B.TECH. PROGRAM CURRICULUM – 2024

(Applicable for the batches admitted from A.Y 2024-25)

Version 3.0

AGRICULTURAL ENGINEERING

Version 1.0–Approved in the BoS meeting on 31-08-2024 & Academic Council meeting on 21-09-2024

Version 2.0–Approved in the BoS meeting on 17-05-2025 & Academic Council meeting on 14-06-2025

Version 3.0–Approved in the BoS meeting on 03-06-2026 & Academic Council meeting on 20-06-2026

ADITYA UNIVERSITY

Aditya Nagar, ADB Road, Surampalem - 533 437

ADITYA UNIVERSITY

Department of Agricultural Engineering

Vision:

To be a globally recognized leader in agricultural engineering by advancing excellence in education, pioneering innovation, and developing sustainable technologies for the future of agriculture."

Mission:

M1: Provide transformative education with industry-ready and interdisciplinary skills.

M2: Advance innovative research through collaboration, experimentation, and practical applications in agriculture.

M3: Promote inclusive, eco-friendly, and sustainable solutions for global agricultural needs.

Program Educational Objectives (PEOs)

PEO 1: Design and develop sustainable and eco-friendly agricultural solutions that benefit society and the environment.

PEO 2: Pursue successful careers in industry, research, or higher studies with interdisciplinary skills and global competencies.

PEO 3: Engage in lifelong learning and adapt to emerging technologies to address evolving challenges in agriculture.

Program Specific Outcomes (PSOs)

PSO 1: Develop farm machinery and green technologies.

PSO 2: Apply post-harvest, dairy and food engineering technologies.

PSO 3: Apply irrigation and drainage engineering and soil and water conservation techniques.

PROGRAM OUTCOMES (PO's)

The 11 Program Outcomes are described as below.

After successful completion of the program, the graduates will be able to

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

PO4 **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO5 **Engineering tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

PO6 **The Engineer and the world :** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

PO7 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

PO8 **Individual and collaborative teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

PO9 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO10 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO11 **Life-long learning**: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Department of Agricultural Engineering

B.Tech (Ag.E) Program Curriculum (w.e.f A.Y 2024-2025)

UG Programs Offered

- B. Tech in (Agricultural Engineering)

Minimum Credit Requirements to Award B. Tech Degree under Each Category:

S.No	Broad Category of Course	Credit Division	
		ICAR	2024-Agri
1	Major/Minor Core Courses (MCC)	116+9#	116+9#
2	Multidisciplinary Courses (MDC)	10	10
3	Ability Enhancement Courses (AEC)	10	10
4	Skill Enhancement Courses (SEC)	08	08
5	Value Added Courses (VAC)	06	06
6	Research Project / Dissertation (PROJ)	15	7
7	Summer Internship (SI)	0	8
8	Audit Courses (AUC)	0	0
Total		**174+10 (NGC)**	**174**

Note:

1. Students must get minimum of 174 credits + Audit courses
2. # Electives

COURSE STRUCTURE

Semester wise course distribution

Course Code	Course Title	Course		L	T	P	C	Hours
		Category	Level					
First Year								
I Semester								
241AE001	Deeksharambh	AUC	FC	0	0	2	0	4
241AE002	Crop Production and Protection Technologies	MDC	FC	3	0	1	4	5
241AE003	Introduction to Agricultural Engineering	MCC	FC	3	0	1	4	5
241AE004	Surveying and Levelling	MCC	FC	1	0	2	3	5
241EN001	Essential Cognitive Skills for Engineers	AEC	FC	0	0	1	1	2
241AE005	Basic Electrical Gadgets and Instruments	MCC	FC	2	0	1	3	4
241AE006	Agricultural Informatics	VAC	FC	2	0	1	3	4
241PE002	NSS/NCC-I	AEC	FC	0	0	1	1	2
Total				11	0	8	19	31
II Semester								
241AE007	Skill Enhancement	SEC	FC	0	0	8	8	16
241AE008	Engineering Drawing	MCC	FC	0	0	2	2	4
241CS071	Computer Programming and Data Structures	AEC	IC	0	0	2	2	4
241AE009	Farming Based Livelihood Systems	MDC	FC	2	0	1	3	4
241AE010	Environmental Studies and Disaster Management	VAC	FC	2	0	1	3	4
241AE011	Workshop Technology and Practice	MCC	FC	0	0	2	2	4
241EN002	Advanced Cognitive Skills for Engineers	AEC	FC	0	0	1	1	2
241PE003	NSS/NCC-II	AEC	FC	0	0	1	1	2
241UC011	Employability Skills-I	AUC	FC	0	0	2	0	2
Total				4	0	20	22	42

Second Year								
III- Semester								
241MA010	Engineering Mathematics-I	MCC	FC	2	1	0	3	3
241PH003	Engineering Physics	MCC	FC	2	0	1	3	4
241CH003	Engineering Chemistry	MCC	FC	2	0	1	3	4
241AE012	Engineering Mechanics	MCC	FC	2	0	1	3	4
241AE013	Soil Mechanics	MCC	IC	1	0	1	2	3
241AE014	Fluid Mechanics and Open Channel Hydraulics	MCC	FC	2	0	1	3	4
241AE015	Engineering Properties of Agricultural Produce and Food Science	MCC	FC	2	0	1	3	4
241AE016	Farm Machinery& Equipment-I	MCC	IC	2	0	1	3	4
241PE004	Physical Education, First Aid and Yoga Practice	AEC	FC	0	0	2	2	4
241UC013	Employability Skills-II	AUC	FC	0	0	3	0	3
Total				16	0	12	25	37
IV Semester								
241MA011	Engineering Mathematics-II	MCC	IC	2	1	0	3	3
241AE017	Theory of Structures	MCC	IC	1	0	1	2	3
241AE018	Building Construction & Cost Estimation	MCC	IC	2	0	0	2	2
241AE019	Watershed Hydrology	MCC	IC	2	0	1	3	4
241AE020	Soil and Water Conservation Engineering	MCC	IC	2	0	1	3	4
241AE021	Farm Machinery& Equipment II	MCC	IC	2	0	1	3	4
241AE022	Renewable Energy Sources	MCC	FC	2	0	1	3	4
241AE023	Post-harvest Engineering of Cereals, Pulses and Oilseeds	MCC	IC	2	0	1	3	4
241AE024	Entrepreneurship Development and Business Management	MDC	IC	2	0	1	3	4
241UC014	Employability Skills-III	AUC	FC	0	0	3	0	3
Total				18	0	10	25	35

Third Year								
V- Semester								
241AE025	Strength of Materials	MCC	IC	1	0	1	2	3
241AE026	Theory of Machines	MCC	IC	2	0	0	2	2
241AE027	Thermodynamics and Heat Transfer	MCC	IC	3	0	0	3	3
241AE028	Tractor & Automotive Engines	MCC	FC	2	0	1	3	4
241AE029	Irrigation and Drainage Engineering	MCC	IC	3	0	1	4	5
241AE034	Food and Dairy Engineering	MCC	IC	3	0	1	4	5
241UC012	Personality Development	AEC	FC	1	0	1	2	3
241AE030	Seminar	MCC		0	0	1	1	2
241AE031	Summer Internship-I + Study tour	SI	IC	0	0	2	0	
241UC015	Employability Skills-IV	AUC	FC	0	0	3	0	3
Total				15	0	11	21	30
VI- Semester								
241AE032	Tractor Systems & Controls	MCC	IC	2	0	1	3	4
241AE033	Groundwater, Wells and Pumps	MCC	IC	2	0	1	3	4
241AE095	Sensors, AI and Robotics in Agriculture	MCC	AC	2	0	1	3	4
241AE035	Agricultural Structures & Environment Control	MCC	IC	2	0	1	3	4
241AE036	Bioenergy Systems: Design and Applications	MCC	AC	2	0	1	3	4
241AE037	Refrigeration and Air-conditioning	MCC	IC	2	0	1	3	4
241AE038	Post-harvest Engineering of Horticultural Crops	MCC	IC	1	0	1	2	3
241AE039	Case Study	MCC	AC	0	0	1	1	2
Total				13	0	8	21	29

Fourth Year								
VII- Semester								
241AE040	Project-I	PROJ	AC	0	0	3	3	6
241AE041	Engineering Graphics and Design	MCC	AC	0	0	2	2	4
241AE042	Food Quality and Safety	MCC	IC	2	0	1	3	4
241AE043	Watershed Planning and Management	MCC	AC	2	0	1	3	4
241AE044	Sprinkler &Micro Irrigation Systems	MCC	AC	1	0	1	2	3
241AE045	Machine Design	MCC	AC	2	0	0	2	2
241AE046	Electrical Machines	MCC	IC	2	0	1	3	4
241AE047	Agricultural Statistics & Data Analysis	MCC	IC	1	0	1	2	3
241AE049	In-plant Training/Research Internship	SI	AC	0	0	0	8	
Total				10	0	10	28	30
VIII – Semester								
241AE048	Project-II	PROJ	AC	0	0	4	4	8
	Elective-I	MCC	AC	2	0	1	3	4
	Elective-II	MCC	AC	2	0	1	3	4
	Elective-III	MCC	AC	2	0	1	3	4
241UC017	Employability Skills-V	AUC	FC	0	0	3	0	3
241AC001	Student Activity - Based Learning	AUC	AC	0	0	2	0	0
	*On-line courses (24 weeks or 80 hours)	AUC				6	0	
Total				6	0	16	13	23

Course Code	Major/Minor Core Courses (MCC)						Marks			Pre-requisite
							CIE	SIE	Total	
241AE003	Introduction to Agricultural Engineering	FC	3	0	1	4	50	50	100	-
241AE004	Surveying and Levelling	FC	1	0	2	3	50	50	100	-
241AE011	Workshop Technology and Practice	FC	0	0	2	2	50	50	100	-
241AE005	Basic Electrical Gadgets and Instruments	FC	2	0	1	3	50	50	100	-
241AE008	Engineering Drawing	FC	0	0	2	2	50	50	100	-
241MA010	Engineering Mathematics-I	FC	2	1	0	3	50	50	100	-
241PH003	Engineering Physics	FC	2	0	1	3	50	50	100	-
241CH003	Engineering Chemistry	FC	2	0	1	3	50	50	100	-
241AE012	Engineering Mechanics	FC	2	0	1	3	50	50	100	-
241AE013	Soil Mechanics	IC	1	0	1	2	50	50	100	-
241AE014	Fluid Mechanics and Open Channel Hydraulics	FC	2	0	1	3	50	50	100	-
241AE015	Engineering Properties of Agricultural Produce and Food Science	FC	2	0	1	3	50	50	100	-
241AE016	Farm Machinery & Equipment- I	IC	2	0	1	3	50	50	100	-
241MA011	Engineering Mathematics-II	IC	2	1	0	3	50	50	100	M-I
241AE017	Theory of Structures	IC	1	0	1	2	50	50	100	-
241AE018	Building Construction & Cost Estimation	IC	2	0	0	2	50	50	100	-
241AE019	Watershed Hydrology	IC	2	0	1	3	50	50	100	FMOCH
241AE020	Soil and Water Conservation Engineering	IC	2	0	1	3	50	50	100	FMOCH

241AE021	Farm Machinery & Equipment II	IC	2	0	1	3	50	50	100	FME I
241AE022	Renewable Energy Sources	FC	2	0	1	3	50	50	100	-
241AE023	Post-harvest Engineering of Cereals, Pulses and Oilseeds	IC	2	0	1	3	50	50	100	-
241AE025	Strength of Materials	IC	1	0	1	2	50	50	100	-
241AE026	Theory of Machines	IC	2	0	0	2	50	50	100	EM
241AE027	Thermodynamics and Heat Transfer	IC	3	0	0	3	50	50	100	-
241AE028	Tractor & Automotive Engines	FC	2	0	1	3	50	50	100	-
241AE029	Irrigation and Drainage Engineering	IC	3	0	1	4	50	50	100	-
241AE034	Food and Dairy Engineering	IC	3	0	1	4	50	50	100	-
241AE030	Seminar	AC	0	0	1	1	50	50	100	-
241AE032	Tractor Systems & Controls	IC	2	0	1	3	50	50	100	T&AE
241AE033	Groundwater, Wells and Pumps	IC	2	0	1	3	50	50	100	-
241AE095	Sensors, AI and Robotics in Agriculture	AC	2	0	1	3	50	50	100	-
241AE035	Agricultural Structures & Environment Control	IC	2	0	1	3	50	50	100	-
241AE036	Bioenergy Systems: Design and Applications	AC	2	0	1	3	50	50	100	RES
241AE037	Refrigeration and Air-conditioning	IC	2	0	1	3	50	50	100	-
241AE038	Post-harvest Engineering of Horticultural Crops	IC	1	0	1	2	50	50	100	-
241AE039	Case Study	AC	0	0	1	1	50	50	100	-
241AE041	Engineering Graphics and Design	AC	0	0	2	2	50	50	100	-
241AE042	Food Quality and Safety	IC	2	0	1	3	50	50	100	-

241AE043	Watershed Planning and Management	AC	2	0	1	3	50	50	100	WH
241AE044	Sprinkler & Micro Irrigation Systems	AC	1	0	1	2	50	50	100	-
241AE045	Machine Design	AC	2	0	0	2	50	50	100	TOM
241AE046	Electrical Machines	IC	2	0	1	3	50	50	100	BEGI
241AE047	Agricultural Statistics and Data Analysis	IC	1	0	1	2	50	50	100	-
	Elective- I	AC	2	0	1	3	50	50	100	-
	Elective- II	AC	2	0	1	3	50	50	100	-
	Elective- III	AC	2	0	1	3	50	50	100	-
	Total		81	0	44	125				

Course Code	**Multi-Disciplinary Courses (MDC)**						**Marks**			**Pre-requisite**
	Course Name	**Level**	**L**	**T**	**P**	**C**	**CIE**	**SEE**	**Total**	
241AE002	Crop Production and Protection Technologies	FC	3	0	1	4	50	50	100	-
241AE009	Farming Based Livelihood Systems	FC	2	0	1	3	50	50	100	-
241AE024	Entrepreneurship Development and Business Management	IC	2	0	1	3	50	50	100	-
	Total		7	0	3	10				

Course Code	Ability Enhancement Courses (AEC)						Marks			Pre-requisite
	Course Name	Level	L	T	P	C	CIE	SEE	Total	
241PE002	NSS/ NCC- I	FC	0	0	1	1	100	-	100	-
241CS071	Computer Programming and Data Structures	IC	0	0	2	2	50	50	100	-
241EN001	Essential Cognitive Skills for Engineers	FC	0	0	1	1	100	-	100	-
241EN002	Advanced Cognitive Skills for Engineers	FC	0	0	1	1	100	-	100	-
241PE003	NSS/ NCC- II	FC	0	0	1	1	100	-	100	-
241PE004	Physical Education, First Aid and Yoga Practice	FC	0	0	2	2	100	-	100	-
241UC012	Personality Development	FC	1	0	1	2	100	-	100	-
	Total		1	0	9	10				

Course Code	Skill Enhancement Courses (SEC)						Marks			Pre-requisite
241AE007	Course Name	Level	L	T	P	C	CIE	SEE	Total	
	1. Skill Enhancement (students can opt any two given modules)	FC	0	0	8	8	50	50	100	-
	a) Operation & maintenance of farm machinery.		0	0	4	4	50	50	100	-
	b) Repair and maintenance of tractors and power tillers.		0	0	4	4	50	50	100	-
	c) Management of agricultural machinery custom hiring and maintenance facilities.		0	0	4	4	50	50	100	-
	d) Valorization of agri-biomass and organic waste.		0	0	4	4	50	50	100	-
	e) Energy audit, energy conservation and energy efficiency.		0	0	4	4	50	50	100	-

	f) Installation and maintenance of micro-irrigation systems.		0	0	4	4	50	50	100	-
	g) Application of remote sensing and GIS for agricultural water management.		0	0	4	4	50	50	100	-
	h) Installation and maintenance of roof top rainwater harvesting systems.		0	0	4	4	50	50	100	-
	i) Agro processing methods, equipment operation and maintenance.		0	0	4	4	50	50	100	-
	j) Food grain godown and warehouse management.		0	0	4	4	50	50	100	-
	k) Post-harvest value chain management including logistics.		0	0	4	4	50	50	100	-
	l) Operation and maintenance of drones used for agricultural applications		0	0	4	4	50	50	100	-
	m)Machine vision, sensors and sensors architecture		0	0	4	4	50	50	100	-
	n) Geophysical survey and investigations for groundwater exploration and installation of tube well/ bore well		0	0	4	4	50	50	100	-
	o) Construction, management and maintenance of protected cultivation structures		0	0	4	4	50	50	100	-
	p) Agro processing methods, equipment operation and maintenance		0	0	4	4	50	50	100	-
	Total		0	0	8	8				

Course Code	Value Added Courses (VAC)						Marks			Pre-requisite
	Course Name	Level	L	T	P	C	CIE	SEE	Total	
241AE006	Agricultural Informatics	FC	2	0	1	3	50	50	100	-
241AE010	Environmental Studies and Disaster Management	FC	2	0	1	3	50	50	100	-
	Total		4	0	2	6				

Course Code	Audit Courses (AUC)						Marks			Pre-requisite
	Course Name	Level	L	T	P	C	CIE	SEE	Total	
241AE001	Deeksharambh	FC	0	0	2	0	100	-	100	-
241UC011	Employability Skills-I	FC	0	0	2	0	100	-	100	-
241UC013	Employability Skills-II	FC	0	0	3	0	100	-	100	ES-I
241UC014	Employability Skills-III	FC	0	0	3	0	100	-	100	ES-II
241UC015	Employability Skills-IV	FC	0	0	3	0	100	-	100	ES-III
241UC017	Employability Skills-V	FC	0	0	3	0	100	-	100	ES-IV
241AC001	Student Activity Based Learning	AC	0	0	2	0				
	*On-line courses (24 weeks or 80 hours)	FC	0	0	6	0	100	-	100	-
	Total		0	0	22	0				

