE colour model.

Thermal properties viz., heat capacity, specific heat, thermal conductivity, thermal diffusivity, heat of respiration, co-efficient of thermal expansion; Electrical and dielectric properties as resistance, capacitance, dielectric loss factor, loss tangent and dielectric constant; Frictional properties, viz. static friction, kinetic friction, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials; Aero-dynamic characteristics such as drag coefficient, terminal velocity.

Rheological characteristics of food, elastic, plastic and viscous behaviour, visco-elasticity; Rheological models to explain food characteristics; Fluid behaviour as Newtonian, non-Newtonian, pseudo-plastic, dilatant, thixotropic, rheopectic and Bingham plastic; Textural characteristics of foods; Non-destructive methods of quality determination of foods; Principles of machine vision systems, spectroscopy, hyperspectral imaging and acoustic techniques.

Introduction to Food Science and Food Technology; Biochemical reactions involved in food processing and storage; Food spoilage agents, general methods for food preservation (physical, chemical and biological methods); Food microbiology: Classification of microorganisms, Multiplication of bacteria, Different beneficial and harmful microorganisms in relation to food preservation and spoilage, Industrial Bacteriology and Food fermentation.

PRACTICAL

Determination of the size of grains, fruits and vegetables using measuring instruments and using projection system; Determination of the shape (sphericity and roundness); Determination of the bulk and particle volume, bulk and particle density, specific gravity and porosity of grains; Determination of the volume, density and specific gravity of large individual objects (F and V); Determination of the surface area of the F and V; Determination of angle of repose, co-efficient of friction of different grains on different surfaces and angle of internal friction; To study the terminal velocity of grains and separating behavior of grains in a vertical wind tunnel; Determination of specific heat and thermal conductivity of some food grains; Determination of electrical properties of food materials; Determination of hardness of food materials; Determination of viscosity of food; Study and comparison of colour of food materials; Determination of carbohydrates; Determination of total nitrogen; Determination of oil content; Determination of ash content; Study of different types of microorganisms and microbiological examination of food products.

TEACHING SCHEDULE

THEORY [PFE-231]

Lecture No.	Topic	Sub-topics/ Key points	Weightage (%)
1	Engineering Properties	Different Engineering properties of food and their importance	10
2	Application of Engineering Properties	Application of Engineering properties in handling, processing and storage	
3 - 6	Physical Properties	viz., Shape, Size, Roundness, Sphericity, Surface area, Volume, Density, Porosity, Specific gravity	15
7	Colour Properties	CIE colour model	15
8 - 10	Thermal Properties	Heat capacity, Specific heat, Thermal conductivity, Thermal diffusivity, Heat of respiration, Coefficient of thermal expansion	
11 - 12	Electrical and Dielectric Properties	Resistance, Capacitance, Dielectric loss factor, Loss tangent and Dielectric constant	
13 - 14	Frictional Properties	Static friction, Kinetic friction, Rolling resistance, Angle of internal friction, Angle of repose, Flow of bulk granular materials	10
15	Aero-dynamic Characteristics	Drag coefficient, Terminal velocity	
16 - 18	Rheological Characteristics of Food	Elastic, plastic and viscous behaviour, Visco-elasticity, Rheological models to explain food characteristics	15
19 - 21		Fluid behaviour as Newtonian, Non-Newtonian, Pseudo-plastic, Dilatant, Thixotropic, Rheopectic and Bingham plastic; Textural characteristics of foods	
22 - 24	Non-destructive Methods of Quality Determination of Foods	Principles of machine vision systems and its application, Spectroscopy, Hyperspectral imaging and Acoustic techniques	15

Continued…

25	Introduction to Food Science and Food Technology	Introduction to Food Science and Food Technology	10
26	Biochemical Reactions	Biochemical reactions involved in food processing and storage	
27	Food Spoilage Agents	Food spoilage agents	
28	General Methods for Food Preservation	Physical, chemical and biological	
29	Food Microbiology	Classification of microorganisms, Multiplication of bacteria	
30 - 31	Different Microorganisms	Different beneficial and harmful microorganisms in relation to food preservation and spoilage	10
32	Industrial Bacteriology and Food Fermentation	Industrial Bacteriology and Food fermentation	
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [PFE-231]

Exercise No.	Exercise Title
1	Determination of the size of grains, fruits and vegetables using measuring instruments and using projection system.
2	Determination of the shape, sphericity and roundness.
3	Determination of the bulk and particle volume, bulk and particle density, specific gravity and porosity of large individual objects (Fruits, Vegetables and Grains)
4	Determination of the surface area of F & V.
5	Determination of angle of repose, co-efficient of friction of different grains on different surfaces and angle of internal friction.
6	To study the terminal velocity of grains and separating behavior of grain in a vertical wind tunnel.
7	Determination of specific heat and thermal conductivity of some food grains.
8	Determination of electrical properties of food materials.
9	Determination of hardness of food materials.
10	Determination of viscosity of food.
11	Study and comparison of colour of food materials.
12	Determination of carbohydrates.
13	Determination of total nitrogen.
14	Determination of oil content.
15	Determination of ash content
16	Study of different types of microorganisms and microbiological examination of food products.

Suggested Readings [PFE-231]:

1. Mohesin N.N. 1980. *Physical Properties of Plants & Animals*. Gordon & Breach Science Publishers, New York.
2. Singhal O.P. and Samuel D.V.K. 2003. *Engineering Properties of Biological Materials*. Saroj Prakasan, New Delhi.
3. Rao M.A. and Rizvi S.H. 1995. *Engineering Properties of Foods*. Marcel Dekker Inc. New York.
4. Jha. S.N. 2010. Non-destructive evaluation of food quality theory and practice. Springer -Verlag Berlin Heidelberg,
5. Ana Maria Jimenez-carvelo, Alejandra Arroyo-Carvelo & Luis Cuadros-Rodriguez. 2024. Non-invasive and Non-destructive methods for food integrity. Springer Nature Switzerland AG, Gewerbestrasse 11,6330, Cham Switzerland.
6. Notes of IGNOU, The people's university. Indira Gandhi National Open University of school of continuing education.
7. Vijaya Khader. 2001. Textbook of food science & Technology. Directorate of knowledge management in agriculture, (ICAR), Pusa, New Delhi.
8. William C. Frazier, Dennies C Westhoff. 2014. Food microbiology. McGraw hill education Pvt. Ltd. Chenni, India
9. Vijaya Khader. 2017. Preservation and processing of fruit and vegetables. Kalyani publication, New Delhi, India.
10. R.P.Shiratsava & Sanjeev Kumar. 2002. Fruit and vegetable preservation principle and practices. CBS publisher & distributor Pvt. Ltd. New Delhi, India
11. Fundamental of food microbiology, Chapter 1. Introduction to food microbiology, (Notes of IGNOU, The people's university. Indira Gandhi National Open University of School of Continuing Education).
12. L.E. Casida. 1968. Industrial Microbiology.
13. Serpil S. and Servet G S. 2005. *Physical Properties of Foods*. Springer Science + Business Media, LLC, 233 Spring Street, New York.

Semester	**:**	**III**		
Course No.	**:**	**FMPE-233**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Farm Machinery and Equipment-I**		

SYLLABUS

Objectives : To make the students acquainted with the basic construction and operational features of different farm machineries used in operations such as seed-bed preparation, sowing, planting and transplanting, etc. and their economics of operation.

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.

Materials used in construction of farm machines; Heat treatment processes and their use in farm machines; Properties of materials used for critical and functional components of agricultural machines; Different types of steels and alloys for agricultural applications; Identification of heat treatment processes specially for the agricultural machinery components.

Seed-bed preparation and its classification; Land reclamation and earth moving equipment; Machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage, viz., mould-board plough, disc plough, chisel plough, sub-soiler, harrows, puddler, cultivators, identification of their major functional components; Attachments with tillage machinery; Hitching systems and controls.

Calculation of field capacities and field efficiency; Draft of tillage tools and calculations for power requirement for the tillage machines; Calculation for economics of machinery usage; Comparison of ownership with hiring of machines.

Sowing, planting and transplanting equipment, viz. seed drills, no-till drills, strip-till drills, different types of planters, bed-planters; Planting equipment for crops like sugarcane, potato; Furrow openers and metering systems in drills and planters; Calibration of seed-drills/ planters; Adjustments during operation. Testing and Evaluation of tillage and sowing equipment and their test codes.

