

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)



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with

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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: Gradual				
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.				

B.Tech. (Agricultural Engineering): Second Semester

Course-wise Syllabus with Teaching Schedules

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

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)
Gradiual Common Course across all UG Degrees

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

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	
<i>*To be offered as MDC-111 w.e.f. Academic year, 2025-26 onwards</i>		

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...

MDC-121...

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 21 st 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	
Gradual 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...

VAC-121...

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 <i>E. coli</i> 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.
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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.

COMP-122...

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...

Operation and Maintenance of Farm Machinery...

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...

Repair and Maintenance of Tractor and Power Tillers ...

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 subsidy 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...

Management of Agricultural Machinery, Custom Hiring and Maintenance Facilities ...

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...

Management of Agricultural Machinery, Custom Hiring and Maintenance Facilities...

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...

Operation and Maintenance of Drones Used for Agricultural Applications ...

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 Bristol 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...

Fabrication, Operation and Maintenance of Renewable Energy Devices...

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

Machine Vision, Sensors and Architecture...

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...

Installation and Maintenance of On-Grid and Off-Grid Solar Systems...

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...

Design and Maintenance of Agri-voltaic System...

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...

Valorisation of Agri-biomass and Organic Waste...

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.
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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, law 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...

Energy Audit, Energy Conservation and Energy Efficiency...

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...

Installation and Maintenance of Micro Irrigation Systems ...

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.
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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...

Application of Remote Sensing and GIS for Agricultural Water Management ...

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. 6th 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...

Operation and Maintenance of Hydro-meteorological Instruments ...

42-44	<i>In-situ</i> 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 <i>etc.</i>
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_Harvesting_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_Policy_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...

Operation and Maintenance of Soil Conservation Structures...

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 :**
- Understanding the concept and importance of protected cultivation,
 - Learning about different types of protected structures, such as greenhouses, polyhouses and shade net houses,
 - Learning about the design, construction, and management of protected structures,
 - 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]

- Vilas M. Salokh and Ajay K. Sharma Greenhouse Technology and Applications, Agrotech Publishing Academy, Udaipur (Raj.)
- G. N. Tiwari. Greenhouse Technology for Controlled Environment, Narosa publishing house, New Delhi/ Mumbai.
- Paul V. Nelson Greenhouse operation and management Prentice Hall, New Jersey – 07458.
- Singh Brahma and Balraj Singh Advances in Protected Cultivation, New India Publishing Company, New Delhi.
- 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 Potatol. 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.
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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 :**
- To study various types of estimates regarding Agricultural Structures,
 - To study of SSR,
 - 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: gully 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]

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

Agro-Processing Method, Equipment Operation and Maintenance...

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...

Operation and Management of Multi-Commodity Agro-Processing Centre...

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
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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...

Primary Processing and Value Addition and Cold Chain Logistics ...

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...

Primary Processing and Value Addition and Cold Chain Logistics...

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...

Food Grain Godown and Warehouse Management...

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...

Food Grain Godown and Warehouse Management...

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- Volume I., Jain Brothers, 873, East Park Road, Karol Bagh, 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...

Post-Harvest Value Chain Management including Logistics ...

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.