Course Code	Summer Internship (SI)						Marks			Pre-requisite
	Course Name	Level	L	T	P	C	CIE	SEE	Total	
241AE031	Summer Internship-1 (Study tour)	FC	0	0	0	0	100	-	100	-
241AE049	In-plant Training/ Research Internship	AC	0	0	8	8	100	-	100	-
	Total		0	0	8	8				

Course Code	Research Project / Dissertation (PROJ)						Marks			Pre-requisite
	Course Name	Level	L	T	P	C	CIE	SEE	Total	
241AE040	Project- I	AC	0	0	3	3	50	50	100	-
241AE048	Project –II	AC	0	0	4	4	50	50	100	-
	Total		0	0	7	7				

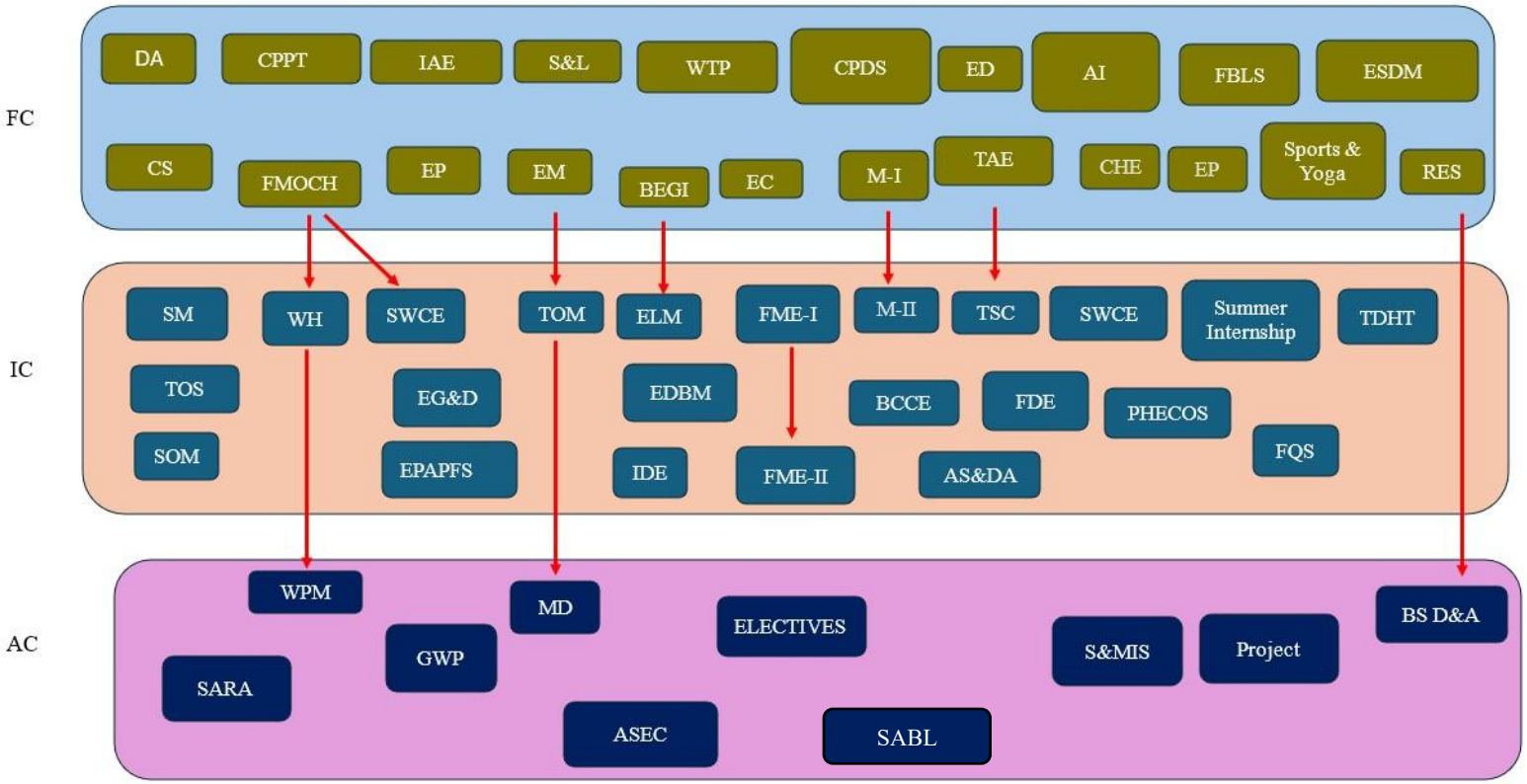
Course Code	Electives						Marks			Pre-requisite
	Title	Level	L	T	P	C	CIE	SEE	Total	
241AE050	Mechanics of Tillage and Traction	AC	2	0	1	3	50	50	100	-
241AE051	Farm Machinery Design and Production	AC	2	0	1	3	50	50	100	-
241AE052	Tractor Design and Testing	AC	2	0	1	3	50	50	100	-
241AE053	Hydraulic Drives and Controls	AC	2	0	1	3	50	50	100	-
241AE054	Human Engineering and Safety	AC	2	0	1	3	50	50	100	-
241AE055	Precision Agriculture and System Management	AC	2	0	1	3	50	50	100	-
241AE056	Photovoltaic Technology and Systems	AC	2	0	1	3	50	50	100	-
241AE057	Wind Power Technology and Systems	AC	2	0	1	3	50	50	100	-
241AE058	Waste and By-products Utilization	AC	2	0	1	3	50	50	100	-
241AE059	Floods and Control Measures	AC	2	0	1	3	50	50	100	-
241AE060	Remote Sensing and GIS Applications	AC	2	0	1	3	50	50	100	-
241AE061	Information Technology for Land and Water Management	AC	2	0	1	3	50	50	100	-
241AE062	Wasteland Development	AC	2	0	1	3	50	50	100	-

241AE063	Minor Irrigation and Command Area Development	AC	2	0	1	3	50	50	100	-
241AE064	Management of Canal Irrigation System	AC	2	0	1	3	50	50	100	-
241AE065	Water Quality and Management Measures	AC	2	0	1	3	50	50	100	-
241AE066	Landscape Irrigation Design and Management	AC	2	0	1	3	50	50	100	-
241AE067	Artificial Intelligence	AC	2	0	1	3	50	50	100	-
241AE068	Advances in Automation and Robotics in Agriculture	AC	2	0	1	3	50	50	100	-
241AE069	Environmental Engineering	AC	2	0	1	3	50	50	100	-
241AE070	Development of Processed Food Products	AC	2	0	1	3	50	50	100	-
241AE071	Food Packaging Technology	AC	2	0	1	3	50	50	100	-
241AE072	Food Plant and Equipment Design	AC	2	0	1	3	50	50	100	-
241AE073	Emerging Technologies in Food Processing	AC	3	0	0	3	50	50	100	-
241AE074	Processing of Livestock, Fish and Marine Products	AC	2	0	1	3	50	50	100	-
241AE075	Food Business Management and Entrepreneurship Development	AC	3	0	0	3	50	50	100	-
241AE076	Natural Fibres: Extraction & Properties	AC	2	0	1	3	50	50	100	-
241AE077	Natural Fibre Applications in Agriculture	AC	2	0	1	3	50	50	100	-
241AE078	Processing of Natural Fibres	AC	2	0	1	3	50	50	100	-
241AE079	Agricultural Marketing and Trade	AC	2	0	1	3	50	50	100	-
241AE080	Operation Research	AC	3	0	0	3	50	50	100	-
241AE081	Mechatronics	AC	2	0	1	3	50	50	100	-
241AE094	Machine Learning	AC	2	0	1	3	50	50	100	-
241CS072	Python Programming	AC	1	0	2	3	50	50	100	-

Minor Degree in Quantum Technologies

S.No.	Course Code	Course Name	L	T	P	C	Semester
Mandatory Courses							
1	241EC097	Survey of Quantum technologies and Application	3	0	0	3	IV
2	241EC098	Foundations of Quantum Technologies	3	0	0	3	V
3	241EC099	Basic Programming Lab (or)	1	0	2	3	V
	241EC100	Basic Laboratory Course for Quantum Technologies					
4	241EC101	Quantum Algorithms and Cryptography	12 week 3 Credit - NPTEL MOOC			3	VII/VIII
Any One course from the below							
5	241EC102	Introduction to Quantum Computation	3	0	0	3	VI
6	241EC103	Introduction to Quantum Communication	3	0	0	3	VI
7	241EC104	Introduction to Quantum Sensing	3	0	0	3	VI
8	241EC105	Introduction to Quantum Materials	3	0	0	3	VI
Any One course from the below							
9	241EC106	Engineering Foundations of Quantum Technologies	3	0	0	3	VII
10	241EC107	Solid State Physics for Quantum Technologies	3	0	0	3	VII
11	241EC108	Quantum Optics	3	0	0	3	VII
12	241EC109	Quantum Cybersecurity	3	0	0	3	VII
13	241EC110	Quantum Machine Learning	3	0	0	3	VII
Total			**18**	**0**	**0**	**18**	

2024 B.Tech Agricultural Engineering Curriculum
Prerequisite Flowchart



Legends:
FC - Foundation Level Courses
IC - Intermediate Level Courses
AC - Advanced Level Courses

Foundation Level Courses:
DA – Deeksharambh
CPPT - Crop Production and Protection Technologies
IAT – Introduction to Agricultural Engineering
S&L –Surveying and Levelling
WTP – Workshop Technology and Practice
CPDS – Computer Programming and Data Structures
ED – Engineering Drawing
AI – Agricultural Informatics
FBLS – Farming Based Livelihood Systems
ESDM – Environmental Studies and Disaster Management
CS – Communication Skills
FMOCH – Fluid Mechanics and Open Channel Hydraulics
EP – Engineering Physics
EM – Engineering Mechanics
BEGI – Basic Electrical Gadgets and Instruments
EC – Engineering Chemistry
M-I –Engineering Mathematics-I
TAE – Tractor & Automotive Engines
EP – Engineering Physics
RES – Renewable Energy Sources

Intermediate Level Courses:
SM – Soil Mechanics
WH – Watershed Hydrology
SWCE – Soil and Water Conservation Engineering
TOM – Theory of Machines
ELM – Electrical Machines
FME-I – Farm Machinery& Equipment-I
M-II- Engineering Mathematics-II
TSC – Tractor Systems & Controls
TDHT – Thermodynamics and Heat Transfer
TOS – Theory of Structures
EDBM – Entrepreneurship Development and Business Management
BCCE – Building Construction& Cost Estimation
FDE – Food and Dairy Engineering
PHECOS – Post-harvest Engineering of Cereals, Pulses and Oilseeds
SOM – Strength of Materials
IDE- Irrigation and Drainage Engineering
FME-II – Farm Machinery& Equipment II
AS&DA – Agricultural Statistics and Data Analysis
FQS – Food Quality and Safety

Advanced Level Courses:
WPM –Watershed Planning and Management
MD –Machine Design
S&MIS –Sprinkler &Micro Irrigation Systems
BS D&A –Bioenergy Systems: Design and Applications
SABL – Student Activity Based Learning

Minor Degree in Agricultural Engineering (offered to other branches students):

Agricultural Engineering							Marks			Pre-requisite
Course Code	**Course Name**	**Level**	**L**	**T**	**P**	**C**	**CIE**	**SEE**	**Total**	
241AE082	Fundamentals of Renewable Energy Sources	FC	3	0	0	3	50	50	100	-
241AE083	Post-harvest Engineering of Cereal Crops	FC	3	0	0	3	50	50	100	-
241AE084	Ground Water Hydrology	FC	3	0	0	3	50	50	100	-
241AE085	Micro Irrigation Systems	IC	2	0	0	2	50	50	100	-
241AE086 241AE087	Surface Water Hydrology (OR) Land & Water Management Engineering	IC	3	0	0	3	50	50	100	GWH
241AE088 241AE089	Agricultural Process Engineering & Food Quality (OR) Post-Harvest Engineering for Horticultural Produce	AC	3	0	0	3	50	50	100	PHECC
241AE090 241AE091	Agricultural Machinery & Equipment (OR) Design of Bio-Energy systems	AC	3	0	0	3	50	50	100	FRES
	Total		**20**			**20**				

Course Code	Major/Minor Core Courses (MCC)						Marks			Pre-requisite
							CIE	SIE	Total	
241AE003	Introduction to Agricultural Engineering	FC	3	0	1	4	50	50	100	-
241AE004	Surveying and Levelling	FC	1	0	2	3	50	50	100	-
241AE011	Workshop Technology and Practice	FC	0	0	2	2	50	50	100	-
241AE005	Basic Electrical Gadgets and Instruments	FC	2	0	1	3	50	50	100	-
241AE008	Engineering Drawing	FC	0	0	2	2	50	50	100	-
241MA010	Engineering Mathematics- I	FC	2	1	0	3	50	50	100	-
241PH003	Engineering Physics	FC	2	0	1	3	50	50	100	-
241CH003	Engineering Chemistry	FC	2	0	1	3	50	50	100	-
241AE012	Engineering Mechanics	FC	2	0	1	3	50	50	100	-
241AE013	Soil Mechanics	IC	1	0	1	2	50	50	100	-
241AE014	Fluid Mechanics and Open Channel Hydraulics	FC	2	0	1	3	50	50	100	-
241AE015	Engineering Properties of Agricultural Produce and Food Science	FC	2	0	1	3	50	50	100	-
241AE016	Farm Machinery & Equipment- I	IC	2	0	1	3	50	50	100	-
241MA011	Engineering Mathematics-II	IC	2	1	0	3	50	50	100	M-I
241AE017	Theory of Structures	IC	1	0	1	2	50	50	100	-

241AE018	Building Construction & Cost Estimation	IC	2	0	0	2	50	50	100	-
241AE019	Watershed Hydrology	IC	2	0	1	3	50	50	100	FMOCH
241AE020	Soil and Water Conservation Engineering	IC	2	0	1	3	50	50	100	FMOCH
241AE021	Farm Machinery & Equipment II	IC	2	0	1	3	50	50	100	FME I
241AE022	Renewable Energy Sources	FC	2	0	1	3	50	50	100	-
241AE023	Post-harvest Engineering of Cereals, Pulses and Oilseeds	IC	2	0	1	3	50	50	100	-
241AE024	Strength of Materials	IC	1	0	1	2	50	50	100	-
241AE026	Theory of Machines	IC	2	0	0	2	50	50	100	EM
241AE027	Thermodynamics and Heat Transfer	IC	3	0	0	3	50	50	100	-
241AE028	Tractor & Automotive Engines	FC	2	0	1	3	50	50	100	-
241AE029	Irrigation and Drainage Engineering	IC	3	0	1	4	50	50	100	-
241AE034	Food and Dairy Engineering	IC	3	0	1	4	50	50	100	-
241AE030	Seminar	AC	0	0	1	1	50	50	100	-
241AE032	Tractor Systems & Controls	IC	2	0	1	3	50	50	100	T&AE
241AE033	Groundwater, Wells and Pumps	IC	2	0	1	3	50	50	100	-
241AE095	Sensors, AI and Robotics in Agriculture	AC	2	0	1	3	50	50	100	-
241AE035	Agricultural Structures & Environment Control	IC	2	0	1	3	50	50	100	-

241AE036	Bioenergy Systems: Design and Applications	AC	2	0	1	3	50	50	100	RES
241AE037	Refrigeration and Air-conditioning	IC	2	0	1	3	50	50	100	-
241AE038	Post-harvest Engineering of Horticultural Crops	IC	1	0	1	2	50	50	100	-
241AE039	Case Study	AC	0	0	1	1	50	50	100	-
241AE041	Engineering Graphics and Design	AC	0	0	2	2	50	50	100	-
241AE042	Food Quality and Safety	IC	2	0	1	3	50	50	100	-
241AE043	Watershed Planning and Management	AC	2	0	1	3	50	50	100	WH
241AE044	Sprinkler & Micro Irrigation Systems	AC	1	0	1	2	50	50	100	-
241AE045	Machine Design	AC	2	0	0	2	50	50	100	TOM
241AE046	Electrical Machines	IC	2	0	1	3	50	50	100	BEGI
241AE047	Agricultural Statistics and Data Analysis	IC	1	0	1	2	50	50	100	-
	Elective- I	AC	2	0	1	3	50	50	100	-
	Elective- II	AC	2	0	1	3	50	50	100	-
	Elective- III	AC	2	0	1	3	50	50	100	-
	Total		81	0	44	124				

Course Code	Electives						Marks			Pre-requisite
	Title	Level	L	T	P	C	CIE	SEE	Total	
241AE050	Mechanics of Tillage and Traction	AC	2	0	1	3	50	50	100	-
241AE051	Farm Machinery Design and Production	AC	2	0	1	3	50	50	100	-
241AE052	Tractor Design and Testing	AC	2	0	1	3	50	50	100	-
241AE053	Hydraulic Drives and Controls	AC	2	0	1	3	50	50	100	-
241AE054	Human Engineering and Safety	AC	2	0	1	3	50	50	100	-
241AE055	Precision Agriculture and System Management	AC	2	0	1	3	50	50	100	-
241AE056	Photovoltaic Technology and Systems	AC	2	0	1	3	50	50	100	-
241AE057	Wind Power Technology and Systems	AC	2	0	1	3	50	50	100	-
241AE058	Waste and By-products Utilization	AC	2	0	1	3	50	50	100	-
241AE059	Floods and Control Measures	AC	2	0	1	3	50	50	100	-
241AE060	Remote Sensing and GIS Applications	AC	2	0	1	3	50	50	100	-
241AE061	Information Technology for Land and Water Management	AC	2	0	1	3	50	50	100	-
241AE062	Wasteland Development	AC	2	0	1	3	50	50	100	-
241AE063	Minor Irrigation and Command Area Development	AC	2	0	1	3	50	50	100	-
241AE064	Management of Canal Irrigation System	AC	2	0	1	3	50	50	100	-
241AE065	Water Quality and Management Measures	AC	2	0	1	3	50	50	100	-
241AE066	Landscape Irrigation Design and Management	AC	2	0	1	3	50	50	100	-
241AE067	Artificial Intelligence	AC	2	0	1	3	50	50	100	-
241AE068	Advances in Automation and Robotics in Agriculture	AC	2	0	1	3	50	50	100	-
241AE069	Environmental Engineering	AC	2	0	1	3	50	50	100	-
241AE070	Development of Processed Food Products	AC	2	0	1	3	50	50	100	-