PRACTICAL

Familiarization with different farm implements and tools; Study of hitching systems; Study on draft measurement; Study of different problems on machinery management.; Study of primary tillage machinery- types, construction, operation, adjustments and calculations of power and draft requirements; Study of secondary tillage machinery- types, construction, operation, adjustments and calculations of power and draft requirements; Study of different types of puddlers and determination of puddling index in the field; Study of sowing and planting equipment- construction, types, calculation for calibration and adjustments; Study of seed drill and its calibration; Study of different types of metering mechanisms used in seed drills and planters; Study of paddy transplanters; Study of various pre-germinated paddy seeder; Study of vegetable transplanters; Identification of materials of construction in agricultural machinery and study of material properties; Testing and Evaluation of tillage and sowing equipment; Visit to a site to observe field operations of paddy transplanters; Visit to an implement manufacturing unit.

TEACHING SCHEDULE

THEORY [FMPE-233]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 3	Farm Mechanization and Selection of Farm Machinery	Introduction to Farm Mechanization; Classification of farm machines; Unit operations in crop production; Identification and selection of machines for various operations on the farm.	10
4 - 7	Construction of Farm Machinery	Materials used in construction of farm machines; Heat treatment processes and their use in farm machines; Properties of materials used for critical and functional components of agricultural machines; Different types of steels and alloys for agricultural applications; Identification of heat treatment processes specially for the agricultural machinery components.	10
8 - 9	Seed-bed Preparation	Seed-bed preparation and its Classification; Land reclamation and earth moving equipment;	10
10 - 14	Tillage Equipment	Machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage viz., mould-board plough, disc plough, chisel plough, sub-soiler, harrows, puddler, cultivators, Identification of their major functional components.	15
15 - 16	Hitching System	Attachments with Tillage machinery; Hitching systems and controls.	5
17 - 20	Performance Parameters and Cost Economics	Calculation of field capacities and field efficiency; Draft of tillage tools and calculations for power requirement for the tillage machines; Calculation for economics of machinery usage; Comparison of ownership with hiring of machines.	10
21 - 25	Sowing and Planting Equipment	Sowing and Planting Equipments viz., Seed drills, no-till drills, strip-till drills, different types of planters, bed-planters; Planting equipment for crops like sugarcane, potato; Furrow openers and metering systems in drills and planters.	20

Continued…

26	Calibration of Seed-drills	Calibration of seed-drills/ planters; Adjustments during operation.	5
27 - 28	Transplanting Equipment	Paddy, vegetables and other transplanters.	5
29 - 32	Testing and Evaluation of Agricultural Equipment	Testing and Evaluation of tillage and sowing equipment and their test codes.	10
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FMPE-233]

Exercise No.	Exercise Title
1	Study of hitching systems
2	Study of draft measurement of agricultural machinery
3	Study of different problems on machinery management
4 - 5	Study of primary tillage machinery- Types, construction, operation, adjustments and calculations of power and draft requirements
6 - 7	Study of secondary tillage machinery- Types, construction, operation, adjustments and calculations of power and draft requirements
8	Study of different types of puddlers and determination of puddling index in the field.
9	Study of Sowing and planting equipments: Construction, metering mechanism and adjustments
10	Study of calibration of seed drills and planters
11	Study of paddy transplanters and various pre-germinated paddy seeder
12	Study of vegetable transplanters
13	Identification of materials of construction in agricultural machinery and study of material properties
14	Testing and Evaluation of tillage and sowing equipment
15	Visit to a site to observe field operations of transplanters
16	Visit to an Implement Manufacturing Unit

Suggested Readings [FMPE-233]:

1. Jain, S.C. and Phillips, G. 2003. Farm Machinery - An Approach. Standard Publishers and Distributors.
2. Kepner, R. A., Bainer, R. and Barger, E. L. 2005. Principles of Farm Machinery. CBS Publishers and Distributors.
3. Lal Radhey and Datta, A.C. 1978. Agricultural Engineering through Worked Out Examples. Saroj Prakashan, Allahabad.
4. Nakra, C.P. 2003. Farm Machines and Equipment. Dhanpat Rai and Publishing Co.
5. Smith, H.P. and Wilkes, L.H. 2011. Farm Machinery and Equipment. McGraw Hill Publication, New York.
6. Srivastav, A.K., Goering, C.E. and Rohrbach, R.P. 2005. Engineering Principles of Agricultural Machines. ASAE. St. Joseph, Mich.
7. Srivastava, A.C. 1991. Elements of Farm Machinery. Oxford and IBH Publication.
8. Srivastava, T.K. 2007. A Work Book on Practical Farm Machinery. Vol. I and II. Saroj Prakashan, Allahabad
9. Suresh, R. and Kumar, S. 2018. Farm Power and Machinery Engineering. Standard Publishers.

Course Curriculum of Fourth Semester

as per the ICAR - Sixth Deans' Committee Report for the Academic Programmes in

AGRICULTURAL ENGINEERING

- ❖ UG-Certificate in Agricultural Engineering
- ❖ UG-Diploma in Agricultural Engineering
- ❖ UG-Degree: B.Tech. (Agricultural Engineering)

Mahatma Phule Krishi Vidyapeeth, Rahuri

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli

Maharashtra Agricultural Universities Examination Board, Pune

Compiled & Submitted by

Dr. A.G. Mohod

Associate Dean, College of Agril. Engineering & Technology, Dr.BSKKV, Dapoli.

UG Degree Syllabus State Coordinator

with

UG Degree Syllabus Discipline Coordinators &

DICC - UG Degree Syllabus Core Committee

Submitted to the

Directors of Instruction Coordination Committee

~ w.e.f. AY, 2025-26 ~

Course Curriculum of Fourth Semester as per the ICAR-Sixth Deans' Committee Report for Academic Programmes in AGRICULTURAL ENGINEERING

Course Layout

B.Tech. (Agricultural Engineering)

Semester: IV (New) ***w.e.f.*** **Academic Year: 2025-26**

Sr. No.	Course No.	Course Title	Credit Hrs.	Remark
1.	**MDC-242**	Entrepreneurship Development and Business Management	3(2+1)	--
2.	**AE-MATH-243**	Engineering Mathematics-II	3(3+0)	--
3.	**FS-242**	Theory of Structures	2(1+1)	--
4.	**FS-243**	Building Construction and Cost Estimation	2(1+1)	--
5.	**SWCE-243**	Watershed Hydrology	3(2+1)	--
6.	**SWCE-244**	Soil and Water Conservation Engineering	3(2+1)	--
7.	**FMPE-244**	Farm Machinery and Equipment-II	3(2+1)	--
8.	**REE-243**	Renewable Energy Sources	3(2+1)	--
9.	**PFE-242**	Post-harvest Engineering of Cereals, Pulses and Oilseeds	3(2+1)	--
10.	**OC-1/ OC-2/...**	Online Course(s)/ MOOCs†	As opted by student	NG
		Total Credits Hrs.=	**25(17+8)**	**G**
MDC: Multidisciplinary Course, **OC**: Online Course, **G**: Gradial, **NG**: Non-gradial				
Post-IV Semester (Only for Exit option for award of UG-Diploma)				
11.	**INT-242**	Internship (10-week)	10(0+10)	NG

† **Note:** It is mandatory for each Student to complete **total 6 credits** (Non-gradial) of **Online Courses** from available resources across III to VIII semesters under the guidance of assigned Faculty/Advisor.

B.Tech. (Agricultural Engineering): Fourth Semester

Course-wise Syllabus with Teaching Schedules

Semester	**:**	**IV**		
Course No.	**:**	**MDC-242**	**Credit Hrs. :**	**3(2+1)**
Course Title	**:**	**Entrepreneurship Development and Business Management**		
Gradial Common Course across B.Sc. (Hons.) Agriculture, B.Tech. (Agricultural Engineering), B.Tech. (Food Technology) and B.Sc. (Hons.) Agri. Business Management				

SYLLABUS

Objectives : (i) To provide student an insight into the concept and scope of entrepreneurship,
(ii) To expose the student to various aspects of establishment and management of a small business unit,
(iii) To enable the student to develop financially viable agribusiness proposal.