241AE071	Food Packaging Technology	AC	2	0	1	3	50	50	100	-
241AE072	Food Plant and Equipment Design	AC	2	0	1	3	50	50	100	-
241AE073	Emerging Technologies in Food Processing	AC	3	0	0	3	50	50	100	-
241AE074	Processing of Livestock, Fish and Marine Products	AC	2	0	1	3	50	50	100	-
241AE075	Food Business Management and Entrepreneurship Development	AC	3	0	0	3	50	50	100	-
241AE076	Natural Fibres: Extraction & Properties	AC	2	0	1	3	50	50	100	-
241AE077	Natural Fibre Applications in Agriculture	AC	2	0	1	3	50	50	100	-
241AE078	Processing of Natural Fibres	AC	2	0	1	3	50	50	100	-
241AE079	Agricultural Marketing and Trade	AC	2	0	1	3	50	50	100	-
241AE080	Operation Research	AC	3	0	0	3	50	50	100	-
241AE081	Mechatronics	AC	2	0	1	3	50	50	100	-
241AE094	Machine Learning	AC	2	0	1	3	50	50	100	-
241CS072	Python Programming	AC	1	0	2	3	50	50	100	-

Introduction to Agricultural Engineering

Semester: I	L	T	P	C
Course Code: 241AE003	3	0	1	4

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Apply engineering principles to optimize agricultural practices and machinery for improved efficiency and productivity.
- **CO2:** Select, operate, and maintain various agricultural machinery and equipment for efficient crop production and protection.
- **CO3:** Identify renewable energy systems, soil and water conservation measures for sustainable agricultural practices.
- **CO4:** Manage irrigation, drainage, and agricultural structures for optimized farm operations.
- **CO5:** Apply principles of food preservation, processing, and storage to maintain quality and extend the shelf life of agricultural commodities.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2			2		2	1		
CO2	2	2	2		2	2		3	2		
CO3	2	2	3		3	3		2	2		
CO4	2	2	3	2				2	1		
CO5	3	2	3	2		2		2	2		

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	3
CO2	-	-	3
CO3	-	-	3
CO4	-	-	3
CO5	-	3	-

UNIT – I

Introduction to Agricultural Engineering and Farm Mechanization

Agricultural Engineering as a discipline; Major divisions of Agricultural Engineering; Importance of Agricultural Engineering for today's agriculture; Different sectors of employment for Agricultural Engineers; Scope of research and higher studies in Agricultural Engineering in India and abroad. Farm mechanization needs and strategy; Classification of farm machinery on the basis of unit operations; Principles of selection of machinery for different sizes of land and matching power sources; Different types of equipment for tillage, sowing, planting and transplanting.

Practice:

1. Study of various implements (tillage, sowing, planting, weeding, fertilizer application).
2. Study of farm implements (pesticide application, harvesting and threshing).

UNIT – II

Agricultural Machinery and Crop Management Techniques

Fertilizer application, weed control, plant protection; Harvesting and threshing equipment for rice, wheat, maize, cotton, sugarcane, fruits, tuber crops and other locally important crops; Functions and capabilities of tractor and power tillers; Introduction to the IC engine systems, fuel and air supply systems, cooling and lubricating systems, and electrical systems in a tractor; Basic parts of a power tiller; Hitching system.

Practice:

1. Study of various components of tractor and matching implements.
2. Study of various components of power tiller and matching implements.
3. Visit to implement manufacturing unit.
4. Visit to a mechanized farm.

UNIT – III

Renewable Energy Systems and Sustainable Agriculture Practices

Introduction to renewable energy systems; Types of biogas plants, Types of solar energy collectors; Solar water heating systems, solar dryers, solar photovoltaic systems; Windmills and their different parts. Importance of soil and water conservation; Different agronomic measures for control of water erosion, mixed cropping, crop rotation, tillage practices, mulching; Different engineering measures; gully control measures; Use of topographical survey and contour maps Different types of water harvesting structures.

Practice:

1. Study of various types of biogas plants and operational parameters.
2. Study of various solar energy application systems.
3. Visit to a watershed.

UNIT – IV

Water Management and Agricultural Structures

Equipment for measurement of irrigation water, viz. weirs, notches, orifices and mouth pieces; Introduction to different surface irrigation methods as border, furrow and check basin, sprinkler, drip irrigation and their different components; Underground water conveyance methods in pipes; Introduction to planning of drainage systems; Introduction to centrifugal pumps and different components.

Different types of agricultural structures; Introduction to planning and layout of farmsteads, animal houses, poultry houses; Different types of grain storage structures; Greenhouse and its different parts; Low cost protected structures.

Practice:

1. Study on various components of sprinkler and drip irrigation.
2. Study on various components centrifugal pump.
3. Visit to a greenhouse with modern irrigation system.

UNIT – V

Post-Harvest Management and Food Processing in Agriculture

Classification of different types of agricultural commodities as durables, perishables, etc.; moisture content and its importance in grain storage; Common reasons of food spoilage, food preservation methods; Different primary processing operations and their necessity; Methods

and equipment used for cleaning, washing, sorting, grading, peeling, size reduction; Different types of traditional and modern storage structures; Storage of perishable commodities; Different types of packaging materials and their suitability for various food products; Basic principles of value addition of food as drying and dehydration, evaporation, thermal processing, refrigerated and frozen storage, chemical preservation and other novel methods.

Practice:

1. Study of various post-harvest operations.
2. Study of different food processing equipment.
3. Value addition of common crops.
4. Visit to a food processing industry.

Text Books:

1. Chakraverty A. Post Harvest Technology of cereals, pulses and oilseeds. Oxford & IBH publishing Co. Ltd., New Delhi. ISBN: 9788120412166.
2. Dash S K, Bebartta J P and Kar. A. Rice Processing and Allied Operations. Kalyani Publishers, New Delhi. ISBN: 9789327220622.

Reference Books:

1. Michael A M and Ojha T P. Principles of Agricultural Engineering. Jain Brothers, New Delhi. ISBN: 9788174090263.
2. Michael A M.Irrigation: Theory and Practice. Vikas Publishing House New Delhi. ISBN: 9788124951158.

Web Links:

1. https://www.slideshare.net/TandarayenKevin/introduction-to-agricultural-engineering-uom
2. https://funaab.edu.ng/funaab-ocw/opencourseware/Introduction%20to%20Agricultural%20Engineering.pdf

Surveying and Levelling

Semester: I	L	T	P	C
Course Code: 241AE004	1	0	2	3

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Apply surveying principles to measure, correct, and plot compass-based traverses accurately
CO2: Perform leveling and contouring to obtain accurate elevation data and maps.
CO3: Use theodolite to measure angles and perform accurate trigonometric leveling.
CO4: Demonstrate modern surveying instruments.
CO5: Compute land areas and earthwork volumes accurately from field measurements..

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2			-				2		
CO2	2	2			1				2		
CO3	2	2			1				2		
CO4	-	2			3				-		
CO5	2	2			-				-		

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	2
CO2	-	-	2
CO3	-	-	2
CO4	-	-	2
CO5	-	-	3

UNIT – I
Introduction
Surveying objectives, plane surveying principles and classification, scales, Types of tapes and chains, offsets, Errors and Corrections.
Compass Surveying: Measurement of directions and angles, types of compass, meridians and bearings, local attraction, traversing, plotting of traverse.

UNIT – II
Leveling and Contouring
Concept and terminology, leveling instruments and their temporary and permanent adjustments, methods of leveling, Contouring; methods, characteristics and uses of contours.

UNIT – III
Theodolite
Description, principles, uses and temporary and permanent adjustments, measurement of horizontal and vertical angles, trigonometric leveling.

UNIT – IV

Advanced Surveying Methods

Principle and types of E.D.M. Instruments. Totalstation - advantages and Applications. Introduction to Global Positioning System. Introduction to Drone survey and LiDAR Survey (Light Detection and Ranging).

UNIT – V

Computation of Areas and Volumes

Area from field notes, computation of areas along irregular and regular boundaries, determination of volume of earth work in cutting and embankments for level section.

INTEGRATED LAB WITH 2 CREDITS

Practice:

1. To find the area by chain survey (closed circuit).

2. To determine the distance between two inaccessible points with compass.

3. To find the area of the given boundary by using compass (closed traverse).

4. To find the area of given boundary by the method of radiation (plane table survey).

5. To find the level difference by height of instrument method or rise and fall method (differential levelling)

6. To find the level difference along the length of the road (longitudinal section) and draw given road profile (fly leveling).

7. To determine the horizontal and vertical angles by method of repetition (theodolite survey)

8. To find the height and distance problem by Trigonometric leveling (When base is accessible).

9. To study about the total station and practicing, setting-up, levelling- up and elimination of parallax error.

10. To determine the remote height and state out using total station

11. To find the area of given boundary by method of intersection (plane table survey).

Additional Practice:

1. To find the distance between two inaccessible points by Theodolite survey.

2. To find the level difference between two points (Fly leveling).

3. To study the Global Positioning System (GPS) and its accessories to find out location of various points.

Text Books:

1. Surveying (Vol No.1, 2 & 3), B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, Laxmi Publications (P) ltd. ISBN:978-8170088530.
2. Advance Surveying, Satish Gopi, R. Sathi Kumar and N. Madhu, Pearson Publications. ISBN: 978-8131700679.

Reference Books:

1. Text book of Surveying, S.K. Duggal (Vol No. 1&2), Tata McGraw Hill Publishing Co. Ltd. New Delhi. ISBN: 978-1249028991.
2. Arora K R "Surveying Vol 1, 2 & 3), Standard Book House, Delhi, 2004. ISBN: 9788189401238.

Web Links:

1. nptel.ac.in/courses/105104101/
2. http://www.nptelvideos.in/2012/11/surveying.html

Workshop Technology and Practice

Semester: II	L	T	P	C
Course Code: 241AE011	0	0	2	2

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Prepare various wooden joints.
CO2: Prepare various fitting joints.
CO3: Develop various sheet metal models.
CO4: Develop basic knowledge of house wiring and plumbing.
CO5: Demonstrate and practice various welded joints.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	1							2	1	1
CO2	1	1							2	1	1
CO3	2	1							2	1	1
CO4	1								2	1	1
CO5	2								2	1	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	2	1	2
CO2	2	1	2
CO3	2	1	1
CO4	2	1	1
CO5	2	1	1

INTEGRATED LAB WITH 2 CREDITS

Practice:

1. Demonstration of Safety Practices and Precautions to be observed in workshop.
2. To make a T-Lap joint from the given wooden workpieces by carpentry.
3. To make a Dovetail joint from the given wooden workpieces by carpentry.
4. To make a V- fit from the given M.S workpieces.
5. To make a Square- fit from the given M.S workpieces.
6. To make a taper tray using the given sheet metal.
7. To make a conical funnel using the given sheet metal.
8. To give connection to three bulbs by series and parallel connections.
9. To give connection to bulbs by using staircase wiring.
10. To cut the threads at the end of the given PVC pipe.
11. To prepare a pipeline connection to the wash basin by plumbing.
12. To make a Butt joint using given M.S pieces by arc Welding.

Additional Practice:

1. To make a Lap joint using given M.S pieces by arc Welding.
2. To make an elbow pipe joint using the given sheet metal.
3. To make a T-joint using given M.S pieces by Arc Welding.

Text Books:

1. Work shop Manual , P.Kannaiah & K.L.Narayana/ SciTech Publishers,2nd edition. ISBN: 9788183711302.
2. Elements of Workshop Technology,Vol I by S.K. Hajra Choudhury, S.K. Hajra Choudhury & Nirjhar Roy,Media Promoters and Publishers Pvt.Limited,14th edition. ISBN:8185099146.

Reference Books:

1. Workshop Technology, Part 1, W.A.J. Chapman, 5th Edition. ISBN: 978-0713132694.
2. Engineering Practices Lab Manual, T.Jeyapoovan & M.Saravanapandian,Vikas Publishing House Pvt. Limited,4th edition. ISBN: 9788124949657.

Web Links:

1. https://bharatskills.gov.in
2. https://www.gopracticals.com/basic-engineering/workshop/

Basic Electrical Gadgets and Instruments

Semester: I	L	T	P	C
Course Code: 241AE005	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Analyze the concepts associated to AC and DC circuits.
CO2: Analyze the concepts associated to three phase ACcircuits.
CO3: Explain the concept and the applications of semiconductor devices.
CO4: Describe the Op-Amps and its Applications.
CO5: Analyze the effectiveness of Transducers.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	3	1						1	1	
CO2	3	3	1						1	1	
CO3	3	2	1						1	1	
CO4	2	2	1						1	1	
CO5	2	2	1						1	1	

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	2	2	1
CO2	2	2	1
CO3	2	2	1
CO4	2	2	1
CO5	2	2	2

UNIT – I
Single – Phase AC Circuits
Basics of AC Circuits:Series and parallel circuits (RL, RC, and RLC). Series and parallel resonance, Q-factorand bandwidth. Difference between AC and DC supply system.

UNIT – II
Three- Phase AC Circuits
Concept of balanced three-phase AC circuits, line and phase quantity in starand delta network, power in three-phase circuits, Methods of three phase power measurement (one wattmeter and two –wattmeter method).

UNIT – III
Diode and Transistor
Diode Rectifier, capacitive filter, Zener diode as voltage regulator. Bipolar junction transistor (CB, CC, and CE), operating point, Biasing methods (fixed, self-biasing and potential divider biasing method).

UNIT – IV

OP-AMP and Digital Electronics

OP-AMP, Ideal OP-AMP characteristics,Linear and non-linear applications of OP-AMP (adder, subtractor, integrator, active rectifier, comparator). Basic theorem of Boolean algebra, Basic gates, combinational logic circuits (SOP rule and K-map).

UNIT – V

Instrumentation

Principles of general instruments, measurement of displacement, temperature, velocity, force and pressure using different instruments (strain gauges, load cell, thermistors, thermocouples, linear variable differential transformer, capacitive transducers). Instruments for measurement of speed, wind velocity (anemometer), solar radiation, Multimeter.

INTEGRATED LAB WITH 1 CREDIT

Practice:

1. Prepare an electrical switch board to control two light points, one plug point, one fan point and fuse (House wiring).
2. Prepare an electrical switch board to control two light points using two two-way switch (staircase wiring).
3. Connect and test a fluorescent lamp.
4. Measure the energy of a single-phase AC circuit using energy meter.
5. Measure the power consumption in a three-phase circuit using two-wattmeter method.
6. Implement a DC power supply unit using diode and filter circuit.
7. Plot V – I characteristics of Zener Diode and its application as voltage Regulator.
8. Measure the displacement and characteristics of LVDT.
9. Measure the pressure using strain gauge.
10. Verification of truth table for different logic gates (and, OR, NOT, Nand, NOR, EX-OR, and EX-NOR).

Additional Practice:

1. Measure the speed, wind velocity, solar radiation using tachometer, anemometer, pyranometer.
2. Find the faults and repair home appliances (heater, electric iron, fans and mixer-grinder).
3. Study the transistor characteristics in CE configuration.

Text Books:

1. Fundamentals of Electrical & Electronics Engineering by Ghosh S., Second edition. PHILearning, New Delhi. ISBN: 978-8120332997.
2. Electronic Device and Circuit Theory by Boylestad R L and Nashelsky L N.Pearson edition.

Reference Books:

1. Electrical & Electronic Measurement & Instruments by A.K.Sawhney, Dhanpat Rai & Co.Publications - 19th revised edition. ISBN: 978-8177000160.
2. Basic Electrical and Electronics Engineering by Rajput R K. Laxmi Publications, New Delhi. ISBN: 978-8131800843.

Web Links:

1. https://be-iitkgp.vlabs.ac.in/List%20of%20experiments.html
2. https://asnm-iitkgp.vlabs.ac.in/List%20of%20experiments.html

Engineering Drawing

Semester: II	L	T	P	C
Course Code: 241AE008	0	0	2	2

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Apply the principles of engineering drawing to construct Engineering curves.
CO2: To Impart knowledge on the projection of points and Lines.
CO3: Construct projections of planes in various positions in first quadrant.
CO4: To improve the visualization skills for better understanding of projection of solids and Developments of surfaces.
CO5: Construct isometric and Orthographic views of simple solids.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1		2					1	
CO2	3	2	1		2						
CO3	3	2	1		2					1	
CO4	3	2	1		2					1	
CO5	3	2	1		2					1	

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	1	2	-
CO2	1	2	-
CO3	2	2	-
CO4	2	2	-
CO5	2	2	-

INTEGRATED LAB WITH 2 CREDITS

Practice:

1.Introduction to Engineering Graphics
Introduction to AutoCAD, 1. Dimensioning, elements of dimensioning, system of dimensioning, Conventions in Drawing.

2. Construction of Cycloids and Involutes
a. Construction of Cycloid, Epicycloid and Hypocycloid
b. Involute of a pentagon and circle

3.Introduction to Orthographic projection
a. Principles of Projection
b. Orthographic Projection – Four Quadrants.
c. First angle & Third angle Projection with examples Reference plane, importance of reference lines or Plane.
d. Projections of a point situated in any one of the four quadrants.

4. Projection of straight lines-I:
a. Projections of straight lines parallel to both reference planes.
b. Projections of straight lines perpendicular to one reference plane and parallel to other reference plane
c. Projections of straight line parallel to one plane & inclined to another plane

5.Projection of straight lines-II:
a. Projections of straight line inclined to both reference planes

6. Projection of planes:
a. Regular planes perpendicular to both reference planes, Parallel to one reference plane and inclined to the other reference plane
Ex: Rectangle, Pentagon, Hexagon and Rhombus etc.

7. Projection of planes
a. Projections of Planes inclined to both reference planes Ex: Rectangle, Pentagon, Hexagon and Rhombus etc.

8. Projection of solids
a. Axis Perpendicular to H.P and Axis Perpendicular to V.P
Ex: Pentagonal and Hexagonal Prisms, Pyramids, Cylinder and Cone
b. Axis Parallel to H.P and V.P
Pentagonal and Hexagonal Prisms, Pyramids, Cylinder and Cone

9. Development of Surfaces
a. Development of a Prisms and Cylinder simple cases

10. Development of Surfaces
a. Development of Pyramids and Cone simple cases

11.Conversion of Isometric views to Orthographic views
a. Practice figure -1
b. Practice figure -2

Additional Practice:
1. Conversion of Isometric views to Orthographic views
a. Practice figure -3
b. Practice figure -4

2. Conversion of Orthographic views to Isometric views
a. Practice figure -1
b. Practice figure -2

3. Conversion of Orthographic views to Isometric views
a. Practice figure -3
b. Practice figure -4

Text Books:

1. Engineering Drawing, N. D. Bhatt, Charotar Publishing House. ISBN: 9789385039706.
2. Engineering Drawing and Graphics ,Venugopal, New Age Publications, 2nd edition. ISBN: 9788122415452.

Reference Books:

1. Engineering Drawing, K.L. Narayana and P. Kannaiah, Tata McGraw Hill. ISBN: 978-8183714433.
2. Computer Aided Engineering Graphics, T. Jeyapoovan,Vikas Publishing house, New Delhi, 1st Edition, 2023. ISBN: 9789356743199.

Web Links:

1. https://nptel.ac.in/courses/112103019/
2. https://academy.autodesk.com/authenticated-home-user

Engineering Mathematics-I

Semester: III	L	T	P	C
Course Code: 241MA010	2	1	0	3

Course Outcomes:

At the end of the Course, Student will be able to:

CO1: Solve the linear differential equations of first order and apply in various engineering problems.

CO2: Solve the linear differential equations of higher order and and apply in various engineering problems.

CO3: Study the calculus of functions of several variables and Solve the linear and non-linear partial differential equations

CO4: Compute areas and volumes using multiple integrals

CO5: Solve the system of Linear equations and Calculate Eigen values and Eigen vectors

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									
CO2	3	2									
CO3	3	2									
CO4	3	2									
CO5	3	2									

UNIT – I

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

UNIT – II

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

UNIT – III

Differential calculus: Functions of two or more variables, Taylor's and Maclaurin's expansions,Maxima and minima.

Partial differential equations: Partial derivative and total derivative, homogeneous functions and Euler's theorem. Formation of PDE, higher order linear PDE with constant coefficients, solution of non-linear PDE, Charpit's method.

UNIT – IV

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

UNIT – V

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

Text Books:

1. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 44'th Edition (2021). ISBN: 978-9383214204.
2. Higher Engineering Mathematics, H. K. Dass, Er. R. Verma, S-Chand publishers, 3rd edition 2023.ISBN: 9788121938907.

Reference Books:

1. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Alpha Science International Ltd., 5th Edition (9th reprint), 2021· ISBN: 978-8184875607.
2. Advanced Engineering Mathematics, Dennis G. Zill, Jones & Bartlett Learning, 2018, 6th Edition.ISBN: 978-1284105902.

Web Links:

1. https://www.classcentral.com/course/differential-equations-engineers-13248
2. https://archive.nptel.ac.in/courses/111/106/111106100/
3. https://www.khanacademy.org/math/differential-equations
4. https://archive.nptel.ac.in/courses/111/104/111104137/
5. https://archive.nptel.ac.in/courses/111/107/111107108/

Engineering Physics

	L	T	P	C
Semester: III				
Course Code: 241PH003	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1 Familiarize the concepts of LASER's and Optical fibers with applications
CO2 Classify the magnetic materials based on behavior of substances
CO3 Acquire the basic knowledge of Superconductors.
CO4 Explain the fundamental concepts of Quantum behavior of matter.
CO5 Familiarize the basic concepts of Semiconductors and their types.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	-	-	-	-	-	1	1	-	-
CO2	2	1	-	-	-	-	-	1	1	-	-
CO3	2	1	-	-	-	-	-	1	1	-	-
CO4	2	1	-	-	-	-	-	1	1	-	-
CO5	2	1	-	-	-	-	-	1	1	-	-

Unit-I: Lasers, Maser & Fibre Optics

Spontaneous and stimulated emission - Einstein's A & B coefficients - population inversion – Ruby lasers and He- Ne laser – Ammonia and Ruby masers- Holography.

Optical fibre - physical structure - basic theory - type of modes - characteristics of optical fibre and applications - Illumination: laws of illumination, luminous flux, luminous intensity, candle power, brightness.

Practice:

1. Study the LCR circuit.
2. Determine the low resistance using Carey Foster bridge without calibrating the bridge wire.
3. Determination of Wavelength of laser source by using diffraction grating.
4. Determination of Moment of Inertia of a Fly Wheel.

Unit-II: Magnetism and spectroscopy

Dia, para and ferro-magnetism-classification- Langevin's theory of dia, and para magnetism- adiabatic demagnetization - Weiss domain theory- Hysteresis curve, soft and hard magnetic materials. Zeeman effect (Qualitative) – Stark effect (Qualitative) - Paschen back effect(Qualitative) - Raman spectroscopy (Qualitative)

Practice:

1. Determination Study the variation of magnetic field along the axis of a circular coil
2. Determination of Frequency of electrically maintained tuning fork by Melde's apparatus.

Unit – III Superconductivity

Super conductivity - critical magnetic field – Meissner effect, isotope effect, Type-I, Type-II superconductors- DC and AC Josephson effect - SQUIDS, introduction to high T_c superconductors.

Unit-IV: Quantum Mechanics & Band Theory

Wave particles duality - de-Broglie concept uncertainty principle, time independent and time dependent Schrodinger equation - Particle in a box.

Statement of Bloch Theorem - bands in solids, effective mass, distinction between metals, insulators, and semi-conductors.

Practice:

1. Find the wavelength of light by using prism and spectrometer.
2. Determine dielectric constant of material.
3. Determination of Young's Modulus of the material by method of single cantilever beam.

Unit-V: Semiconductors

Introduction to Intrinsic and extrinsic semi-conductors - Drift and Diffusion currents - Einstein's relation - law of mass action – donors - and acceptor levels - Hall effect and applications.

Practice:

1. Determination of Energy band gap of a semiconductor by using P-N junction diode.
2. Study the relation between Temperature and resistance and finding the constants A & B of a thermistor.
3. Determination of V-I characteristics of P-N Junction Diode.

Textbooks:

1. "Engineering Physics" Dr. K. Vijay Kumar, S Chand & Company Ltd. (2012). ISBN: 81-219-3852-X
2. "Concepts of Modern Physics" Authur Beiser, Shobhit Mahajan and S Rai Choudhary, McGraw Hill (2017). ISBN: 9789351341857

Reference Books:

1. "Electricity and Magnetism" D. Chattopadhyay and P.C. Rakshit, S. Chand (2011) **ISBN**: 978-8173812414
2. "Introduction to Solid State Physics" C. Kittel, (2005) Wiley Eastern Pvt. Ltd. **ISBN**: 978-8126578436
3. "Introduction to Quantum Mechanics " Griffiths D J and Schroeter (2018) .Cambridge University Press **ISBN**: 978-1107189638

Web Links:

1. http://nptel.ac.in/courses/122107035/11
2. http://nptel.ac.in/courses/115102023/-
3. https://phet.colorado.edu/en/simulations/category/physics

Engineering Chemistry

Semester:III	**L**	**T**	**P**	**C**
Course Code: 241CH003	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Summarize the fundamentals and applications of phase rule and colloids
CO2: Outline the importance of chemistry in biomolecules
CO3: Understand the fundamentals of polymers and fuels – for sustainable energy solutions
CO4: Interpret the importance of lubrication in prevention of corrosion
CO5: Apply the knowledge of water treatment and instrumentation for engineering applications

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2							1	1	1	
CO2	2							1	1	1	
CO3	2					1		1	1	1	
CO4	3					1	2	1	1	1	
CO5	3						1	1	1	1	

Unit I:

Phase Rule and Colloids

Phase Rule: Introduction to the Phase Rule, Definition, and Significance of Phase Rule, Explanation of Gibbs' phase rule equation: $F=C-P+2$, Examples of phase rule application. One-Component Systems (water), Two-Component Systems (Pb-Ag), and Applications of Phase Rule in Metallurgy and Material Science.

Colloids: Definition and types of colloidal systems (sols, gels, emulsions, foams, aerosols), Classification based on the dispersed phase and dispersion medium. Preparation (Condensation and dispersion techniques), and Purification (Dialysis, ultrafiltration, and electrophoresis) of Colloids. Properties-Optical properties (Tyndall effect, scattering of light), and Electrical properties (Electrophoresis, electro-osmosis) of Colloids. Factors (Particle size, charge, and interaction with the medium) affecting the stability of Colloids. Applications of Colloids.

Practice:

1. pH sensitivity of colloids.

Unit II:

Enzymes and Food Chemistry

Enzymes: Introduction to Enzymes, Definition and classification of enzymes, Enzyme nomenclature, Mechanism of enzyme action, Factors affecting enzyme activity, Applications of enzymes in food processing. Enzymes role in ethanol and acetic acid manufacturing by fermentation methods.

Food Chemistry: Introduction to Food Chemistry, Basic chemical composition of foods, Principles of Food Chemistry, Introduction to Macronutrients: carbohydrates, proteins, lipids, Micronutrients: vitamins, minerals. Introduction to types of food additives (preservatives, colorants, flavor enhancers).

Practice:

1. Estimation of starch content in potatoes.

Unit III:

Fuels and Polymers

Fuels: Introduction to Fuels, Definition, and Classification of Fuels, Properties of Fuels (Calorific Value, Density, Viscosity), and Applications of Fuels in Various Industries. Renewable Fuels (Biofuels, Hydrogen, Solar Fuels), Future Trends and Innovations in Fuel Technology.

Polymers: Definition and Classification of Polymers, Polymerization Processes (Addition and Condensation Polymerization), Physical and Chemical Properties of Polymers, Biodegradable Polymers and Their Applications. Methods for the determination of the molecular weight of polymers.

Practice:

1. Preparation of Bakelite.
2. Determination of the flash point and fire point of fuels.
3. Determination of calorific value of fuel.

Unit IV:

Corrosion and Lubricants

Corrosion: Introduction to Corrosion, Theories of Corrosion (Electrochemical Theory of Corrosion, and Chemical Theory of Corrosion), Types of Corrosion (Galvanic corrosion, pitting corrosion, crevice corrosion, intergranular corrosion, and stress-corrosion cracking). Factors Affecting Corrosion, Prevention and Control of Corrosion.

Lubricants: Definition of Lubricants, Types of Lubricants (Overview of oils, greases, solid lubricants, and synthetic lubricants), Lubricant Properties (Viscosity and Viscosity Index), Lubrication Methods (Manual, automatic, centralized, and splash lubrication systems). Lubricant Tests (Flashpoint & Fire point, Cloud point & Pour point), and Applications of lubricants.

Practice:

1. Determination of the viscosity of oil.

Unit V:

Water Technology and Instrumentation

Water: temporary and permanent hardness. disadvantages of hard water, scale, and sludge formation in boilers, boiler corrosion, industrial water treatment (Zeolite and ion exchange method)

Analytical methods like thermo-gravimetric. polarographic analysis. nuclear radiation. Detectors and analytical applications of radioactive materials. Introduction to IR spectroscopy.

Practice:

1. Estimation of dissolved oxygen in water.
2. Estimation of chloride in water.
3. Determination of COD in a water sample.
4. Determination of the temporary and permanent hardness of water by the EDTA method.
5. Determination of BOD in a water sample.
6. Estimation of available chlorine in bleaching powder.
7. Estimation of the alkalinity of a water sample.
8. Determination of λ max and verification of Beer Lambert Law.
9. Identification of functional groups (alcohol, aldehyde, ketones, carboxylic acid and amide) by IR.

Text Books:

1. Engineering Chemistry, Jain P L and Jain M.. Danpat Rai publishing company Pvt.Ltd., Delhi. ISBN: 978-9352160006 .
2. Essentials of Physical Chemistry. Bahl B S, Arun Bahl and Tuli B D. S. Chand and Co. Ltd., Delhi. ISBN:978-9352836093.

Reference Books:

1. Engineering Chemistry, Uppal M.M, Jain and Jain. Khanna Publishers, 35th Edition, ISBN:978-8174092624.
2. A Textbook of Engineering Chemistry, Dr S.S.Dara,Dr S.S.Umare S.Chand Publication, 2022 . ISBN:978-8121903592.
3. Molecular Modelling Principles and applications IIed. Andrew R.Leach Prentice Hall. ISBN:978-0582382107.

Web Links:

1. https://archive.nptel.ac.in/courses/113/104/113104068/
2. https://archive.nptel.ac.in/courses/104/105/104105124/
3. https://onlinecourses.nptel.ac.in/noc23_bt05/preview
4. https://nptel.ac.in/courses/113108051
5. https://nptel.ac.in/courses/105106119

Engineering Mechanics

Semester: III	L	T	P	C
Course Code: 241AE012	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Analyze of plane and complex stress, principal planes and principal stresses.
- **CO2:** Determine centre of gravity (CG) of symmetric sections, unsymmetrical sections, solid bodies and cut sections.
- **CO3:** Calculate the moment of inertia of composite sections and cut sections.
- **CO4:** Explain the concept of friction.
- **CO5:** Calculate SFD and BMD of cantilever and simply supported and overhanging beams.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1									
CO2	1	1	1								
CO3	3	2	1								
CO4	2	1	1								
CO5	3	2	1								

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	1	2	-
CO2	2	2	-
CO3	3	2	-
CO4	1	2	-
CO5	1	2	-

UNIT – I

Introduction to Engineering Mechanics

Basic concepts of engineering mechanics, statics, dynamics, kinetics, scalar quantities, vector quantities, systems of units; Simple stresses and strain, Hooke's law, Poisson's ratio, modulus of elasticity, Strain related problems. Principal stresses and strain, analysis of plane and complex stress, principal planes and principal stresses, Mohr's circle, finding out principal stresses, different analysis.

Practice:

1. Study the moments of a force; Problems related to resultant of a concurrent-coplanar force system.
2. Problems related to non-concurrent coplanar force system; Systems of couples in space.
3. Problems on simple stress and strains.
4. Analysis of plane and complex stresses.

UNIT – II

Determination of CG

Composition and resolution of forces, analytical method, graphical method; Laws of forces, moments and their application, levers, parallel forces and couples; Equilibrium of forces, free body diagrams. Centre of gravity (CG) of simple geometrical figures, CG by moments, plane figures, axis of references, CG of symmetric sections, unsymmetrical sections, solid bodies and cut sections.

Practice:

1. Problems on composition and resolution of forces.
2. Problems related to centroids of composite areas.
3. Analysis of equilibrium of concurrent coplanar and non-concurrent coplanar force system.
4. Analysis of simple trusses by methods of joints and methods of sections.
5. Analysis of simple trusses by graphical method.

UNIT – III

Moment of Inertia

Moment of inertia: methods of finding out M.I., methods of integration, M.I. of different sections,Theorem of perpendicular axes, parallel axes, M.I. of composite sections and cut sections. Analysis of simple framed structures, methods of sections, force table, methods of joints, hinged joints, roller support, vertical and inclined loads.

Practice:

1. Problems on Moment of Inertia, radius of gyration of composite areas.

UNIT – IV

Friction

Frictional forces, static friction, dynamic friction, limiting friction, normal reaction, angle of friction, coefficient of friction, laws of friction, equilibrium of a body lying in horizontal and inclined planes, ladder friction; wedge friction, screw friction, screw jack.

Practice:

1. Problems involved with frictions.

UNIT – V

Shear Force and Bending Moments

Shear force and bending moment, fundamentals of shear force and bending moment, SFD and BMD of cantilever and simply supported and overhanging beams, point of contra-flexture; Torsion of circular shaft, torsional effect, hoop stress, power transmitted by a shaft.

Practice:

1. Problems on shear and bending moment diagrams.

Text Books:

1. Khurmi R S. A Text Book of Engineering Mechanics. S. Chand Publishing. ISBN-13 978-9352833962.
2. Bansal R K. A Text Book of Engineering Mechanics. Laxmi Publishers, New Delhi. ISBN: 9788131804094.

Reference Books:

1. Basudeb Bhattacharya., Engineering Mechanics, 2/e, Oxford University Press (India). ISBN:978- 0198096320.
2. Irving Shames, G K M Rao, Engineering Mechanics: Statics and Dynam-ics, 4/e, Pearson. ISBN:978- 8177581232.

Web Links:

1. https://www.hzg.de/imperia/md/content/hzg/institut_fuer_werkstoffforschung /wms/eng_mech_2006.pdf.
2. https://www.iitg.ac.in/rkbc/me101/Presentation/L01-03.pdf.

Soil Mechanics

Semester: III	L	T	P	C
Course Code: 241AE013	1	0	1	2

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Identify the type of soil at field conditions and able to determine nature of soil.
- **CO2:** Calculate the vertical stresses condition for different load conditions.
- **CO3:** Determine the shear strength of soils through theoretical shear parameters.
- **CO4:** Calculate the different engineering properties of the soil such as compaction, consolidation and determines them in the laboratory.
- **CO5:** Calculate the factor of safety for various retaining structures.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1				2					2
CO2	2	1				2					2
CO3	3	1				2					2
CO4	3	2				2					2
CO5	3	2				2					2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	2
CO2	-	-	2
CO3	-	-	2
CO4	-	-	2
CO5	-	-	2

UNIT – I

Introduction to Soil Mechanics

Introduction to soil mechanics, field and scope of soil mechanics; Phase diagram, physical and index properties of soil, particle size distribution, grain size distribution curve, soil indices; plastic limit, liquid limit, shrinkage limit. Classification of soils, effective and neutral stress.