THEORY

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/ competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning– spotting of opportunity- scanning of environment– identification of product/ service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the products/ services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management– product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management– raw material costing, inventory control. Personal management– manpower planning, labour turn over, wages/ salaries. Financial management/accounting– funds, fixed capital and working capital, costing and pricing, long-term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

PRACTICAL

Visit to small scale industries/agro-industries. Interaction with successful Entrepreneurs/ Agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

TEACHING SCHEDULE

THEORY [MDC-242]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	**Introduction to Entrepreneurship**	Meaning and Definitions of an Entrepreneur, Entrepreneurship; Concept & Scope of Entrepreneurship	6
2	**Importance of Entrepreneurship**	Importance of Entrepreneurship in Agribusiness	
3	**Entrepreneurship Development**	Need for and objectives of Entrepreneurial development	4
4	**Motivational Factors**	Types of motivational factors, Role of social and environmental factors in entrepreneurship	4
5	**Characteristics of Entrepreneurs**	Characteristics, Entrepreneurial attributes and Competencies	4
6	**Types of Entrepreneurs**	Various types and their significance	4
7	**Functions of Entrepreneurs**	Key roles and Responsibilities	2
8	**Evolution of Entrepreneurship**	Historical perspective and Growth	3
9	**Process of Entrepreneurship Development**	Stages and Approaches in developing entrepreneurship	4
10	**Environmental Scanning**	Need for scanning, Techniques	2
11	**Opportunity Identification**	Spotting and Analyzing opportunities	2
12	**Infrastructure and Support Systems**	Policies, Schemes and Role of financial and other agencies in entrepreneurship development	4
13	**Enterprise Functioning Steps**	Steps to establish an Enterprise	4
14	**Selection of Products/Services**	Choosing products, Services and Business forms	3
15	**Enterprise Location and Capital Sources**	Registration, Site selection, Capital sources/ Acquisition	3

Continued….

16	**Manufacturing and Distribution**	Acquiring manufacturing know-how, Packaging and Distribution essentials	3
17	**Planning of an Enterprise**	Short term and Long-term planning of an Enterprise	3
18 - 19	**Project Formulation**	Project identification, Selection, Steps in project formulation and Report preparation, etc.	8
20	**Enterprise Management**	Basics and Importance of managing an Enterprise	3
21	**Production Management**	Product types, Levels of products, Product mix, Quality control, Cost of production, Production control	4
22	**Material Management**	Raw material costing and Inventory control strategies	4
23	**Personnel Management/ Human Resource Management**	Manpower planning, Labour turnover, Wages/ Salaries	4
24	**Financial Management**	Funds, Fixed and Working capital, Costing, Pricing, Book-keeping basics	4
25 - 26	**Accounting and Taxation**	Journals, Ledgers, Subsidiary books, Annual financial statements, Taxation basics	4
27	**Marketing Management**	Market, Types of markets, Marketing assistance	4
28 - 29	**Market Strategies and Pricing**	Marketing strategies, Pricing strategies and Market penetration	4
30	**Crisis Management**	Crisis types, Strategies for managing raw material, etc.	2
31	**Leadership in Crisis Situations**	Role of leadership in handling crises	2
32	**Financial Crises and Solutions**	Strategies for financial crisis management	2
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [MDC-242]

Exercise No.	Exercise Title
1	Visit to Small-Scale Industries/ Agro-Industries. (Objective: To understand setup and operations of small-scale units)
2	Interaction with Successful Entrepreneurs. (Objective: To gain insights from real-life entrepreneurial experiences)
3	Case Study on Agro-Entrepreneurs. (Objective: To analyze successful agribusiness ventures)
4	Visit to Financial Institutions. (Objective: To learn about funding options and financial support)
5	Identification of Agribusiness Ideas. (Objective: To identify viable agribusiness ideas based on demand)
6	Analyzing Project Proposals. (Objective: To study structure and elements of project proposals)
7	Preparing a Project Proposal. (Objective: To develop a basic proposal for an agribusiness venture)
8	Project Report Writing Techniques. (Objective: To practice format and structure for project reports)
9	Marketing Strategies Case Study. (Objective: To analyze effective marketing strategies in agribusiness)
10	Production and Cost Control Analysis (Objective: To study basic cost control measures in production)
11	Inventory Control Simulation (Objective: To apply inventory management methods in a hypothetical setup)
12	Basic Bookkeeping (Objective: To practice fundamental bookkeeping for small businesses)
13	Market Research Techniques (Objective: To use surveys and questionnaires for market insights)
14	Project Proposal Presentation (Objective: To present project ideas for feedback)
15	Review of Project Proposal (Objective: To refine project proposals based on feedback)
16	Final Evaluation of Proposals (Objective: To assess and finalize projects)

Suggested Readings [MDC-242]:

1. Charantimath P.M. 2009. Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
2. Desai V. 2015. Entrepreneurship: Development and Management, Himalaya Publishing House.
3. Desai V. 1997. Small Scale Industries and Entrepreneurship. Himalaya Publ. House, Mumbai.
4. Gupta C.B. 2001. Management Theory and Practice. Sultan Chand and Sons, New Delhi.
5. Indu Grover. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy, Udaipur.
6. Khanka S.S. 1999. Entrepreneurial Development. S. Chand and Co., New Delhi.
7. Mehra P. 2016. Business Communication for Managers. Pearson India, New Delhi.
8. Pandey M. and Tewari D. 2010. The Agribusiness Book. IBDC Publishers, Lucknow.
9. Singh D. 1995. Effective Managerial Leadership. Deep and Deep Publ., New Delhi.
10. Singhal R.K. 2013. Entrepreneurship Development and Management, Katson Books.
11. Tripathi P.C. and Reddy P.N. 1991. Principles of Management. Tata McGraw Hill, New Delhi.

Semester	**:**	**IV**		
Course No.	**:**	**AE-MATH-243**	**Credit Hrs.** **:**	**3(3+0)**
Course Title	**:**	**Engineering Mathematics-II**		

SYLLABUS

Objectives : To make the students acquainted with the application of various advanced mathematics such as vector calculus, Fourier series and Laplace transform and applications of numerical methods in engineering.

THEORY

Vector calculus: Scalar and vector point functions, vector differential operator Del, gradient of scalar point function, divergent and curl of vector point function and their physical interpretations, line, surface and volume integrals, Green's, Stock's and Divergence theorem (without proofs)

Functions of a complex variable: limit, continuity and analytic function, Cauchy-Riemann equations, harmonic functions.

Fourier series: Periodic functions, Euler's formulae, functions having arbitrary period, even and odd functions, half range series expansion, series expansion of functions with finite discontinuity.

Laplace Transform: Rules for Laplace transform and inverse Laplace transform applications to find solutions of ordinary and simultaneous differential equations.

Numerical Methods: Finite difference operators and their relationship, factorial notation. Newton's forward and backward interpolation formula, Newton's divide difference interpolation and Lagrange's interpolation formula, numerical differentiation and integration rule, numerical solutions of ODE by Taylor's series, Euler's method modified Euler's method, Runge-Kutta method of order four.

TEACHING SCHEDULE

THEORY [AE-MATH-243]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 7	**Vector Calculus**	Scalar and vector point functions	15
		Vector differential operator Del	
		Gradient of scalar point function	
		Divergent and curl of vector point function and their physical interpretations	
		Line, surface and volume integrals	
		Green's, Stock's and Divergence theorem	
8 - 12	**Functions of a Complex Variable**	Limit, Continuity, Derivative	10
		Analytic function	
		Cauchy-Riemann equations	
		Harmonic functions	
13 - 19	**Fourier Series**	Periodic functions	15
		Euler's formulae	
		Functions having arbitrary period	
		Series expansion of functions with finite discontinuity	
		Even and odd functions	
		Half range series expansion	
20 - 31	**Laplace Transform**	Laplace Transform of elementary functions	25
		Properties of Laplace Transforms: Linearity, Shifting and Change of Scale Property	
		Laplace Transform of derivatives	
		Laplace Transform of an integral	
		Laplace Transform of function multiplied by t^n	
		Laplace Transform of function divided by t	
		Inverse Laplace Transform	
		Applications to find solutions of ordinary and simultaneous differential equations with constant coefficients	

Continued….

32 - 43	**Numerical Methods**	Finite difference operators and their relationship	25
		Newton's forward and backward interpolation formula	
		Newton's divide difference interpolation	
		Factorial notation	
		Lagrange's interpolation formula	
		Numerical differentiation	
		Numerical integration rule	
44 - 48	**Numerical solutions of Ordinary Differential Equations by**	Taylor's series method,	10
		Euler's method and modified Euler's method	
		Runge-Kutta method of order four	
		Total =	**100**

Suggested Readings [AE-MATH-243]:

1. Grewal B.S., 2015. Higher Engineering Mathematics. Khanna Publishers, Delhi. (43rd Edition)
2. Narayan, S. 2016. A Text Book of Vector. S. Chand and Co. Ltd., New Delhi.
3. Narayan, S. 2016. Differential Calculus. S. Chand and Co. Ltd., New Delhi.
4. Narayan, S. 2016. Integral Calculus. S. Chand and Co. Ltd., New Delhi.
5. Raman, B.V.2008. Engineering Mathematics. Tata McGraw Hill, New Delhi.

Semester	**:**	**IV**		
Course No.	**:**	**FS-242**	**Credit Hrs.** **:**	**2(1+1)**
Course Title	**:**	**Theory of Structures**		

SYLLABUS

Objectives : (i) To make the students acquainted with the principles of structural design,

(ii) To enable the students to design small and medium RCC and steel structures.

THEORY

Types of Load and use of BIS Codes.

Design of steel structures - specifications, use of IS code (IS 800-2007) and steel table, design of steel sections under tension, compression and bending, use of any one design software such as STAAD Pro, ETABS, etc. for design of roof truss.

Design of RCC Structures - specifications, use of IS code (IS 456-2000), analysis and design of singly and doubly reinforced sections, design of beams, design of one way and two-way slabs, columns and foundations, design considerations for retaining walls and silos, use of design software for simple RCC structures.

PRACTICAL

Design and drawing of steel roof truss including tension member, compression member and member under bending, use of design softwares. Design and drawing of RCC building including single reinforced beam, double reinforced beam, one-way slab, two-way slabs, columns and foundations, Use of design softwares for simple RCC structures.

TEACHING SCHEDULE

THEORY [FS-242]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	**Types of Load and Use of BIS Codes**	Introduction, Characteristic strength and Characteristics load, Partial safety factors for load and material, Various loads acting on structures, BIS codes.	20
2	**Design of Steel Structures**	Specifications, Use of IS code (IS 800-2007) and Steel table	20
3 - 4		Design of steel sections under tension	
5 - 6		Design of steel sections under compression and bending	
7		Use of any one design software such as- STAAD Pro, ETABS, etc. for design of roof truss.	
8	**Design of RCC Structures**	Specifications, Use of IS code (IS 456-2000)	20
9 - 10		Analysis and design of singly reinforced sections	
11 - 12		Analysis and design of doubly reinforced sections	
13 - 14		Design of beams, Design of one-way slab, Design of two-way slab	20
15 - 16		Columns and foundations Types of footing/ foundations, Design of Isolated RCC footing, Design considerations for retaining walls and silos, Use of design software for simple RCC structures.	20
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FS-242]

Exercise No.	Exercise Title
1	To study standard rolled steel sections and use of steel table to find their properties.
2	Design and drawing of steel roof truss including tension member.
3	Design and drawing of steel roof truss including compression member.
4	Design and drawing of steel roof truss including member under bending.
5	Use of design softwares for trusses (STAAD Pro, ETABS, etc).
6	Use of design softwares for simple steel structures.
7	Design of concrete using various grades of concrete mixes.
8	Design and drawing of RCC building including single reinforced beam.
9	Design and drawing of RCC building including double reinforced beam.
10	Design of one-way slab.
11	Design of two-way slab.
12	Design and drawing of columns.
13	Design and drawing of foundations.
14	Design and drawing of various retaining wall.
15	Design and drawing of silos.
16	Use of design softwares for simple RCC structures (STAAD Pro, ETABS, etc).

Suggested Readings [FS-242]:

1. Bhavikatti S.S. 2014. Design of Steel Structures: By Limit State Method as Per IS: 800-2007. I K International Publishing House Pvt. Ltd.
2. Duggal S.K. 2017. Limit State Design of Steel Structures. McGraw Hill Education.
3. Punmia B.C, Jain A.K. and Jain A.K. 2016. Limit State Design of Reinforced Concrete. Laxmi Publications.
4. Raju N.K. 2019. Design of Reinforced Concrete Structures: IS:456-2000. CBS Publishers & Distributors.
5. L.S. Negi 2012 Design of Steel Structures. Tata McGraw-Hill, New Delhi.
6. V.L. Shah and S.R. Karve 2008. Illustrated Reinforced Concrete Design. Structures publications, Pune.

7. T.P. Ojha and A.M. Michael. 2003. Principles of Agricultural Engineering, Volume-I. Jain Brothers, New Delhi.
8. V.L. Saha and S.R. Karve. 2012. Limit State Theory and Design of Reinforced Concrete Structures Publishers, Pune.
9. N. Krishan Raju and R.N. Pranesh. 2012. Reinforced Concrete Design (IS 456-2000), Principles and Practice. New Age International.
10. N.C. Sinha and S.K. Roy. Fundamentals of Reinforced Concrete. S. Chand and Company.
11. S.K. Duggal 2011. Design of Steel Structures. Tata McGraw- Hill, New Delhi.
12. M. Raghupati 2011. Design of Steel Structure. Tata McGraw- Hill, New Delhi.
13. Ramchandra 2010. Design of Steel Structures. Dhanpatrai and Sons Publication Company, New Delhi.
14. Sushilkumar 2000. RCC Design Standard Book House, New Delhi.
15. M.G. Shah and C.M. Kale 1984. RCC Theory and Design MacMillan, Delhi.

Semester	**: IV**	
Course No.	**: FS-243**	**Credit Hrs. : 2(1+1)**
Course Title	**: Building Construction and Cost Estimation**	

SYLLABUS

Objectives : (i) To make the students get acquainted with the methods of construction of agricultural buildings,

(ii) To enable them to prepare various types of estimates of buildings.

THEORY

Building Materials: Description of important building materials, rocks, different stones; Formation of stones, types of stones, quarrying process, stone products and uses; Bricks, types, preparation and burning of bricks, properties and uses; Tiles, types and classification; Lime, properties and uses, cement, different uses and grades.

Concrete: Grades, preparation, mixing and laying of concrete, use of sand; Use of Ferrous material, Iron and Steel products; Use of non-ferrous metals, glass, rubber, plastics, Aluminum, Copper, Nickel; Timber and its uses, seasoning, defects, commercial form of timber, miscellaneous building materials.

Building Construction: Building components, foundations, brick work, lintels, columns, roofs and stair cases, different types of floors, plastering and pointing, damp proofing and waterproofing, white washing, distempering and painting, steps for building construction, needs of different agricultural buildings, types and uses, types of roofs, slope and flat roof buildings.

Estimating and Costing: Types of estimates, rough cost, detailed and supplementary estimate, Preparation of cost estimates, cost analysis, schedule of rates, analysis of rates, factors affecting building costs, building codes, estate development.

Cost Economics: Measurement and pricing, Economic methods for evaluation of buildings, Benefit cost calculation, Rate of return period (Payback period).

TEACHING SCHEDULE

THEORY [FS-243]

Lecture No.	Topic	Sub-topics / Key Points	Weightage (%)
1 - 2	**Building Materials**	Description of important building materials.	25
	Rocks and Stones	Different stones; Formation of stones, Types of stones, Quarrying process, Stone products and Uses.	
	Bricks	Types, Preparation and burning of bricks, Properties and Uses.	
	Tiles	Types and Classification.	
	Lime	Properties and Uses.	
3	**Cement, Concrete**	Different uses and grades. Grades, Preparation, Mixing and Laying of concrete, Use of sand. Use of Ferrous material, Iron and Steel products; Use of non-ferrous metals, Glass, Aluminum, Copper, Nickel.	25
4	**Timber**	Timber and its Uses, Seasoning, Defects, Commercial form of timber.	
5	**Miscellaneous Building Materials**	Rubber: Types, Uses. Plastic: Types, Uses.	
6 -7	**Building Construction**	Steps for building construction, Foundations, Brick work	25
8	**Building Components**	Lintels, Columns, Roofs and Stair cases	
9	**Floors**	Different types of floors	
10	**Plastering and Pointing**	Types, materials, application methods used in Plastering and Pointing	
11	**Distempering and Painting**	Damp proofing and waterproofing, White washing, distempering and painting	
12	**Needs of different Agricultural Buildings**	Needs of different agricultural buildings, Types and Uses	25
13	**Roofs**	Types of roofs, Slope and flat roof buildings	

Continued…

14 - 15	**Estimating and Costing**	Types of Estimates, Rough cost, Detailed and supplementary estimate, Preparation of cost estimate, Cost analysis, Schedule of rates, Analysis of rates, Factors affecting building costs, Building codes, Estate development.	
16	**Cost Economics**	Measurement and Pricing, Economic methods for evaluation of buildings, Benefit Cost calculation, Rate of Return period (Payback period).	
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FS-243]

Exercise No.	Exercise Title
1	Study of different types of rocks.
2	Study of water absorption of stone and brick materials.
3	Determination of soundness of cement by Le Chatelier apparatus.
4	To determine fineness of cement.
5	Test of adhesiveness of mortar to building units.
6	To determine standard consistency of cement.
7	To determine initial setting time of cement.
8	Preparation of concrete using various ingredients.
9	To test workability of cement by Slump cone method.
10	To test workability of cement by Compaction factor method.
11	Determination of Bulking of sand and silt content in the sand.
12	To determine void ratio and bulk density of fine aggregate and course aggregate.
13	Study of market forms of timber.
14	Measurement of components of an agricultural structure.
15	Preparation of an estimate of agricultural structure.
16	Visit to a Construction Site and to Brick kiln / Cement factory/ Stone quarry / Other Building material.