Practice:

1. Determination of moisture content and specific gravity of soil sample.
2. Study of field density by core cutter.
3. Study of bulk density, dry density by sand replacement method.
4. Determination of grain size distribution of coarse grained soil by sieving.
5. Determination of grain size by hydrometer method.
6. Determination of liquid limit and plastic limit of soil specimen.
7. Determination of shrinkage limit of soil.

UNIT – II

Concept on Boussinesq's Analysis

Boussinesq and Wester-guard's analysis, New-mark's influence chart, stress distribution and diagrams.

UNIT – III

Shear Strength

Shear stress, Mohr's circle, direct shear stress, triaxial test and vane shear test; Mohr coulomb failure theory, effective stress principle, determination of shear parameters by direct shear test, tri-axial test & vane shear test. Numerical exercise based on various types of tests.

Practice:

1. Shear strength of soil by direct shear test.
2. Shear strength of soil by tri-axial shear test.

UNIT – IV

Compaction of Soils

Compaction of soils, standard and modified protector test, Abbot's compaction and Jodhpur mini compaction test, field compaction method and control; Consolidation of soils, Terzaghi's theory of one dimensional consolidation, spring analogy, Laboratory consolidation test, calculation of void ratio and coefficient of volume change, Taylor's and Casagrande's method.

Practice:

1. Determination of optimum moisture content of saturated soil by Abbot's compaction test.
2. Determination of optimum moisture content of saturated soil by Proctor's mould.
3. Determination of consolidation characteristics of soil.

UNIT – V

Earth pressure

Earth pressure: plastic equilibrium in soils, active and passive states, Rankine's theory of earth pressure, active and passive earth pressure for cohesive soils, simple numerical exercises; Stability of slopes: introduction to stability analysis of infinite and finite slopes friction circle method, Taylor's stability number, friction circle method.

Text Books:

1. Punmia B C, Jain A K and Jain A K. Soil Mechanics and Foundations. Laxmi Publications (P) Ltd. New Delhi. ISBN: 978- 8170087915
2. Basic and Applied Soil Mechanics by Gopal Ranjan and S. R. Rao, New Age International Publishers, 3rd edition. ISBN: 978- 8122440393

Reference Books:

1. Fundamentals of Soil Mechanics by D.W.Taylor., Wiley. ISBN: 978-1248768928
2. An introduction to Geotechnical Engineering by Holtz and Kovacs; Prentice Hall. ISBN: 978- 0130317216

Web Links:

1. http://www.nptelvideos.in/2012/11/soil-mechanics.html
2. http://ecoursesonline.iasri.res.in/course/view.php?id=544

Fluid Mechanics and Open Channel Hydraulics

Semester: III	L	T	P	C
Course Code: 241AE014	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to

CO1: Differentiate between ideal and real fluids, and apply principles such as Pascal's law and Archimede's principle to analyze pressure forces and buoyancy in engineering structures.

CO2: Describe fluid motion using Lagrangian and Eulerian methods, solve the continuity equation, and apply Bernoulli's theorem to various fluid flow scenarios.

CO3: Calculate head loss in pipe flow using Darcy's equation and Moody's diagram, and design efficient open channel systems using Chezy's, Manning's, and other formulas.

CO4: Conduct discharge measurements and analyze fluid flow behavior over different weirs and notches, considering factors like end contraction and nappe types.

CO5: Utilize Rayleigh's method, Buckingham's pi theorem, and dimensionless numbers to perform dimensional analysis and ensure similarity in fluid mechanics modeling and experiments.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	-	1	-	-	-	-	-	-	-
CO2	3	2	1	-	-	1	1	-	-	-	-
CO3	3	2	1	1	-	-	-	-	-	-	-
CO4	3	2	1	1	1	-	-	-	-	-	-
CO5	2	2	1	1	1	1	1	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	3
CO2	-	-	3
CO3	-	-	3
CO4	-	-	3
CO5	-	-	2

UNIT – I

Properties of Fluids and Hydrostatics

Properties of fluids: ideal and real fluid, units; Pressure and its measurement, Pascal's law, pressure forces on plane and curved surfaces, centre of pressure, pressure diagram, application of hydrostatics in engineering structures; Buoyancy, Archimede's principle, metacentre and metacentric height, condition of floatation and stability of submerged and floating bodies.

Practice:

1. Study of manometers and pressure gauges
2. Study of transmissibility of liquid pressure
3. Determination of meta-centric height

UNIT – II

Fluid Kinematics and Dynamics

Kinematics of fluid flow: Lagrangian and Eulerian description of fluid motion, continuity equation, path lines, streak lines and stream lines, stream function, velocity potential and flow net. Types of fluid flow, translation, rotation, circulation and vorticity, vortex motion; Dynamics of fluid flow, Bernoulli's theorem, venturimeter, orifice meter and pitot tube, siphon.

Practice:

1. Study of various types of flow such as laminar flow, uniform flow, steady flow, vertex flow, rotational flow
2. Verification of Bernoulli's theorem
3. Determination of coefficient of discharge of venturi-meter and orifice meter

UNIT – III

Flow Through Orifices, Notches, and Pipes

Flow through orifices (measurement of discharge, measurement of time), flow through mouthpieces; Flow over notches, flow over weirs, end contraction of rectangular weirs, ventilation of weirs, various types of nappe; laminar and turbulent flow in pipes, general equation for head loss Darcy equation, Moody's diagram, minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic gradient and energy gradient, Chezy's formula for loss of head in pipes, flow through simple and compound pipes, transmission of power through pipes.

Practice:

1. Determination of coefficient of friction in pipeline
2. Determination of coefficient of discharge for rectangular and triangular notch
3. Determination of coefficient of discharge, coefficient of velocity, and coefficient of contraction for flow through orifice
4. Determination of coefficient of discharge for mouth piece

UNIT – IV

Open Channel Hydraulics

Open channel design and hydraulics: Chezy's formula, Bazin's formula, Kutter's, Manning's formula, best hydraulic section, velocity and pressure profiles in open channels, hydraulic jump; Discharge measurement in open channels: current meter.

Practice:

1. Measurement of velocity by current meter
2. Study of open channel flow: velocity distribution in open channels and determination of Manning's coefficient of Rugosity and Chezy's roughness coefficient

UNIT – V

Dimensional Analysis and Fluid Machinery

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

Practice:

1. Determination of efficiency of hydraulic ram
2. Study of various types of models and prototypes: geometrical, kinematic and dynamic similarities
3. Study on non-dimensional constants such as Froude's number and Reynold's number
4. Study of various types of pumps and its components

Text Books:

1. Bansal R K. 2019. A Text book of Fluid Mechanics. Laxmi Publications, New Delhi.ISBN:978-8131808153.
2. Ramanuthan S. Hydraulics, Fluid Mechanics & Hydraulic Machines. Dhanpat Rai & Sons, Delhi. ISBN:978-8187433842.

Reference Books:

1. Khurmi R S and Khurmi N. Hydraulics,Fluid Mechanics and Hydraulic Machines. S. Chand & Co. Ltd., New Delhi. ISBN:978-8121901628.
2. Modi P N and Seth S M. Hydraulics & Fluid Mechanics including hydraulic machines. Standard Book House, Delhi. ISBN:978-8189401269.

Web Links:

1. http://nptel.ac.in/courses/105103095/
2. http://www.colincaprani.com/files/notes/Fluid%20Mechanics.pdf

Engineering Properties of Agricultural Produce and Food Science

Semester: III	L	T	P	C
Course Code: 241AE015	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain the importance of various engineering properties.
- **CO2:** Measure thermal and electrical properties of agricultural products.
- **CO3:** Measure frictional and aero dynamic properties of agricultural products.
- **CO4:** Measure rheological properties, rheological models and non-destructive methods of quality determination.
- **CO5:** Explain the basics of food science and food microbiology.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1			1	1					
CO2	3	2	1	1	2	1					
CO3	3	2	1	1	2	1					
CO4	3	3	1	2	2	1					
CO5	3	1			2	2					

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	2	-
CO2	-	2	-
CO3	-	2	-
CO4	-	3	-
CO5	-	2	-

UNIT – I

Physical Properties

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

Practice:

1. Determination of the size of grains, fruits and vegetables using measuring instruments and using projection system.
2. Determination of the shape (sphericity & roundness).
3. Determination of the bulk and particle volume, bulk and particle density, specific gravity and porosity of grains.
4. Determination of the surface area, volume, density and specific gravity of large individual objects (F &V).

UNIT – II

Thermal and Electrical Properties

Thermal properties: Heat capacity, specific heat, thermal conductivity, thermal diffusivity, heat of respiration, co-efficient of thermal expansion. Electrical and dielectric properties: Resistance, capacitance, dielectric loss factor, loss tangent, and dielectric constant.

Practice:

1. Determination of specific heat and thermal conductivity of some food grains.
2. Determination of electrical properties of food materials.

UNIT – III

Frictional and aerodynamic properties

Frictional properties: Static friction, kinetic friction, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials; Aero-dynamic properties: Drag coefficient, frictional drag and profit drag or pressure drag, terminal velocity. Rheological properties of food: Elastic, plastic and viscous behaviour, visco-elasticity.

Practice:

1. Determination of angle of repose, co-efficient of friction of different grains on different surfaces and angle of internal friction.
2. To study the terminal velocity of grains and separating behavior of grains in a vertical wind tunnel.
3. Determination of viscosity of food.

UNIT – IV

Rheology

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

UNIT – V

Food Science and Microbiology

Introduction to food science and food technology; Biochemical reactions involved in food processing and storage; Food spoilage agents, general methods for food preservation (physical, chemical and biological methods); Food microbiology: Classification of microorganisms, multiplication of bacteria, different beneficial and harmful microorganisms in relation to food preservation and spoilage, industrial bacteriology and food fermentation.

Practice:

1. Study and comparison of colour of food materials.
2. Determination of carbohydrates, total nitrogen, oil content, ash content.
3. Study of different types of microorganisms and microbiological examination of food products.

Text Books:

1. Physical properties of plant and animal materials, Mohsenin N N, Gordon and Breach Science Publishers, New York. ISBN: 978-0-677-02300-7.
2. Engineering Properties of Foods, Rao M A, Syed S H Rizvi and Ashim K Datta, CRC Press – Taylor & Francis Group, Boca Raton, FL. ISBN: 9781466556430.

Reference Books:

1. Food and Process Engineering Technology, Wilhelm L R, Suler W A and Brusewitz, G H, American Society of Agricultural Engineers (ASAE), St.Joseph, Ml. ISBN: 978-1892769435.
2. Engineering Properties of Biological Materials, O.P. Singhal and D.V.K.Samuel, Saroj Prakashan, Allahabad. ISBN: 8170976243.

Web Links:

1. http://ecoursesonline.iasri.res.in/course/view.php?id=24
2. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=5108

Farm Machinery& Equipment-I

Semester: III	L	T	P	C
Course Code: 241AE016	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Identify the needs and benefits of farm mechanization.
CO2: Identify materials used in construction of farm machines.
CO3: Explain the different type's equipment for tillage operations.
CO4: Estimate the cost economics of different field operations.
CO5: Explain the sowing, planting and transplanting operation of various implements used for these operations.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3										
CO2	2	2									
CO3	3	1								2	
CO4	1	3									1
CO5	3	1									

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	1	-	-
CO2	1	-	-
CO3	1	-	-
CO4	2	-	-
CO5	2	-	-

UNIT – I
Introduction to Farm Mechanization
Introduction to farm mechanization; Classification of farm machines; Unit operations in crop production; Identification and selection of machines for various operations on the farm; Seed-bed preparation and its classification; Land reclamation and earth moving equipment.
Practice:
1. Familiarization with different farm implements and tools, Visit to an implement manufacturing unit and Visit to a site to observe field operations of paddy transplanters.

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

Practice:

1. Identification of materials of construction in agricultural machinery and study of material properties.

UNIT – III

Tillage Equipment

Machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage, viz. Mouldboard plough, disc plough, chisel plough, sub-soiler, harrows, puddler, cultivators, identification of their major functional components; Attachments with tillage machinery, Hitching systems and controls.

Practice:

1. Study of hitching systems.
2. Study of primary tillage machinery- types, construction, operation, adjustments and Calculations of power and draft requirements.
3. Study of secondary tillage machinery- types, construction, operation, adjustments and calculations of power and draft requirements.
4. Study of different types of puddlers and determination of puddling index in the field.

UNIT – IV

Analysis of Tillage Equipment

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

Practice:

1. Study on draft measurement.

UNIT – V

Seeding & Transplantation Equipment

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

Practice:

1. Study of sowing and planting equipment- construction, types, calculation for calibration and adjustments.
2. Study of seed drill and its calibration and adjustments.
3. Study of different types of metering mechanisms used in seed drills and planters.
4. Study of paddy transplanters; Study of various pre-germinated paddy seeders.
5. Study of vegetable transplanters.

Text Books:

1. Kepner RA, Roy Barger & EL Barger. Principles of Farm Machinery.International Publishers. ISBN-13: 978-8123909776.
2. Principles of Agricultural Engineering (Vol. II). A. M. Michael and T.P. Ojha, Jain brothers, New Delhi. ISBN-13: 978-8183601849.

Reference Books:

1. Kelnin, N.I.,Popov, I.F., and Sakun, V.A. Agricultural Machines. Amerind Publishers, New Delhi. ISBN: 978-9061914488.
2. Srivastava, A. K., Goering, C. E., Rohrbach, R. P., & Buckmaster, D. R. Engineering principles of agricultural machines. ISBN: 978- 1892769503.

Web Links:

1. https://nptel.ac.in/courses/126/105/126105009/
2. http://www.hillagric.ac.in/edu/coa/agengg/lecture/243/agriengg-243.htm

Engineering Mathematics-II

Semester: IV	L	T	P	C
Course Code: 241MA011	2	1	0	3

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Calculate the gradient, divergence and curl and Compute work done, flux using vector integration

CO2: Examine the continuity and analyticity of functions of complex variables and Compute Fourier series of a function.

CO3: Apply Laplace transform to solve initial value problems.

CO4: Apply numerical methods to interpolation of polynomials.

CO5: Apply numerical methods to solve problems involving differentiation, integration and initial value problems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									
CO2	3	2									
CO3	3	2									
CO4	3	2									
CO5	3	2									

UNIT – I

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

UNIT – II

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

Fourier series: periodic functions, Euler's formulae, Functions having arbitrary period, even and oddfunctions, half range series expansion, series expansion of functions with finite discontinuity

UNIT – III

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

UNIT – IV

Numerical Methods: Finite difference operators and their relationship, factorial notation. Newton's forward and backward interpolation formula, Newton's divide difference interpolation and Lagrange'sinterpolation formula,

UNIT – V

Numerical differentiation and integration: Numerical differentiation and integration rule, numerical solutions of ODE by Taylor's series, Euler's and modified Euler's method, Runge-Kutta method of order four

Text Books:

1. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 44'th Edition (2021). ISBN: 978-9383214204.
2. Higher Engineering Mathematics, H. K. Dass, Er. R. Verma, S-Chand publishers, 3rd edition 2023.ISBN: 9788121938907.

Reference Books:

1. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Alpha Science International Ltd., 5th Edition (9th reprint), 2021· ISBN: 978-8184875607.
2. Advanced Engineering Mathematics, Dennis G. Zill, Jones & Bartlett Learning, 2018, 6th Edition.ISBN: 978-1284105902.

Web Links:

1. https://archive.nptel.ac.in/courses/111/105/111105122/
2. https://swayam.gov.in/nd1_noc19_ma21/preview
3. https://onlinecourses.nptel.ac.in/noc20_ge20/preview
4. https://onlinecourses.nptel.ac.in/noc23_ma43/preview
5. https://onlinecourses.nptel.ac.in/noc22_ma62/preview

Theory of Structures

Semester: IV	L	T	P	C
Course Code: 241AE017	1	0	1	2

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Identify and apply various types of loads using BIS codes, specifically IS 800-2007 for steel structures and IS 456-2000 for RCC structures.

CO2: Design steel sections under tension, compression, and bending according to specifications and standards, and utilize design software (e.g., Staad Pro, Etabs) for designing roof trusses.

CO3: Analyze and design singly and doubly reinforced RCC sections, including beams, one-way and two-way slabs, columns, and foundations, following IS code specifications.

CO4: Develop design considerations for specialized RCC structures like retaining walls and silos, ensuring compliance with relevant codes and standards.

CO5: Implement design software tools to perform structural analysis and design for simple RCC structures, enhancing practical skills and efficiency in structural engineering projects.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	-	-	-	-	-	-	-	-	-
CO2	3	2	2	-	-	-	-	-	-	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-
CO4	2	2	2	-	-	-	-	-	-	-	-
CO5	2	2	1	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	1	-	1
CO2	1	-	1
CO3	1	-	1
CO4	1	-	1
CO5	1	-	1

UNIT – I

Types of Loads and BIS Code Usage

Types of Load and use of BIS code Design of steel structures- specifications, use of IS code (IS 800-2007) and steel table.

Practice:

1. Introduction to STAAD Pro/ETABS for structural load analysis.
2. Load analysis using BIS codes for a simple frame structure.

UNIT – II

Design of Steel Structures

Design of steel sections under tension, compression and bending, use of any one design software such as Staad Pro, Etabs, etc. for design of roof truss.

Practice:

1. Design and drawing of steel roof truss using IS 800-2007.
2. Design of tension members in steel structures using STAAD Pro/ETABS.

Analysis of compression members using STAAD Pro/ETABS.

UNIT – III

Design of RCC Structures

Design of RCC structures- specifications, use of IS code (IS 456-2000), analysis and design of singly and doubly reinforced sections.

Practice:

1. Design and drawing of a singly reinforced RCC beam using IS 456-2000.
2. Design and drawing of a doubly reinforced RCC beam using design software.
3. Design and drawing of one-way and two-way slabs using STAAD Pro/ETABS.