Suggested Readings [FS-243]:

1. Punmia B.C., Jain A.K. and Jain A.K. 1984. Building Construction. Laxmi Publications (P) Ltd., New Delhi.
2. Duggal S.K. 2012. Building Material. New Age International Publishers.
3. Sane Y.S. 1964. Planning and Designing of Buildings. Engineering Book Publishing Co., Pune.
4. Rangwala S.C. 1994. Engineering Materials. Charotar Publishing House, Anand.
5. Dutta B.N. 2000. Estimating and Costing. UBS Publishers.

Semester	**:**	**IV**		
Course No.	**:**	**SWCE-243**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Watershed Hydrology**		

SYLLABUS

Objectives : To make the students acquainted with the different hydrological processes, their methods of analysis, so as to enable them to apply these for watershed development, water harvesting, minor irrigation, drought and flood control, etc.

THEORY

Hydrologic cycle, components; Precipitation and its forms, rainfall measurement and estimation of mean rainfall, estimation of missing rainfall, optimum number of rain gauges; 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; Flood routing - channel and reservoir routing; Hydrology of dry land areas, Troll's climatic classification; Drought- classification, causes and impacts, drought management strategy.

PRACTICAL

Visit to meteorological observatory and study of different instruments; Study of optimal rain gauge network; Study of intensity - frequency - duration curves, Study of depth - area - duration curve; Analysis of rainfall data and estimation of mean rainfall by different methods; Analysis of frequency of hydrologic data and estimation of missing data, test for consistency of rainfall records; 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; Study and determination of geomorphic parameters of watersheds; Study of runoff hydrograph and separation of base flow and surface flow; Study of unit hydrograph; Study of synthetic hydrograph; Study of flood routing; Study of various discharge measuring devices.

TEACHING SCHEDULE

THEORY [SWCE-243]

Lecture No.	Topics	Sub-topics/Key points	Weightage (%)
1 - 7	Hydrologic Cycle and Rainfall	Hydrologic cycle components, Precipitation and its forms, Rainfall measurement, Estimation of mean rainfall, Estimation of missing rainfall Optimum number of rain gauges, Frequency analysis of point rainfall	20
8 - 13	Rainfall Analysis and Hydrologic Processes	Mass curve, Hyetograph, Depth- Area- Duration curves Intensity - Duration - Frequency Relationship, Hydrologic processes - Interception, Infiltration- Factors influencing, Infiltration measurement and indices, Evaporation- Estimation and measurement	20
14 - 20	Surface Runoff and Geomorphology	Runoff- Factors affecting, Runoff measurement, Stage- Discharge rating curve, Estimation of peak runoff rate and volume, Rational method, Cook's method, SCS curve number method, Geomorphology of watersheds - Linear, aerial and relief aspects of watersheds- Stream order, Drainage density and Stream frequency	20
21 - 26	Hydrograph	Hydrograph- Components, Hydrograph- Base flow separation, Unit hydrograph theory, S-curve, Synthetic hydrograph, Unit Hydrograph- applications and limitations	20
27 - 30	Flood Routing	Flood routing- Channel routing, Flood routing- Reservoir routing, Hydrology of dryland areas, Troll's climatic classification	20
31 - 32	Drought	Drought- Classification, Causes and Impacts, Drought management strategy	
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [SWCE-243]

Exercise No.	Exercise Title
1	Visit to Meteorological Observatory and study of different instruments.
2	Study of optimal rain gauge network.
3	Study of intensity - frequency - duration curves and Study of depth - area - duration curve.
4	Analysis of rainfall data and estimation of mean rainfall by different methods.
5	Analysis of frequency of hydrologic data, Estimation of missing data and Test for consistency of rainfall records.
6	Computation of infiltration indices.
7	Computation of peak runoff and runoff volume by Cook's method.
8	Computation of peak runoff rate by rational formula.
9	Computation of runoff volume by SCS curve number method.
10	Study of stream gauging instruments - Current meter and Stage level recorder.
11	Study and determination of geomorphic parameters of watersheds.
12	Study of runoff hydrograph and separation of base flow and surface flow.
13	Study of unit hydrograph.
14	Study of synthetic hydrograph.
15	Study of flood routing.
16	Study of various discharge measuring devices.

Suggested Readings [SWCE-243]:

1. Chow V.T. Maidment D.R. and Mays L.W. 2010. Applied Hydrology. McGraw Hill, New York.
2. Jaya Rami Reddy P. 2011. A Text Book of Hydrology. University Science Press, New Delhi.
3. Linsley R.K, Kohler M.A. and Paulhus J.L.H. 1984. Hydrology for Engineers. McGraw-Hill Publishing Co., Japan.
4. Panigrahi Band Panigrahi K. 2016. Engineering Hydrology. New India Publishing Agency, New Delhi.
5. Mutreja K.N. 1990. Applied Hydrology. Tata McGraw-Hill Publishing Co., New Delhi.
6. Raghunath H.M.2006. Hydrology: Principles Analysis and Design. 2nd Edition, New Age International (P) Limited Publishers, New Delhi.
7. Subramanya K. 2008. Engineering Hydrology. 3rd Edition, Tata McGraw-Hill, New Delhi.
8. Suresh R. 2005. Watershed Hydrology. Standard Publishers and Distributors, Delhi.
9. Varshney R.S. 1986. Engineering Hydrology. Nem Chand and Brothers, Roorkee, U.P.
10. Garg S.K. 1998. Hydrology and Water Resources Engineering. Khanna Publishers, Delhi.
11. Das G. 2000. Hydrology and Soil Conservation Engineering. PHI, New Delhi.

Semester	**:**	**IV**			
Course No.	**:**	**SWCE-244**	**Credit Hrs.**	**:**	**3(2+1)**
Course Title	**:**	**Soil and Water Conservation Engineering**			

SYLLABUS

Objectives :

i) To enable the students with design of soil and water conservation structures and water harvesting structures,

ii) To make the students acquainted with the different causes of soil erosion and water loss and the different measures for soil and water conservation.

THEORY

Soil erosion: Introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion.

Water erosion: Mechanics and forms - splash, sheet, rill, gully, ravine and stream bank erosion; Gullies: classification, stages of development; Soil loss estimation- Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity- estimation by KE > 25 and EI_{30} methods; Soil erodibility- topography, crop management and conservation practice factors; Measurement of soil erosion- Runoff plots, soil samples.

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

Energy and momentum principles in open channels; specific energy and specific force hydraulic jump and its application, types of hydraulic jump, energy dissipation due to the jump.

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.

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, Dryland farming; Rate of sedimentation, silt monitoring and storage loss in tanks, control of sedimentation in reservoirs.

Water harvesting techniques: Classification based on source, storage and use, runoff harvesting - short-term and long-term techniques; 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.

PRACTICAL

Estimation of soil loss by USLE, 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: Estimation/measuring techniques of soil loss, 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 drying method. Calculation of rate of sedimentation and storage loss in tanks; Study on sedimentation of reservoirs, Design and layout of contour bunds and graded bunds; Design and layout of broad base terraces and bench terraces; Design of vegetative waterways; Design of shelter belts and wind breaks for wind erosion control; Farm pond- design, capacity and estimation, Hydraulic design of drop spillway; Determination of uplift force and construction of uplift pressure diagram, structural design and stability analysis of drop spillway, Hydraulic and structural design of chute spillway, design of SAF energy dissipater; Design of drop inlet spillway; Study on components of earth embankments and its design; Design of water harvesting structures; Study on prioritization of watershed: Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures; Visit to watershed.