UNIT – IV

RCC Elements Design

Design of beams, design of one way and two way slabs, columns and foundations.

Practice:

1. Design of retaining walls using IS 456-2000 and software tools.
2. Analysis and design of a complete RCC building structure using STAAD Pro/ETABS.

UNIT – V

Advanced RCC Design and Software Application

Design considerations for retaining walls and silos, use of design software for simple RCC structures.

Practice:

1. Analysis and design of a steel industrial building using design software.
2. Analysis and design of a silo structure using STAAD Pro/ETABS.

Text Books:

1. Bhavikatti S S. Design of Steel Structures: By Limit State Method as Per IS: 800-2007. I K International Publishing House Pvt. Ltd.ISBN: 978-9382332947.
2. Duggal S K. Limit State Design of Steel Structures. McGraw Hill Education. .ISBN: 978-9351343509.

Reference Books:

1. Punmia B C, Jain A K and Jain A K. Limit State Design of Reinforced Concrete. Laxmi Publications. ISBN: 978-81-318-0241-0.
2. Raju N K. 2019. Design of Reinforced Concrete Structures: IS:456-2000. CBS Publishers & Distributors. ISBN: 978-9385915369.

Web Links:

1. https://nptel.ac.in/courses/105105105
2. https://www.academia.edu/8007881/Design_of_Concrete_Structures_Notes_1

Building Construction & Cost Estimation

Semester: IV	L	T	P	C
Course Code: 241AE018	2	0	0	2

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain various building materials and formation of stones.
CO2: Explain preparation of concrete, seasoning of timber and miscellaneous building materials.
CO3: Illustrate construction of buildings and need of different agricultural buildings.
CO4: Apply different types of estimates and cost analysis.
CO5: Analyze the cost economics and evaluate the buildings by various economic methods.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	1					1				
CO2	1	1					1				
CO3	1						1				2
CO4	1										3
CO5	1										3

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	1	1	1
CO2	1	1	1
CO3	1	2	3
CO4	1	2	2
CO5	1	1	2

UNIT – I
Building materials
Building materials: description of important building materials, rocks, different stones; formation of stones, types of stones, quarrying process, stone products and uses; Bricks, types, preparation and burning of bricks, properties and uses; Tiles, types and classification; Lime, properties and uses, cement, different uses and grades.

UNIT – II
Concrete
Concrete: grades, preparation, mixing and laying of concrete, use of sand; Use of ferrous material, iron and steel products; Use of non-ferrous metals, glass, rubber, plastics, aluminum, copper, nickel; Timber and its uses, seasoning, defects, commercial form of timber, miscellaneous building materials.

UNIT – III

Building Construction

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

UNIT – IV

Estimating and Costing

Estimating and costing: types of estimates, rough cost, detailed and supplementary estimate, preparation of cost estimate, cost analysis, schedule of rates, analysis of rates, factors affecting building costs, building codes, estate development.

UNIT – V

Cost Economics

Cost economics: measurement and pricing, economic methods for evaluation of buildings, benefit cost calculation, rate of return period (payback period).

Text Books:

1. Punmia B C. Jain A K and Jain A K. Building Construction. Laxmi Publications (P) Ltd., New Delhi. ISBN: 978-8131804285.
2. Duggal S K. Building material. New Age International Publishers. ISBN: 978-9387788398

Reference Books:

1. Sane Y S. Planning and Designing of Buildings. Engineering Book Publishing Co. Pune. ISBN: 978- 8180140723.
2. Rangwala S C. Engineering Materials. Charotar Publishing House, Anand. ISBN: 978- 9385039171.
3. Dutta B N. Estimating and Costing. UBS publishers. ISBN: 978- 8174767707.

Web Links:

1. http://ecoursesonline.iasri.res.in/course/view.php?id=204
2. http://www.digimat.in/nptel/courses/video/105102088/L01.html

Watershed Hydrology

Semester:IV	L	T	P	C
Course Code: 241AE019	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain rainfall measuring devices and computation of mean areal precipitation using various methods.
- **CO2:** Estimate frequency analysis and know presentation of rainfall data.
- **CO3:** Estimate runoff volume, peak rate of runoff by using Rational, Curve number methods and Cook's method.
- **CO4:** Apply various hydrograph techniques to convert multiple duration graph into single duration vice-versa.
- **CO5:** Apply flood routing techniques in planning a reservoir and know about drought management.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1		1								
CO2	1	1	2	3							
CO3	2	1									
CO4	2	1			2						
CO5	2	1			2						2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	3
CO2	-	-	2
CO3	-	-	2
CO4	-	-	2
CO5	-	-	2

UNIT – I

Hydrologic cycle

Hydrologic cycle, components; Precipitation and its forms, rainfall measurement and estimation of mean rainfall, estimation of missing rainfall, optimum number of rain gauges.

Practice:

1. Visit to meteorological observatory and study of different instruments.
2. Estimation of missing data and mean rainfall by different methods.

UNIT – II

Analysis of Rainfall Data

Frequency analysis of point rainfall; Mass curve, hyetograph, depth-area-duration curves and intensity duration-frequency relationship. Hydrologic processes- interception, infiltration - factors influencing infiltration, measurement and indices.

Practice:

1. Study of intensity - frequency - duration curves and depth - area – duration curves.
2. Analysis of frequency of hydrologic data and test for consistency of rainfall records.
3. Computation of infiltration indices.

UNIT – III

Evaporation and Runoff

Evaporation- estimation and measurement; Runoff- factors affecting, measurement, stage – discharge rating curve, estimation of peak runoff rate and volume, rational method, Cook's method and SCS curve number method.

Practice:

1. Computation of peak runoff and runoff volume by Cook's method, Rational method and SCS curve number method.
2. Study of various discharge measuring devices.

UNIT – IV

Hydrograph

Geomorphology of watersheds – linear, aerial and relief aspects of watersheds- stream order, drainage density and stream frequency; Hydrograph - components, base flow separation, unit hydrograph theory, s-curve, synthetic hydrograph, applications and limitations.

Practice:

1. Study and determination of geomorphic parameters of watersheds.
2. Study of runoff hydrograph and separation of base flow and surface flow.
3. Study of unit hydrograph.
4. Study of synthetic unit hydrograph.

UNIT – V

Flood Routing

Flood routing – channel and reservoir routing; Hydrology of dry land areas, Troll's climatic classification; Drought- classification, causes and impacts, drought management strategy.

Practice:

1. Study of flood routing.

Text Books:

1. Engineering Hydrology. Subramanya, K. Tata McGraw-Hill Publishing Compan Limited. New Delhi. ISBN-13. 978-1249029974.
2. Hydrology and Soil Conservation Engineering. Ghanshyam Das, PHI Learning Privat Limited, New Delhi. ISBN-13. 978-8120335868.

Reference Books:

1. Engineering Hydrology. Raghunath, H.M. Willey Eastern Limited, New Delhi, 3r edition. ISBN-13: 978-0-85226-298-6.
2. Watershed Management. Dhruvnarayana, V.V. ICAR Publication, New Delhi.

Web Links:

1. http://www.nptelvideos.in/2012/11/advanced-hydrology.html
2. https://www.slideshare.net/MohammedSalaha1./chapter-3-surface-water- hydrology

Soil and Water Conservation Engineering

Semester: IV	L	T	P	C
Course Code: 241AE020	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Apply methods for assessing and mitigating soil erosion to enhance soil conservation and sustainable land management.

CO2: Design, implement, and evaluate various water erosion control measures, incorporating both agronomical and engineering approaches to enhance soil conservation and land sustainability.

CO3: Apply energy and momentum principles in open channels, design soil erosion control structures, and implementing permanent gully control structures, ensuring hydrologic, hydraulic, and structural integrity.

CO4: Demonstrate wind erosion control measures, land use capability classification and sedimentation of reservoirs.

CO5: Classify water harvesting techniques, design and construct various structures such as farm ponds and percolation ponds, and apply design considerations for nala bunds.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2			3		2	1		2
CO2	2	3	3			3		2	1		2
CO3	2	3	3			3		2	1		2
CO4	2	2				2					
CO5	2	2	2			2			1		

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	3
CO2	-	-	3
CO3	-	-	3
CO4	-	-	3
CO5	-	-	3

UNIT – I

Soil Erosion: Causes, Types, Mechanisms, and Measurement

Soil erosion: introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion;

Water erosion: mechanics and forms- splash, sheet, rill, gully, ravine and stream bank erosion; Gullies: classification, stages of development; Soil loss estimation– Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity- estimation by KE>24 and EI30 methods; Soil erodibility- topography, crop management and conservation practice factors; Measurement of soil erosion- Runoff plots, soil samples.

Practice:

1. Estimation of soil loss by USLE, computation of rainfall erosivity index, computation of soil erodibility index in soil loss estimation.
2. Estimation of sediment rate using Coshocton wheel sampler and multi-slot devisor.

UNIT – II

Water Erosion Control Measures and Techniques

Water erosion control measures- agronomical measures, contour farming, strip cropping, conservation tillage and mulching; Engineering measures- bunds and terraces, bunds: contour and graded bunds- design and surplussing arrangements; terraces: level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stone wall and trenching; Gully and ravine reclamation- principles of gully control, vegetative measures, temporary structures and diversion drains. Grassed waterways and design.

Practice:

1. Design and layout of contour bunds and graded bunds.
2. Design and layout of broad base terraces and bench terraces.
3. Design of vegetative waterways.

UNIT – III

Hydraulic Principles and Soil Erosion Control Structures

Energy and momentum principles in open channels; specific energy and specific force, hydraulic jump and its application, types of hydraulic jump, energy dissipation due to the jump; Soil erosion control structures- introduction, classification and functional requirements. Permanent structures for soil conservation and gully control- check dams, drop, chute and drop inlet spillways- design requirements, planning for design, design procedures- hydrologic, hydraulic and structural design and stability analysis;

Practice:

1. Hydraulic design of drop spillway.
2. Determination of uplift force and construction of uplift pressure diagram, structural design and stability analysis of drop spillway.
3. Hydraulic and structural design of chute spillway, design of SAF energy dissipater.

UNIT – IV

Wind Erosion and Sedimentation Control in Agriculture

Wind erosion- factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes;

Land capability classification, dryland farming; Rate of sedimentation, silt monitoring and storage loss in tanks, control of sedimentation in reservoirs;

Practice:

1. Determination of sediment concentration through oven drying method.
2. Study on sedimentation of reservoirs.

UNIT – V

Water Harvesting Techniques and Structures for Agricultural Use

Water harvesting techniques- classification based on source, storage and use, runoff harvesting- short- term and long-term techniques; Structures- farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes; Farm pond- components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways,

cost estimation and construction; Percolation pond - site selection, design and construction details. Design considerations of nala bunds.

Practice:

1. Farm pond- design, capacity and estimation.
2. Design of water harvesting structures.

Text Books:

1. Chow V T. Open-Channel Hydraulics. McGraw- Hill Book Company, Inc. ISBN: 9780070241500.
2. Singh G, Venkataraman C, Sastry G and Joshi B P. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. ISBN: 9788120415938.

Reference Books:

1. Murthy V V N. Land and Water Management Engineering. 5th Edition, Kalyani Publishers, New Delhi. ISBN: 9789327214659.
2. Michael A M and Ojha T P. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi. ISBN: 9788174090910.

Web Links:

1. Course: Soil & Water Conservation Engg. 3(2+1) (iasri.res.in)
2. Soil-and-Water-Conservation-Engineering.pdf (agrimoon.com)

Farm Machinery & Equipment II

Semester: IV	L	T	P	C
Course Code: 241AE021	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain inter-culture equipments and understand the plant protection and fertilizer operation with various implements used for these operations.
- **CO2:** Explain about harvesting principles, mower, reaper, windrowers and hay machines.
- **CO3:** Explain working principles and construction details of combine harvester.
- **CO4:** Explain working principles and construction details of root crop harvesting equipment.
- **CO5:** Identify different cotton, maize, vegetable and fruit harvesters.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3										
CO2	3	0								2	
CO3	3	2		1							
CO4	3										
CO5	3	1								2	

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	2	-	-
CO2	2	-	-
CO3	3	-	-
CO4	2	-	-
CO5	1	-	-

UNIT – I

Inter Culture and Plant protection equipment

Plant protection equipment- different types of sprayers and dusters; Classification of sprayers and dusters; Types of nozzles; Calculations for calibration of sprayers and chemical application rates; Introduction to interculture equipment; Weeders- different types of manual and powered weeders; Functional requirements of weeders and main components; Different types of fertilizer application methods and equipment.

Practice:

1. Familiarization with plant protection and interculture equipment.
2. Study of sprayers- types, functional components, calibration.
3. Study of dusters- types and functional components; Calculations for chemical application rates.
4. Study of nozzle types and spread pattern using patternator.
5. Familiarization with manual and powered weeding equipment and identification of functional components.

6. Study of fertilizer application equipment including manure spreaders and fertilizer broadcasters.

UNIT – II

Harvesting Equipment and machines

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

Practice:

1. Study of various types of mowers, reaper, reaper binder; Study of functional components of mowers and reapers.

UNIT – III

Thershers and combime Harvesters

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

Practice:

1. Study of threshing systems, cleaning systems in threshers, calculations of losses in threshers.
2. Study of functional units of grain combines and their types, calculations for grain losses in a combine.

UNIT – IV

Root Crop Harvesters

Straw combines- working principle and constructional details Root crop diggers- principles of operation, functional components, blade adjustment and approach angle, calculation of material handled; Potato and groundnut diggers.

Practice:

1. Study of root crop diggers and familiarization with the functional units and attachments.

UNIT – V

Cotton, Vegetables and Fruit Harvester

Cotton harvesting- cotton harvesting mechanisms, cotton pickers and strippers; Maize harvesting combines; Vegetables and fruit harvesting equipment and tools. Chaff cutters- working principle, constructional features and capacity calculations.

Practice:

1. Study of the working of cotton and maize harvesters.
2. Study of different vegetable and fruit harvesters.

Text Books:

1. Kepner RA, Roy Barger & EL Barger. Principles of Farm Machinery.International Publishers. ISBN: 978-8123909776.
2. Principles of Agricultural Engineering (Vol. II). A. M. Michael and T.P. Ojha, Jain brothers, New Delhi. ISBN: 978-8183601849.

Reference Books:

1. Farm Machinery and Equipment. Smith H.P, Tata McGraw-Hills Publishing Co.Ltd., New Delhi. ISBN: 978-9386595140.
2. Srivastava, A. K., Goering, C. E., Rohrbach, R. P., & Buckmaster, D. R. Engineering principles of agricultural machines. ISBN: 978-978-1892769503.

Web Links:

1. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=2262
2. http://www.agrimoon.com/farm-power-and-machinery-icar-ecourse-pdf-book/

Renewable Energy Sources

Semester: IV	L	T	P	C
Course Code: 241AE022	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain the fundamental concepts of renewable energy.
CO2: Analyze the principles of solar energy and explore its various applications.
CO3: Describe wind energy conversion systems, including wind generators, and evaluate their power generation capabilities.
CO4: Analyze the processes involved in biogas production from biomass.
CO5: Explain the basic principles and operations of tidal energy, fuel cells, and geothermal energy systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	3	2	-	-	-	-	-	-	-
CO2	3	2	2	2	-	-	-	-	-	-	-
CO3	3	-	3		2	-	-	-	-	1	-
CO4	3	-	3	2	1	-	-	-	-	-	-
CO5	3	-	3	2	1	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	2	1	1
CO2	1	1	1
CO3	2	1	1
CO4	3	1	1
CO5	1	1	1

UNIT – I

Renewable energy sources

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

Practice:

1. Study of natural convection solar dryer.
2. Study of forced convection solar dryer.
3. Study of solar desalination unit.
4. Study of solar greenhouse for agriculture production.

UNIT – II

Solar energy

Solar energy- energy available from sun, solar radiation data, solar energy conversion into heat through flat plate and concentrating collectors, different solar thermal devices, principle of natural and forced convection solar drying system. Solar photo voltaics- basics and applications, p-n junctions. Solar cells, PV systems, stand alone, grid connected solar power station. Calculation of energy through photovoltaic power generation and cost economics

Practice:

1. Study of solar thermal devices like solar cookers, solar water heating system and solar air heater/dryer.
2. Study of cost economics of solar thermal devices including solar panels.
3. Study of solar photovoltaic system and study of characteristics of solar photovoltaic panel.

UNIT – III

Wind Energy

Wind energy- energy availability, general formula, lift and drag. Basics of wind energy conversion, effect of density, frequency variances, angle of attack, wind speed, types of windmill rotors, determination of torque coefficient, induction type generators. Working principle of wind power plant. Wind farms, aero-generators, wind power generation system.

UNIT – IV

Energy from Biomass

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

Practice:

1. Study of biogas plants and its components.
2. Performance evaluation of a fixed dome type biogas plant.
3. Performance evaluation of floating drum type biogas plant.

UNIT – V

Other source of energy

Power generation from urban, municipal and industrial waste. Ocean thermal and electric power generation, wave and tidal power. Power generation from biomass (gasification & Dendro- thermal). Mini and micro hydel plants. Fuel cells and its associated parameters.

Practice:

1. Study of biomass gasifiers.
2. Study of cost economics of biogas system

Text Books:

1. Rai G D. Non-Conventional Energy Sources. Khanna Publishers, New Delhi. ISBN: 978-8174090737.
2. Basu P. 2018. Biomass Gasification and Pyrolysis Practical Design and Theory. Academic Press. ISBN: 978-0123749888.