TEACHING SCHEDULE

THEORY [SWCE-244]

Lecture No.	Topics	Sub-topics/Key points	Weightage (%)
1 - 2	**Soil Erosion**	Introduction, Causes and Types - Geological and Accelerated erosion, Agents, Factors affecting and Effects of erosion.	14
3 - 4		Water erosion: Mechanics and Forms- splash, sheet, rill, gully, ravine and stream bank erosion.	
5	**Gullies**	Gullies: Classification, Stages of gully development.	
6 - 8	**Soil Loss Estimation**	Soil Loss Estimation- Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity- Estimation by KE > 25 and EI_{30} methods; Soil Erodibility- Topography, crop management and conservation practice factors.	18
9		Measurement of Soil Erosion- Runoff plots, Soil samples.	
10 - 11	**Agronomical & Engineering Measures**	Water erosion control measures: Agronomical measures, contour farming, strip cropping, conservation tillage and mulching;	18
12 - 14		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 stone wall and Trenching.	
15	**Gully Reclamation**	Gully and Ravine Reclamation- Principles of gully control, Vegetative measures.	10
16	**Diversion Drains**	Temporary structures and Diversion drains.	
17	**Grassed Waterways**	Grassed waterways and Design.	

Continued…

18 - 19	**Hydraulic Jump**	Energy and Momentum Principles in Open channels; Specific energy and Specific force hydraulic jump and its application, Types of hydraulic jump, Energy dissipation due to the jump.	10
20	**Permanent Structures**	Soil erosion control structures- Introduction, Classification and Functional requirements.	
21 - 22		Design procedures- Hydrologic, Hydraulic and Structural design and Stability analysis.	
23 - 25		Permanent structures for Soil conservation and Gully control- Check dams, drop, chute and drop inlet spillways. Design requirements, Planning for design.	
26 - 27	**Wind Erosion**	Wind Erosion: Factors affecting, Mechanics, Soil loss estimation and Control measures- Vegetative, Mechanical measures, Wind breaks and Shelter belts and Stabilization of sand dunes.	5
28	**Sedimentation**	Land capability classification, Dryland farming; Rate of sedimentation, Silt monitoring and Storage loss in tanks, Control of sedimentation in reservoirs.	5
29 - 31	**Water Harvesting**	Water harvesting techniques: Classification based on source, Storage and use, Runoff harvesting short-term and long-term techniques.	20
	Farm Pond	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.	
		Farm pond: Cost estimation and construction.	
32	**Percolation Pond**	Percolation pond - Site selection, design and construction details.	
	Nala Bunds	Design considerations of *Nala* bunds.	
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [SWCE-244]

Exercise No.	Exercise Title
1	Computation of Rainfall erosivity Index.
	Computation of Soil erodibility index.
	Determination of length of slope (LS) and cropping practices (CP) factors.
	Estimation of Soil loss by USLE.
2	Estimation and Measuring Techniques of soil loss.
3	Study of rainfall simulator for erosion assessment.
4	Estimation of sediment rate using Coshocton wheel sampler and Multi-slot devisor.
5	Determination of sediment concentration through oven drying method.
6	Calculation of rate of sedimentation and storage loss in tanks.
	Study on sedimentation of reservoirs.
7	Design and layout of contour bunds and graded bunds.
8	Design and layout of broad base terraces and bench terraces.
9	Design of vegetative waterways.
	Design of shelter belts and wind breaks for wind erosion control.
10	Design, computation of storage capacity and estimation of farm ponds.
11	Hydraulic design of drop spillway.
	Determination of uplift force and construction of uplift pressure diagram.
	Structural design and stability analysis of drop spillway.
12	Hydraulic and structural design of chute spillway.
	Design of chute spillway with SAF energy dissipater.
13	Design of drop inlet spillway.
14	Study on components of earth embankments and its design.
15	Design of water harvesting structures.
	Study on prioritization of watershed.
16	Visit to Soil erosion sites and Watershed project areas for studying erosion control and water conservation measures.
	Visit to Watershed.

Suggested Readings [SWCE-244]:

1. Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.
2. Chow, V. T. 1985. Open-Channel Hydraulics. McGraw-Hill Book Company, Inc.
3. Frevert, R.K., Schwab, G.O., Edminster, T.W. and Barnes, K.K. 2009. Soil and Water Conservation Engineering. 4th Edition, John Wiley and Sons, New York.
4. Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service, New Delhi.
5. Mal, B.C. 2014. Introduction to Soil and Water Conservation Engineering. Kalyani Publishers.
6. Michael, A.M. and Ojha, T.P. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
7. Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
8. Norman Hudson. 1985. Soil Conservation. Cornell University Press, Ithaka, New York, USA.
9. Samra, J.S., Sharda, V.N. and Sikka, A.K. 2002. Water Harvesting and Recycling: Indian Experiences. CSWCR&TI, Dehradun, Allied Printers, Dehradun.
10. Sharda, V.N., Juyal, G.P., Prakash, C. and Joshi, B.P. 2007. Training Manual: Soil Conservation and Watershed Management (Vol.-II) - CSWCRTI Publication, Dehradun.
11. Singh, G., Venkataraman, C., Sastry, G. and Joshi, B.P. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
12. Das, G. 2000. Hydrology and Soil Conservation Engineering. Prentice Hall of India Pvt. Ltd, New Delhi.
13. USDA. 1964. Engineering Hand Book on Drop Spillways (Section-11). USDA, Soil Conservation Service.

Semester	**:**	**IV**		
Course No.	**:**	**FMPE-244**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Farm Machinery and Equipment-II**		

SYLLABUS

Objectives : To make the students acquainted with the basic construction and operational features and economics of operation of different farm machineries used in operations such as weeding, harvesting, etc., including operations done by combines etc.

THEORY

Plant protection equipment: Different types of sprayers and dusters; Classification of sprayers and sprays; Types of nozzles; Calculations for calibration of sprayers and chemical application rates;

Introduction to intercultural equipment; Weeders- different types of manual and powered weeders; Functional requirements of weeders and main components; Different types of fertilizer application methods and equipment.

Harvesting of crops: Harvesting methods, harvesting terminology; Mowers- types, constructional details, working and adjustments; Shear type harvesting devices- cutter bar, inertia forces, counter balancing, terminology, cutting pattern; Reapers, binders and windrowers- principle of operation and constructional details; Hay conditioning, importance, methods of hay conditioning, and calculation of moisture content of hay.

Threshing: manual and mechanical systems; Types of threshing drums and their applications; Types of threshers- tangential and axial, constructional details and cleaning systems; Factors affecting thresher performance; Grain combines- combine terminology and features, classification of grain combines, study of material flow in combines; Computation of combine losses; Combine troubles and troubleshooting; Chaff cutters- working principle, constructional features and capacity calculations; Straw combines- working principle and constructional details.

Root crop diggers: Principles of operation, functional components, blade adjustment and approach angle, calculation of material handled; Potato and groundnut diggers; Cotton harvesting: cotton harvesting mechanisms, cotton pickers and strippers; Maize harvesting combines; Vegetables and fruit harvesting equipment and tools.

Testing and Evaluation of intercultural, plant protection and harvesting machinery and their test codes.

PRACTICAL

Familiarization with plant protection and interculture equipment; Study of sprayers types, functional components, calibration; 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; Study of threshing systems, cleaning systems in threshers, calculations of losses in threshers; Study of 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; Study of the working of cotton and maize harvesters; Study of different vegetable and fruit harvesters; Testing and evaluation of intercultural, plant protection and harvesting machinery; Visit to field showing operations various machines; Visit to implement manufacturing unit.

TEACHING SCHEDULE

THEORY [FMPE-244]

Lecture No.	Topic	Subtopics/ Key Points	Weightage (%)
1 - 5	**Plant Protection Equipment**	Different types of sprayers and dusters; Classification of sprayers and sprays; Types of nozzles; Calculations for calibration of sprayers and chemical application rates.	15
6 - 9	**Inter-culture Equipment**	Weeders- Different types of manual and powered weeders; Functional requirements of weeders and main components; Different types of fertilizer application methods and equipment	15
10 - 13	**Harvesting Equipment**	Harvesting methods, Harvesting Terminology; Mowers - Types, Constructional details, Working and Adjustments; Shear type harvesting devices- Cutter bar, Inertia forces, Counter balancing, Terminology, Cutting pattern; Reapers, Binders and Windrowers- Principle of operation and Constructional details.	15
14	**Hay Preparation**	Hay conditioning, Importance, Methods of hay conditioning, and Calculation of moisture content of hay.	3
15 - 20	**Threshing Equipment**	Threshing: Manual and Mechanical systems; Types of threshing drums and their applications; Types of threshers- Tangential and Axial, Constructional details and Cleaning systems; Factors affecting thresher performance.	18
21 - 23	**Grain Combines**	Combine Terminology and Features, Classification of grain combines, Study of material flow in combines; Computation of combine losses; Combine troubles and troubleshooting; Straw Combines - Working principle and Constructional details.	10
24	**Chaff Cutters**	Chaff Cutters- Working principle, Constructional features and Capacity calculations;	3
25 - 26	**Root Crop Diggers**	Principles of operation, Functional components, Blade adjustment and approach angle, Calculation of material handled, Potato and Groundnut diggers	5
27 - 28	**Other Harvesting Equipment/Tools**	Cotton Harvesting: Cotton harvesting mechanisms, Cotton pickers and strippers; Maize harvesting combines; Vegetables and fruit harvesting equipment and tools.	6
29 - 32	**Equipment Testing and Evaluation**	Testing and Evaluation of intercultural, plant protection and harvesting machinery and their test codes.	10
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FMPE-244]

Exercise No.	Exercise Title
1	Familiarization with plant protection equipment, Study of different types of sprayers. functional components, calculations for chemical application rates and calibration.
2	Study of various types of dusters and functional components.
3	Study of manual and powered weeding equipment and functional components.
4	Study of fertilizer application equipment.
5	Study of various types of mowers and reapers and reaper binder, functional components of mowers and reapers.
6-7	Study of different types of threshers, cleaning systems in threshers, calculations of losses in threshers.
8-9	Study of functional units of grain combines and their types, calculations for grain losses in a combine.
10	Study of root crop diggers and familiarization with the functional units and attachments.
11	Study of the working of cotton and maize harvesters.
12	Study of different vegetable and fruit harvesters.
13	Testing and evaluation of intercultural and harvesting machinery.
14	Testing and evaluation of plant protection equipment, study of nozzle types and spread pattern using patternator.
15	Visit to field showing operations various machines.
16	Visit to implement manufacturing unit.

Suggested Readings [FMPE-244]:

1. Jain, S.C. and Phillips, G. 2003. Farm Machinery - An Approach. Standard Publishers and Distributors.
2. Kepner, R.A., Bainer, R. and Barger, E.L. 2005. Principles of Farm Machinery. CBS Publishers and Distributors.
3. Lal Radhey and Datta, A.C. 1978. Agricultural Engineering through Worked Out Examples. Saroj Prakashan, Allahabad.
4. Nakra, C.P. 2003. Farm Machines and Equipment. Dhanpat Rai and Publishing Co.
5. Smith, H.P. and Wilkes, L.H. 2011. Farm Machinery and Equipment. McGraw Hill Publication, New York.
6. Srivastav, A.K., Goering, C.E. and Rohrbach, R.P. 2005. Engineering Principles of Agricultural Machines. ASAE. St. Joseph, Mich.
7. Srivastava, A.C. 1991. Elements of Farm Machinery. Oxford and IBH Publication.
8. Srivastava, T.K. 2007. A Work Book on Practical Farm Machinery. Vol. I and II. Saroj Prakashan, Allahabad
9. Suresh, R. and Kumar, S. 2018. Farm Power and Machinery Engineering. Standard Publishers.

Semester	**:**	**IV**			
Course No.	**:**	**REE-243**	**Credit Hrs.**	**:**	**3(2+1)**
Course Title	**:**	**Renewable Energy Sources**			

SYLLABUS

Objectives : (i) To make the students acquainted with the different renewable energy sources.

(ii) To enable them to analyse and select the appropriate technology to meet the energy demand in different types of agricultural operations.

THEORY

Different sources of renewable energy: Concepts and limitations of different renewable energy sources (RES) such as solar, wind, geothermal, biomass, ocean energy sources; Criteria for assessing the potential of RES; Comparison of renewable energy sources with non-renewable sources.

Solar energy: Energy available from the 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 solar drying system; Solar photo-voltaics: basics and applications, 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 availability, general formula, lift and drag; Basics 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. Wind farms, aero-generators wind power generation system.

Biogas: Basic of anaerobic digestion, types and constructional details of biogas plants, biogas generation and its properties, factors affecting biogas generation and usages, design considerations, advantages and disadvantages of biogas spent slurry, Generation of power from biogas, Design and use of different commercial biogas plants.

Power generation from urban, municipal and industrial waste, Ocean thermal and electrical power generation, wave and tidal power, Power generation from biomass (Gasification and Dendro-thermal); Mini- and micro-hydel plants, Fuel cell and its associated parameters.

PRACTICAL

Study of solar thermal devices like solar cookers; Study of solar water heating system; Study of natural convection solar dryer; Study of forced convection solar dryer; Study of solar desalination unit; Study of solar greenhouse for agriculture production; Study of cost economics of solar thermal devices including solar panels; Study of solar photovoltaic system and study of characteristics of solar photovoltaic panel; Study of evaluation of solar air heater/dryer; Study of biogas plants and its components; Performance evaluation of a fixed dome type biogas plant; Performance evaluation of floating drum type biogas plant; Study of biomass gasifiers; Study of cost economics of biogas system; Visit to a windmill plant.

TEACHING SCHEDULE

THEORY [REE-243]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 2	**Renewable Energy Sources**	Concepts and Limitations *viz*; solar, wind, geothermal, biomass, ocean energy sources; Criteria for assessing the potential, Classification, Comparison of with non-renewable sources	10
3 - 7	**Solar Energy**	Energy available from the sun, Solar radiation data Solar energy conversion into heat through flat plate and concentrating collectors. Principal components, working and uses of different solar thermal devices *viz*. Solar cooker, Solar water heater, Solar Distillation, Solar Dryer. Principle of natural and forced convection solar drying system.	20
8 - 12	**Solar Photovoltaics**	Basics and Applications; p-n junctions, Solar cells, PV systems; Stand-alone, grid-connected solar power station. Calculation of energy through photovoltaic power generation and cost economics.	10
13 - 18	**Wind Energy**	Energy availability, General formula, Lift and drag forces. Basics 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, Wind farms, Aero-generators wind power generation system.	20
19 - 22	**Biogas**	Basic of Anaerobic digestion, Types and constructional details of biogas plants, Biogas generation and its properties, Factors affecting biogas generation and usages, Design considerations, advantages and disadvantages of biogas spent slurry. Generation of power from biogas, Design and use of different commercial biogas plants. Power generation from urban, municipal and industrial waste.	20
23 - 26	**Gasification**	Power generation from biomass- (Gasification and Dendro-thermal),	10
27 - 32	**Other Renewable Energy Sources**	Electrical power generation from- Ocean thermal energy conversion: - Wave and tidal - Mini- and micro-hydel plants, Fuel cell and its associated parameters.	10
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [REE-243]

Exercise No.	Exercise Title
1	Study of solar cookers.
2	Study of solar water heating system.
3	Study of natural convection solar dryer.
4	Study of forced convection solar dryer.
5	Study of solar desalination unit.
6	Study of solar greenhouse for agriculture production.
7	Study of cost economics of solar thermal devices including solar panels.
8	Study of solar photovoltaic system.
9	Study of characteristics of solar photovoltaic panel.
10	Study of evaluation of solar air heater/dryer.
11	Study of biogas plants and its components.
12	Performance evaluation of a fixed dome type biogas plant.
13	Performance evaluation of floating drum type biogas plant.
14	Study of cost economics of biogas system.
15	Study of biomass gasifiers.
16	Visit to a windmill plant.