Reference Books:

1. Patel M R.Wind and Solar Power Systems. CRC Press, Bota Racon.ISBN: 978-0849315701.
2. Deublein D and Steinhauser A. Biogas from Waste and Renewable Resources. WILEY- VCH Verlag GmbH & Co. KGaA, Weinheim. ISBN: 9783527621705.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc22_ch27/preview
2. https://www.vssut.ac.in/lecture_notes/lecture1428910296.pdf

Post-harvest Engineering of Cereals, Pulses and Oilseeds

Semester: IV	L	T	P	C
Course Code: 241AE023	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain the importance of different unit operations and working of size reduction equipments.
- **CO2:** Identify various methods for determining moisture content, EMC and drying rate.
- **CO3:** Compare separator equipments based on physical characteristics of grains and explain various material handling devices.
- **CO4:** Explain the importance, design and working of milling equipment for wheat, corn and oil seeds processing.
- **CO5:** Explain the importance, design and working of milling equipment for rice processing.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	3	2		1						
CO2	3	2	2	2							
CO3	3	2	2	2	2						
CO4	3	2	2	2							
CO5	3	2	2	1							

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	3	-
CO2	-	3	-
CO3	-	3	-
CO4	-	3	-
CO5	-	3	-

UNIT – I

Unit operations in grain processing

General unit operations in agricultural process engineering and importance of these unit operations in grain processing; Structure and composition of cereals, pulses and oil seeds; Cleaning and grading: Principles of cleaning, scalping, sorting and grading; Size reduction: Principle; Bond's law, Kick's law, Rittinger's law; Sieve analysis; Different classifications of size reduction machines; description of jaw crusher, hammer mill, attrition mill, and ball mill.

Practice:

1. Study of different size reduction machines.
2. Sieve analysis, determination of fineness modulus and uniformity index.

UNIT – II

Drying

Moisture content and water activity, free moisture, bound moisture and equilibrium moisture content, isotherm, hysteresis effect, EMC determination; Psychrometric chart and its use in drying; Drying principles and theory, thin layer and deep bed drying analysis, falling rate and constant rate drying periods, maximum and decreasing drying rate periods, drying equations, mass and energy balance, Shedd's equation; Drying methods (conduction, convection, radiation, batch, continuous); Different types of grain dryers (bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray), tempering during drying; dryer performance.

Practice:

1. Measurement of moisture content: dry basis and wet basis.
2. Study on drying characteristics of grains and determination of drying constant.
3. Determination of EMC (static and dynamic method).
4. Study of psychrometric chart.
5. Study of various types of dryers.

UNIT – III

Separation and Material Handling

Screens, different types of screen separators, fixed and variable aperture screens, capacity and effectiveness of screens, sieve analysis; various types of separators as specific gravity, magnetic, disc, spiral, pneumatic, inclined belt draper, velvet roll separator, colour sorter, cyclone separator.

Basic parts of different types of conveyors and elevators, viz. belt, roller, chain, screw, and bucket elevator, cranes & hoists, pneumatic conveying, power requirement for conveying and elevating.

Practice:

1. Study of different types of screens and study of screen effectiveness.
2. Study of construction and operation of different types of cleaners and separators.
3. Study of different types of conveying and elevating equipment.

UNIT – IV

Milling of wheat, corn, pulses and oil seeds

Milling of wheat: unit operations and equipment; Milling of corn: unit operations and equipment in dry and wet milling methods; Milling of pulses: pre-conditioning, dry milling and wet milling methods, CFTRI and Pantnagar methods, pulse milling machines; Milling of oilseeds: preconditioning of oilseeds, mechanical expression, screw press, hydraulic press, solvent extraction method, refining of oil.

Practice:

1. Study of different unit operations and machineries in pulse mills.
2. Study of different unit operations and machineries in oil mills.
3. Study of different unit operations and machineries in wheat/ flour mills.
4. Study of different unit operations and machineries in corn processing units.
5. Study of extrusion process

UNIT – V

Milling of Rice

Merits and demerits, changes during parboiling of rice, parboiling methods, viz. traditional methods, CFTRI method, Jadavpur method, pressure parboiling; different unit operations and equipment involved in traditional and modern rice milling methods; Preparation of rice products as rice flakes and puffed rice;

Practice:

1. Study of different unit operations and machineries in rice mills.

Text Books:

1. Unit Operations of Agricultural Processing, Sahay KM and Singh KK, Vikas Publishin House Pvt. Ltd., New Delhi. ISBN: 9788124911424.
2. Post-Harvest Technology of Cereals, Pulses and oil seeds, Chakraverty A, Oxford an IBH Publishing. Ltd., Calcutta. ISBN: 9788120409699.

Reference Books:

1. Transport Processes and separation Process Principle, Geankoplis C J Prentice-HallInc New Jersey. ISBN-13. 978-0134181028.
2. Unit Operations of Chemical Engineering, McCabe WL, Smith JC and Harriott P McGraw-Hill Book Co., Boston. ISBN-13. 978-0072848236.

Web Links:

1. http://www.cigr.org/documents/CIGRHandbookVol4.pdf
2. http://ecoursesonline.iasri.res.in/course/view.php?id=22

Strength of Materials

Semester: V	L	T	P	C
Course Code: 241AE024	1	0	1	2

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain the principles and concepts of strength of materials and their applications in structural analysis.

CO2: Calculate the slope and deflection of beams using various methods such as integration techniques, moment area theorems, and the conjugate beam method.

CO3: Analyze the stability and strength of columns and struts, solving related problems to determine critical load and buckling behavior.

CO4: Perform analysis of steel connections, including riveted and welded joints, to ensure proper design and safety in structural applications.

CO5: Analyze statically indeterminate structures, including propped, fixed, and continuous beams, using methods like superimposition, three-moment equation, and moment distribution method.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	-	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-
CO4	2	2	1	-	-	-	-	-	-	-	-
CO5	2	3	2	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	1	1	1
CO2	1	1	1
CO3	1	1	1
CO4	1	1	1
CO5	1	1	1

UNIT – I

Fundamentals of Strength of Materials and Beam Deflection

Introduction to strength of materials; Slope and deflection of beams: slope and deflection of beam using integration techniques, moment area theorems, conjugate beam method, problems of slope and deflection.

Practice:

1. To determine the quality of two different aggregates through Impact test.
2. To perform the tensile test of steel specimen and observe its behavior under load.
3. To prepare concrete specimens and perform compression, bending tests at 2nd and 4th weeks.
4. To perform the Brinell's hardness test on a given specimen.

UNIT – II

Theory and Problems of Columns and Struts

Theory of columns and struts, problems of column and struts.

Practice:

1. To determine young's modulus of elasticity of beam with the help of deflection produced at centre due to loads placed at centre and quarter points.
2. To study the load-deflection properties of closely coiled helical spring in tension and compression

UNIT – III

Steel Connections

Steel connections: analysis of rivet connections, analysis of welded connections.

Practice:

1. To perform a tensile test and compression test on a mortar specimen prepared 2 weeks before.
2. To prepare mortar specimens using different cements and perform tension and compression tests after 4 weeks.

UNIT – IV

Stability and Indeterminate Structures

Stability analysis of masonry dam; problems on masonry dam Statically indeterminate structures- analysis of propped beams, analysis of fixed beams, analysis of continuous beams using superimposition and three moment equation.

Practice:

1. To perform compression and bending tests on concrete specimens prepared 4 weeks before.
2. To study the behaviour of materials under torsion and evaluate the elastic constants.

UNIT – V

Advanced Analysis Methods for Beams

Analysis of beam using moment distribution method and solving problems.

Practice:

1. Verification of moment distribution method for a simple continuous beam.
2. Moment distribution analysis of a propped cantilever beam.

Text Books:

1. Junarkar S B. Mechanics of Structures (Vo-I). Choratar Publishing House, Anand. ISBN: 9789385039270.
2. Khurmi R S. Strength of Materials. S. Chand Publishing, New Delhi. ISBN: 9789352833979.

Reference Books:

1. Lehri R S and Leheri R S. Strength of Materials. S.K. Kataria & Sons, New Delhi. ISBN: 978-8185749440.
2. Ramamrutham S. and Narayanan R. Strengths of Materials. Dhanpat Rai and Sons, Nai Sarak, New Delhi. ISBN: 978-9352165452.

Web Links:

1. https://www.aboutcivil.org/solid-mechanics.html
2. https://nptel.ac.in/courses/105105108

Theory of Machines

Semester: V	L	T	P	C
Course Code: 241AE026	2	0	0	2

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Determine the velocity and acceleration for different mechanisms by graphical and analytical methods.
- **CO2:** Explain the power transmission of belt and chain drivers.
- **CO3:** Compare different types of gears and gear trains.
- **CO4:** Examine various types of governors.
- **CO5:** Calculate the balancing forces of rotating masses and flywheel applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1								
CO2	3	2	1								
CO3	1	3	2								
CO4	3	2									
CO5	3	2	1	1							

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	2	1	-
CO2	3	1	-
CO3	3	1	-
CO4	3	1	-
CO5	2	1	-

UNIT – I

Introduction to Theory of Machines

Simple mechanism: elements, links, pairs, kinematics chain, and mechanisms; classification of pairs and mechanisms; lower and higher pairs; four bar chain, slider crank chain and their inversions; Velocity mechanism: determination of velocity and acceleration using graphical (instantaneous centres) method.

UNIT – II

Belt and Chain Drives, Concept of Friction

Belt drives: types of drives, belt materials, length of belt, transmitted power, velocity ratio, belt size for flat and V belts; effect of centrifugal tension, creep and slip on power transmission; chain drives, classification of chain drive, terms used in chain drive. Types of friction, laws of dry friction; friction of pivots and collars; single disc, multiple disc, and cone clutches, rolling friction.

UNIT – III

Gears

Types of gears, law of gearing, velocity of sliding between two teeth in mesh; Involute and cycloidal profile for gear teeth; Spur gear, nomenclature; Introduction to helical, spiral, bevel and worm gear; Simple, compound, reverted, and epicyclic trains; determining velocity ratio by tabular method.

UNIT – IV

Governors

Types of governors, constructional details and analysis of Watt, Porter, Proell governors, effect of friction, controlling force curves. sensitiveness, stability, hunting, iso-chronism, power and effort of a governor.

UNIT – V

Flywheel

Turning moment diagrams, coefficient of fluctuation of speed and energy, weight of flywheel, flywheel applications; Static and dynamic balancing, balancing of rotating masses in one and different planes.

Text Books:

1. Rattan. S.S. Theory of Machines. Tata Mc Graw Hill Publishing Company Limited.Nev Delhi. ISBN: 9351343472, 9789351343479.
2. Khurmi R S and Gupta J K. A Text Book of Theory of Machines. Euresia Publishin House (P) Ltd., New Delhi. ISBN: 978-8121924242.

Reference Books:

1. Rao, J.S. Theory of Machines through solved problems. New Age Internationa publishers, New Delhi. ISBN: 978-9395161459.
2. Erdman. A.G and Sandor G.N. Mechanism Design: Analysis Synthesis (Vol. 1 an 2).Prentice Hall of India, New Delhi. ISBN: 978-0132677820.

Web Links:

1. http://nptel.ac.in/courses/112104121/16
2. https://www.tutorialspoint.com/theory_of_machines/gear_and_gear_trains.

Thermodynamics and Heat Transfer

Semester: V	L	T	P	C
Course Code: 241AE027	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Outline the basic concepts of thermodynamics.
CO2: Explain the thermodynamic laws and carnot cycle.
CO3: Determine heat transfer through conduction, convection, radiation.
CO4: Determine the rate of heat transfer of the extended surfaces, Log Mean Temperature Difference & Number of Transfer Units for designing of heat exchangers.
CO5: Explain the principles and laws involved in mass transfer.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1	1	1						
CO2	3	2	1	1	2						
CO3	3	1	2	2							
CO4	3	2	1	2							
CO5	3	2		2							

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	1	2	-
CO2	1	2	-
CO3	1	3	-
CO4	-	3	-
CO5	-	3	-

UNIT – I
Basics of Thermodynamics
Basic concepts and definitions of thermodynamics, statistical and classical thermodynamics, microscopic and macroscopic point of view; Thermodynamic systems- thermodynamic equilibrium, properties of systems; state, path, process, cycle; point function, path function; temperature and zeroth law of thermodynamics; pressure, specific volume, density, energy, work and heat.

UNIT – II
Thermodynamic laws and Carnot cycle
First law of thermodynamics- internal energy, law of conservation of energy, first law of thermodynamics, application of first law to a process. Energy-a property of system, perpetual motion machine of the first kind-PMM1; characteristic equation of state, specific heats; application of first law of thermodynamics to non-flow or closed system; free expansion &throttling process; Second law of thermodynamics: limitations of first law of thermodynamics and introduction to second law, statements of second law of thermodynamics; Clausius statement, Kelvin-Planck statement; perpetual motion machine

of the second kind-PMM2; Clausius inequality; Carnot Cycle, Carnot's Theorem, entropy, entropy changes for a closed system.

UNIT – III

Heat transfer- Conduction

Concept, modes of heat transfer, thermal conductivity of materials, measurement, general differential equation of conduction, one dimensional steady state conduction through plane and composite walls, tubes and spheres without heat generation, electrical analogy, insulation materials.

UNIT – IV

Heat transfer- Convection and Radiation

Fins; Free and forced convection, Newton's law of cooling, heat transfer coefficient in convection, non-dimensional numbers; equation of laminar boundary layer on flat plate and in a tube, laminar forced convection on a flat plate and tube, combined free and forced convection; Thermal radiation, black body radiation, Stefan-Boltzman law, black body emissive power, emissivity, absorptivity, reflectivity and transmissivity.

UNIT – V

Heat exchangers and Mass Transfer

Heat transfer analysis involving conduction, convection and radiation; Types of heat exchangers; fouling, log mean temperature difference, heat exchanger performance, transfer units; Heat exchanger analysis restricted to parallel and counter flow heat exchangers; Introduction to mass transfer, analogy between heat and mass transfer, Fick's law of diffusion.

Text Books:

1. Engineering Thermodynamics, Nag PK, Mc Graw Hill Publishing, 6th edition. ISBN:9352606429.
2. Heat and Mass Transfer, R. K. Rajput, S. Chand Limited, Revised Edition. ISBN: 8121926173.

Reference Books:

1. Thermal Engineering, R.K.Rajput S.Chand & Co. ISBN: 978-8121924730.
2. Transport processes and Unit Operations, Geankoplis C. J. Allyn and Bacon Inc., Newton, Massachusetts**.** ISBN: 978-0205059393.

Web Links:

1. http://ecoursesonline.iasri.res.in/course/view.php?id=444
2. http://ecoursesonline.iasri.res.in/course/view.php?id=624

Tractor & Automotive Engines

Semester: V	L	T	P	C
Course Code: 241AE028	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain farm power sources, classify tractors and IC engines, and analyze thermodynamic principles and efficiencies.
CO2: Examine engine components, compare 2-stroke and 4-stroke cycles, CI and SI engines, and analyze valve systems and air cleaning mechanisms.
CO3: Conduct fuel tests for SI and CI engines & study carburetion and fuel injection systems.
CO4: Analyze lubrication and cooling systems.
CO5: Explain SI engine ignition systems, electrical systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	1	2	-		-			1
CO2	3	2	2	2	-	-		1			-
CO3	3	3	-	3	2	-		-			-
CO4	3	3	2	-	2	1		-			-
CO5	3	2	-	2	2	-		-			1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	2	-	-
CO2	2	-	-
CO3	2	-	-
CO4	2	-	-
CO5	2	-	-

UNIT – I
IC engines
Sources of farm power- conventional and non-conventional energy sources. Classification of tractors and IC engines. Review of thermodynamic principles of IC (CI & SI) engines and deviation from ideal cycle. General energy equation and heat balance sheet. Derivation of thermal efficiency of Otto cycle, Diesel cycle and Dual cycle. Mechanical, thermal and volumetric efficiencies.
Practice:
1. Study of different systems of CI engines.
2. Study of tractor engine heat balance and engine performance curves.

UNIT – II
Engine Terminology, Components and its Functions
Study of engine components their construction, operating principles and functions. Engine strokes and comparison of 2-stroke and 4-stroke engine cycles and CI and SI engines. Engine

valve systems, valve mechanism, valve timing diagram, valve clearance adjustment. Cam profile, valve lift and valve opening area. Inlet and exhaust systems.
Importance of air cleaning system. Types of air cleaners and performance characteristics of various air cleaners. Fuel supply system, types of fuels, properties of fuels, calculation of air-fuel ratio.

Practice:

1. Study of engine parts and functions, working principles, etc..
2. Study of valve systems construction and adjustments.
3. Study of air cleaning system.

UNIT – III

Fuel Supply and Governor Systems

Different tests on fuel for SI and CI engines. Detonation and knocking in IC engines. Carburetion system, carburetors and their main functional components. Fuel injection system- injection pump, their types, working principles. Fuel injector nozzles- types and working principles. Engine governing- need of governors, governor types and governor characteristics.

Practice:

1. Determination of physical properties of oil and fuel.
2. fuel supply system of SI engine.
3. Study of diesel injection system & timing.

UNIT – IV

Lubrication and Cooling System

Lubrication system- need, types, functional components. Lubricants- physical properties, additives and their application. Engine cooling system- need, cooling methods and main functional components. Need and types of thermostat valves. Additives in the coolant. Radiator efficiency.

Practice:

1. Study of cooling system, and fan performance, thermostat and radiator performance evaluation.
2. Study of lubricating system and adjustments.

UNIT – V

Electrical System

Ignition system of SI engines. Electrical system including battery, starting motor, battery charging, cut-out, etc.. Comparison of dynamo and alternator. Basics of engine testing .

Practice:

1. Visit to engine manufacturer/ assembler/ spare parts agency.
2. Study of electrical system of tractor.

Text Books:

1. Ganesan V. Internal combustion engines. Mc Graw Hill, New Delhi. ISBN: 9781249006197.
2. Goering C E, Hansen A C. Engine and Tractor Power. ASAE. St Joseph, Michigan. ISBN: 978-1892769428.

Reference Books:

1. Liljedahl J B, Turnquist P K, Smith D W and Hoki M. Tractors and Their Power Units.Van Nostrand Rainhold, New York. ISBN: 978-0929355726.
2. Jagdishwar Sahy, Elements of Agricultural Engineering. Standrad Publishers distributors. New Delhi. ISBN: 9788180140440.