Suggested Readings [REE-243]:

1. Basu P. 2018. Biomass Gasification and Pyrolysis Practical Design and Theory. Academic Press.
2. Deublein D. and Steinhauser A. 2008. Biogas from Waste and Renewable Resources. WILEY-VCH Verlag GmbH and Co. KGaA, Weinheim.
3. Duffie J.A. and Beckman W.A. 2013. Solar Engineering of Thermal Process. John Wiley and Sons.
4. Julian Chen C. 2011. Physics of Solar Energy. John Wiley and Sons, Inc.
5. Khan B.H. 2006. Non-Conventional Energy Resources. The McGraw Hill Publishers.
6. Knothe G, Gerpen J.V. and Krahl J. (Eds.). 2010. The Biodiesel Handbook. AOCS Press.
7. Patel M.R. 2005. Wind and Solar Power Systems. CRC Press, Boca Raton.
8. Rai G.D. 2013. Non-Conventional Energy Sources. Khanna Publishers, New Delhi.
9. Rai G.D. 2020. Solar Energy Utilization. Khanna Publishers, New Delhi.
10. Reed T.B. and Das A. 1988. Handbook of Biomass Downdraft Gassifier Engine Systems. SERI, USA.
11. Ryszard Petela. 2010. Engineering Thermodynamics of Thermal Radiation for Solar Power Utilization. The McGraw-Hill Companies.
12. Stefan C.W. Krauter. 2008. Solar Electric Power Generation – Photovoltaic Energy Systems. Springer.

Semester	**:**	**IV**		
Course No.	**:**	**PFE-242**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Post-Harvest Engineering of Cereals, Pulses and Oilseeds**		

SYLLABUS

Objectives **:** To make the students acquainted with the different unit operations in processing of major cereals, pulses and oilseeds and the different equipment for the operations.

THEORY

General unit operations in agricultural process engineering and importance of these unit operations in grain processing; Structure and composition of cereals, pulses and oil seeds. Cleaning and grading. Principles of cleaning, scalping, sorting and grading; Screens, different types of screen separators, fixed and variable aperture screens, capacity and effectiveness of screens, sieve analysis; various types of separators like specific gravity, magnetic, disc, spiral, pneumatic, inclined belt draper, velvet roll separator, colour sorter, cyclone separator. Drying: Moisture content and water activity, free moisture, bound moisture 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 periods, drying equations, mass and energy balance, Shedd's equation. Drying methods (conduction, convection, radiation, batch, continuous); Different types of grain dryers (bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray), tempering during drying; dryer performance; Principles of grain storage; different types of grain storage structures; deep bin and shallow bin; design of a silo, structural and functional requirements of a grain storage go-down Size reduction: Principle; Bond's law, Kick's law, Rittinger's law; Sieve analysis; Different classifications of size reduction machines; description of jaw crusher, hammer mill, attrition mill, and ball mill; Material handling: Basic parts of different types of conveyors and elevators, *viz*. belt, roller, chain, screw, and bucket elevator, cranes and hoists, pneumatic conveying, power requirement for conveying and elevating. Milling of rice: parboiling- merits and demerits, changes during parboiling of rice, parboiling methods, *viz.* traditional methods, CFTRI method, Jadavpur method, pressure parboiling; different unit operations and equipment involved in traditional and modern rice milling methods; Preparation of rice products as rice flakes and puffed rice; Milling of wheat: unit operations and equipment; Milling of corn: unit operations and equipment in dry and wet milling methods. Milling of pulses: pre-conditioning, dry milling and wet milling methods, CFTRI and Pantnagar methods, pulse milling machines; Milling of oilseeds: preconditioning of oilseeds, mechanical expression, screw press, hydraulic press, solvent extraction method, refining of oil, stabilization of rice bran.

PRACTICAL

Study of different types of screens and study of screen effectiveness; Study of construction and operation of different types of cleaners and separators; 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 psychrometric chart; Study of various types of dryers; Study of different size reduction machines; Sieve analysis, determination of fineness modulus and uniformity index; Study of different unit operations and machineries in rice mills; Study of different unit operations and machineries in pulse mills; Study of different unit operations and machineries in oil mills; Study of different unit operations and machineries in wheat/ flour mills; Study of different unit operations and machineries in corn processing units; Study of extrusion process; Study of different types of conveying and elevating equipment.

TEACHING SCHEDULE

THEORY [PFE-242]

Lecture No.	Topic	Sub-topics/Key Points	Weightage (%)
1 - 2	**General Unit Operations in Agricultural Process Engineering**	Unit operations and its importance, Grain processing, Structure and composition of cereals, pulses and oilseeds.	5
3 - 6	**Cleaning and Grading**	Principles of cleaning, scalping, sorting and grading; Screens, Different types of screen separators.	12
		Fixed and variable aperture screens, Capacity and effectiveness of screens, sieve analysis.	
		Various types of separators like specific gravity, magnetic, disc, spiral, pneumatic Inclined belt draper, velvet roll separator, colour sorter, cyclone separator.	
7 - 14	**Drying**	Moisture content and water activity, free moisture, bound moisture and equilibrium moisture content, isotherm, hysteresis effect, EMC determination.	22
		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 periods.	
		Drying equations, Mass and energy balance, Shedd's equation.	
		Drying methods (conduction, convection, radiation, batch, continuous).	
		Different types of Grain dryers (bin, flat bed, LSU, columnar, RPEC, fluidized Rotary and tray), Tempering during drying; dryer performance.	
15 - 16	**Principles of Grain Storage**	Different types of grain storage structures; Deep bin and Shallow bin;	8
		Design of a silo, Structural and functional requirements of a grain storage go-down	

Continued…

17 - 18	**Size Reduction**	Principle; Bond's law, Kick's law, Rittinger's law; Sieve analysis.	8
		Different classifications of size reduction machines; Description of jaw crusher, hammer mill, attrition mill and ball mill.	
19 - 21	**Material Handling**	Basic parts of different types of conveyors and elevators, *viz.* belt, roller, chain and screw.	10
		Basic parts of different types of conveyors and elevators, *viz.* bucket elevator, cranes and hoists.	
		Pneumatic conveying, Power requirement for conveying and elevating	
22 - 26	**Milling of Rice**	Parboiling- Merits and demerits, Changes during parboiling of Rice.	15
		Parboiling methods *viz.* Traditional methods, CFTRI method, Jadavpur method.	
		Pressure parboiling; Different unit operations and equipment involved in Traditional milling methods	
		Pressure parboiling; Different unit operations and equipment involved in Modern Rice milling methods	
		Preparation of Rice products as- Rice flakes and Puffed rice.	
27	**Milling of Wheat**	Unit operations and equipment for Wheat	6
28	**Milling of Corn**	Unit operations and equipment in dry and wet milling methods	
29 - 30	**Milling of Pulses**	Pre-conditioning, Dry milling and Wet milling methods, CFTRI and Pantnagar methods, Pulse milling machines.	8
31 - 32	**Milling of Oilseeds**	Preconditioning of oilseeds, Mechanical expression, screw press, hydraulic press. Solvent extraction method, Refining of oil, Stabilization of Rice bran	6
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [PFE-242]

Exercise No.	Exercise Title
1.	Study of different types of screens and its effectiveness.
2.	Study of construction and operation of different types of cleaners.
3.	Study of construction and operation of different types of Separators.
4.	Measurement of moisture content: dry basis and wet basis.
5.	Study of drying characteristics of grains and determination of drying constant. Determination of EMC (static and dynamic method).
6.	Study of psychrometric chart.
7.	Study of various types of dryers.
8.	Study of different size reduction machines. Sieve analysis-
9.	Determination of fineness modulus and uniformity index.
10.	Study of different unit operations and machineries in Rice mills.
11.	Study of different unit operations and machineries in pulse mills.
12.	Study of different unit operations and machineries in oil mills.
13.	Study of different unit operations and machineries in Wheat/ flour mills.
14.	Study of different unit operations and machineries in corn processing units.
15.	Study of extrusion process.
16.	Study of different types of conveying and elevating equipment.

Suggested Readings [PFE-242]:

1. Sahay K.M. and Singh K.K. 1994. Unit Operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd. New Delhi.
2. Chakraverty A. 1999. Post-Harvest Technology of Cereals, Pulses and Oilseeds. Oxford & IBH publishing Co. Ltd., New Delhi.
3. B.L. Bala, 1997, Drying and Storage of Cereals Grains, Oxford and IBH Publishing Co. Ltd., Calcutta.
4. Dash S.K. Bebartta J.P. and Kar A. 2012. Rice Processing and Allied Operations. Kalyani Publishers, New Delhi.
5. Swain S, Dash S.K. Mangaraj S, and Ali N. 2016. Agricultural Process Engineering. Vol I. Kalyani Publishers, New Delhi.
6. Geankoplis C.J. 2002. Transport Processes and Unit Operations. Prentice Hall of India Pvt. Ltd, New Delhi.
7. McCabe W.L, Smith J.C. and Harriott P. 1993. Unit Operations of Chemical Engineering. McGraw Hill.