Web Links

1. https://agrimoon.com/agricultural-engineering-icar-ecourse-pdf-books-free-download/
2. https://onlinecourses.nptel.ac.in/

Irrigation and Drainage Engineering

Semester: V	L	T	P	C
Course Code: 241AE029	3	0	1	4

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Analyze major and medium irrigation schemes in India, assess the purpose, merits, and demerits of irrigation, evaluate various sources of irrigation water, and measure irrigation water using different methods.
- **CO2:** Design and lining of irrigation field channels, implementing on-farm structures for water conveyance, control, and distribution, design underground pipeline conveyance systems, applying criteria and methods for land grading and leveling to optimize agriculture.
- **CO3:** Explain soil-water-plant relationships, estimating crop water requirements, and implementing efficient irrigation practices for optimized agricultural production.
- **CO4:** Design and implement surface water application methods such as border, check basin, and furrow irrigation, understand the causes and impacts of waterlogging, and design surface drainage systems.
- **CO5:** Design, implement, and manage subsurface drainage systems, understand salt balance and reclamation techniques for saline and alkaline soils, and apply principles of conjunctive use of fresh and saline waters.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2	2		2		2	2		2
CO2	2	3	3	2		2		2	2		2
CO3	2	2	3			2		2	1		2
CO4	2	2	2			2		2			
CO5	2	2	3			2		2			

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	3
CO2	-	-	3
CO3	-	-	3
CO4	-	-	3
CO5	-	-	3

UNIT – I

Irrigation Systems and Water Resources Management in India

Major and medium irrigation schemes of India, purpose of irrigation, merits and demerits of irrigation, source of irrigation water, present status of development and utilization of different water resources of the country; Measurement of irrigation water: weir, flumes and orifices and other methods.

Practice:

1. Measurement of irrigation water.

UNIT – II

Design and Management of Irrigation Conveyance Systems and Land Grading

Design and lining of irrigation field channels, on-farm structures for water conveyance, control & distribution; Underground pipeline conveyance system: components and design; land grading; Criteria for land leveling, land levelling design methods.

UNIT – III

Soil-Water-Plant Relationship and Crop Water Requirements

Soil-water-plant relationship: soil properties influencing irrigation management, soil water movement, infiltration, soil water potential, soil moisture characteristics, soil moisture constants, measurement of soil moisture, moisture stress and plant response; Water requirement of crops: concept of evapotranspiration (ET), measurement and estimation of ET, water and irrigation requirement of crops, depth of irrigation, frequency of irrigation, irrigation efficiencies.

Practice:

1. Measurement of soil moisture by different instruments.
2. Measurement of infiltration characteristics.
3. Estimation of evapotranspiration and water requirement of crops.
4. Study on scheduling of irrigation of field crops.

UNIT – IV

Surface Irrigation and Drainage Systems in Agriculture

Surface methods of water application: border, check basin and furrow irrigation-adaptability, specification and design considerations; Water logging-causes and impacts; Drainage, objectives of drainage, familiarization with the drainage problems of the state, drainage coefficient; Surface drainage, types and design;

Practice:

1. Study of advance, recession and computation of infiltration opportunity time.
2. Design of surface drainage systems.
3. Study on drainage coefficients determination.

UNIT – V

Subsurface Drainage Systems and Soil Reclamation Techniques

Sub-surface drainage: purpose and benefits, investigations of design parameters, hydraulic conductivity, drainable porosity, water table etc., types and use of subsurface drainage system, interceptor and relief drains. Derivation of Hooghoudt's and Ernst's drain spacing equations; Design of subsurface drainage system, drainage materials, drainage pipes, drain envelope; Layout, construction and installation of drains; Drainage structures, vertical drainage, bio- drainage, tile drains, mole drain;

Salt balance, reclamation of saline and alkaline soils, leaching requirements; Conjunctive use of fresh and saline waters.

Practice:

1. Study on in-situ measurement of hydraulic conductivity by auger hole method.
2. Study of tile drainage; cost analysis of surface and sub- surface drainage system.
3. Determination of various chemical properties of soil and water.
4. Visit to a waterlogged area and study of a drainage project.

Text Books:

1. Israelsen O W, Hansen V E and Stringham G E. Irrigation Principles and Practices. John Wiley & Sons, Inc. USA. ISBN: 9780471030077.
2. Majumdar D K. Irrigation Water Management Principles. PHI learning Private Limited, New Delhi. ISBN: 9788120347730.

Reference Books:

1. Michael A M. Irrigation: Theory and Practice. Vikas Publishing House, New Delhi. ISBN: 9788124951158.
2. Bhattacharya A K. Drainage Engineering. ICAR Publications, New Delhi. ISBN: 9788171642441.

Web Links:

1. https://archive.nptel.ac.in/courses/126/105/126105010/
2. https://www.aau.in/irrigation-and-drainage-engineering

Food and Dairy Engineering

Semester: V	L	T	P	C
Course Code: 241AE034	3	0	1	4

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain the different thermal and chemical properties of milk; unit operations and principles involved in processing of different milk products.
- **CO2:** Identify different mixing equipments for powder; high and low viscosity liquids.
- **CO3:** Compare different thermal, non- thermal processing techniques of milk.
- **CO4:** Compare different filtration methods.
- **CO5:** Identify various methods of filling and packaging of milk and milk- based products.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	3		1	1						
CO2	3	2	1	2	2						
CO3	3	2	1	2							
CO4	3	2	1	2							
CO5	3	2	1	2	1	2	1				

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	2	-
CO2	-	2	-
CO3	-	3	-
CO4	-	2	-
CO5	-	2	-

UNIT – I

Unit Operations in Milk Processing

Introduction to different unit operations in food processing; Process flow charts for preparation of various food products; mass and energy balance; unit operations in milk processing: engineering, thermal and chemical properties of milk and milk products; Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization, cream separation, preparation of butter, cheese, paneer and ice cream.

Practice:

1. Study of measurement of different properties of milk and milk products.
2. Preparation of flow charts for different food processing industries.
3. Study of milk pasteurizer, sterilizer and homogenizer.
4. Study on preparation of cream and butter.

UNIT – II

Mixing, Separation and Non Thermal Processing

Mixing: theory of mixing of solids and pastes, mixing index, mixers for solids, liquid foods and pastes, viz. tumbling mixer, screw mixer, ribbon mixer, liquid mixers, sigma-blade mixer,

anchor and gate agitator; Separation processes: principle and equipment for sedimentation of solids in liquid and solids in air; Principle and operation of tubular bowl centrifuge and disc bowl centrifuge. Principles and applications of different non-thermal processing methods as vacuum processing, high pressure processing, PEF processing, Ultrasonication, radiation processing; Principles and applications of novel heating methods, viz. ohmic, infrared and dielectric heating.

Practice:

1. Study of different types of mixers for solids and liquids.
2. Determination of mixing effectiveness and mixing index.

UNIT – III

Drying and Evaporation

Dehydration of foods; dryers for solid foods, construction and operation of direct and indirect type solar dryers, tray dryer, tunnel dryer, vacuum dryer, microwave dryer, freeze dryer, etc.; dryers for liquid foods, construction and operation of drum dryer, spray dryer and vacuum band dryer; Evaporation of food products: principle, different types of evaporators, factors affecting steam economy, multiple effect evaporation, vapour recompression.

Practice:

1. Study of different types of evaporators and multiple effect evaporation system.
2. Study of drum dryer and spray dryer and comparison of product qualities.

UNIT – IV

Thermal Processing and Filtration

Thermal processing: thermo- bacteriology, D value, Z value, reaction quotient, process time, different types of retorts and continuous sterilizers, canning process, aseptic processing. Filtration: principle, construction and working principles of different types of filters as plate and frame filter press, shell and leaf filter, centrifugal filter, rotary drum filter, continuous belt filter; Membrane separation: principle, characteristics and applications of reverse osmosis, nano-filtration, ultra-filtration and macro-filtration; membrane modules; Extrusion cooking: principle, factors affecting extrusion cooking, single and twin-screw extruders.

Practice:

1. Study of different types of filters.
2. Study of membrane modules and different types of membranes.

UNIT – V

Filling and Packaging

Selection of different types of packaging materials for different types of food products; Equipment for filling and packaging of liquid foods such as gravity filler, filling by metering-FFS system, piston type filler, metering cup filler, filling of pastes, filling of powders; aseptic filling of pouches and bottles; Nanotechnology and its applications in food industry; Basics of food plant design and layout; Plant utilities.

Practice:

1. Study of different types of packaging materials.
2. Study of different types of filling machines for liquids and powder/ granules.

Text Books:

1. Food Engineering and Dairy Technology by Kessler H G, Veriag A. Kessler Publisher. ISBN:3980237857.
2. Outlines of Dairy Technology by Sukumar De., Oxford University Press, New Delhi. ISBN: 0195611946.

Reference Books:

1. Developing Technologies in Food Science: Status, Applications, and Challenges by Murlidhar Meghwal and Megh R. Goyal, Apple Academic Press; 1st edition. ISBN: 978-1-77463-041-9.
2. Principles of Food Science by Fennema O R, Marcel Dekkar Inc., New York. ISBN: 978-0824763220.

Web Links:

1. http://ecoursesonline.iasri.res.in/course/view.php?id=47
2. https://elearning.icar.gov.in/DisplayPG_ECoursesContent.aspx?CourseCode=ENmVoVQAP7x1!EE!GrPopA==#!

Tractor Systems & Controls

Semester: VI	L	T	P	C
Course Code: 241AE032	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain the need and types of transmission systems in tractors, including clutches and gearboxes.
- **CO2:** Describe the function and components of differential, brake systems and steering.
- **CO3:** Illustrate the principles and components of hydraulic systems and tractor power outlets.
- **CO4:** Analyze traction mechanisms, tyre specifications, and calculate traction-related forces.
- **CO5:** Evaluate the mechanics, stability, and ergonomic considerations of tractors, including testing protocols.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	2	2	-	-	-	-	-	-
CO2	3	3	2	2	-	-	-	-	-	-	-
CO3	3	-	-	2	2	-	-	-	-	-	-
CO4	3	2	-	3	2	-	-	-	-	-	-
CO5	3	2	-	3	-	2	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	2	-	-
CO2	1	-	-
CO3	2	-	-
CO4	3	-	-
CO5	2	-	-

UNIT – I

Transmission system

Transmission system- need of the system in a tractor, types, major functional systems; Clutch- need, types, functional requirements, construction and principle of operation; Single plate, multi-plate, centrifugal and dual clutch systems; Gear box- principle of operation, gear box types, functional requirements, and calculation for speed ratio.

Practice:

1. Study of basic transmission systems and clutch.
2. Study of different types of gear box, calculation of speed ratios, design problems on gear box.

UNIT – II

Brake and Steering System

Differential system- need, functional components, construction, calculation for speed reduction; Final drive; Brake system- types, principle of operation, construction, calculation for braking torque; Steering system- requirements, steering geometry characteristics, functional components, calculation for turning radius; Ackerman steering; Steering systems in track type tractors.

Practice:

1. Study on differential, final drive and planetary gears.
2. Study of brake systems and some design problems.
3. Study of geometry and adjustments of tractor steering.

UNIT – III

Hydraulic system and Tractor Power outlets

Hydraulic system- principle of operation, types, main functional components, functional requirements. hydraulic system adjustments and ADDC; Tractor power outlets- PTO standards, types and functional requirements.

Practice:

1. Study of hydraulic systems in a tractor, hydraulic trainer and design problems.
2. Study of various controls in different makes of tractors in relation to anthropometric measurements
3. Study of hitching system of tractor with various matching implements

UNIT – IV

Traction

Traction- traction terminology, theoretical calculation of shear force and rolling resistance of traction device; Wheels and tyres- solid tyres and pneumatic tyres, tyre construction and tyre specifications; Traction aids.

Practice:

1. Study of traction performance of a traction wheel

UNIT – V

Tractor mechanics and Testing

Tractor mechanics- forces acting on the tractor, determination of CG of a tractor, importance and determination of moment of inertia of a tractor, tractor static equilibrium, tractor stability especially at turns; Maximum drawbar pull and its determination; Tractor as a spring-mass system; Ergonomic considerations and operational safety; Tractor testing; Engine test codes.

Practice:

1. Determination of CG and moment of inertia of a tractor
2. Study on safety requirements of tractor during operation
3. Study of tractor testing

Text Books:

1. Barger E L, Liljedahl J B and McKibben E C. Tractor and their Power Units. Wiley Eastern. ISBN:978-8180140601.
2. Jain S C and Rai C R. Farm Tractor, Maintenance and Repair. Standard Publisher and Distributers, Delhi. ISBN:8180142055.

Reference Books:

1. Giri N K. Automobile Mechanics (SI Units). Khanna Publishers, Delhi. ISBN:978 8174092168.
2. M. L. Mehta , S.R. Verma , S. K. Misra 2024. Testing and Evaluation of Agricultura Machinery, Daya Publishing House. ISBN:978-8170354161.

Web Links:

1. https://agrimoon.com/agricultural-engineering-icar-ecourse-pdf-books-free-download/
2. https://onlinecourses.nptel.ac.in/

Groundwater, Wells and Pumps

	L	T	P	C
Semester: VI				
Course Code: 241AE033	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Demonstrate aquifer properties, groundwater flow dynamics, well classification, and design principles.
- **CO2:** Apply Darcy's law, determining hydraulic conductivity through laboratory and field methods, analyzing groundwater hydraulics using Dupuit's and Thiem's methods, assessing aquifer parameters via various techniques, and designing tube wells with appropriate gravel pack and sanitary protection measures.
- **CO3:** Explain groundwater exploration techniques, methods of well drilling methods, development of tube wells, understanding basin-wise groundwater development, determining safe yield using Hill's method, and applying principles of conjunctive use of groundwater.
- **CO4:** Assessing groundwater quality and pollution, implementing artificial groundwater recharge techniques, understanding sea water intrusion dynamics in coastal aquifers, and applying the Ghyben-Herzberg relationship to manage saline water intrusion.
- **CO5:** Explain water lifting devices, classifying pumps, analyzing the components and operation of pumps, selection and installing pumps, interpreting performance curves, and troubleshooting pumping systems, including hydraulic ram, deep well turbine pump, and submersible pump technologies.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2	2		2					2
CO2	3	3	3	2		2			1		2
CO3	2	3	3	2		2			1		2
CO4	2	2	2	3		2					2
CO5	2	2			3			2	2		2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	3
CO2	-	-	3
CO3	-	-	3
CO4	-	-	3
CO5	-	-	3

UNIT – I

Groundwater Hydrology, Aquifer Properties, and Well Design

Groundwater hydrology and hydrologic cycle, groundwater resources of World and India; Occurrence and movement of ground water, aquifer and its types, aquifer properties, groundwater flow direction, flow in relation to groundwater contours; Classification of wells, fully penetrating tube wells and open wells, familiarization of various types of bore wells, design of open wells.

Practice:

1. Study on various types of wells.
2. Estimation of specific yield and specific retention.

UNIT – II

Groundwater Flow and Well Hydraulics

Darcy's law, determination of hydraulic conductivity by laboratory and field method; Groundwater hydraulics- Dupit's assumptions and Dupit's method, Thiem's method; Well interference; determination of aquifer parameters by different method such as Theis, Jacob and Chow's, Theis recovery method; Design of tube well and gravel pack, sanitary protection of tube wells.

Practice:

1. Determination of hydraulic conductivity by laboratory and field methods.
2. Study of piezometer, observation well and measurement of water table.
3. Estimation of aquifer parameters by Theis method, Coopers-Jacob method, Chow method and Theis Recovery method.

UNIT – III

Groundwater Exploration, Well Drilling Techniques

Groundwater exploration techniques; methods of drilling of wells: percussion, rotary, reverse rotary; DTH; Development of tube well; Basin wise ground water development, safe yield, factors governing safe yield, computation of safe yield by Hill's method, conjunctive use of ground water.

Practice:

1. Study of different drilling equipment.
2. Sieve analysis for gravel and well screens design.
3. Determination of safe yield by Hill's method.

UNIT – IV

Groundwater Quality, Pollution, Recharge Techniques, and Coastal Aquifers

Quality of ground water, groundwater pollution; Artificial groundwater recharge techniques; different direct, indirect and combination of methods; Sea water intrusion, coastal aquifers, sources of saline water intrusion, upcoming of saline water, Ghyben-Herzberg relationship between fresh and saline water.

Practice:

1. Study of various artificial ground water recharge structures.
2. Determination of various parameters on groundwater quality.

UNIT – V

Pumping Systems: Types, Components, and Performance Characteristics

Pumping systems: water lifting devices; Classification of pumps, components of centrifugal pumps, priming, pump selection, installation and troubleshooting, performance curves, effect

of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics; Hydraulic ram, deep well turbine pump and submersible pump.

Practice:

1. Study of centrifugal pumps, multistage centrifugal pumps, installation and testing of centrifugal pump.
2. Visit to a groundwater project and a river lift project.

Text Books:

1. Todd D K and Mays L W. Ground Water Hydrology. John Wiley & Sons, New York. ISBN: 9780471758046.
2. Raghunath H M. Ground Water. New Age Publications, New Delhi. ISBN: 9788122424185.

Reference Books:

1. Garg S P. Groundwater and tube wells. Oxford & IBH Publishing Co. Ltd., New Delhi. ISBN: 9788120413552.
2. Michael A M, Khepar S D and Sondhi S K. Water Well & Pump Engineering. Tata Mc- Graw Hill. ISBN: 9780070617386.

Web Links:

1. Course: Ground Water,Wells and Pumps 3(2+1) (iasri.res.in)
2. Centrifugal Pump Basics - How centrifugal pumps work working principle hvacr (youtube.com)

Sensors, AI and Robotics in Agriculture

	L	T	P	C
Semester: VI				
Course Code: 241AE095	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain the principles, classifications, and characteristics of sensors and transducers, and their importance in agricultural applications.
- **CO2:** Apply knowledge of various sensors and AI programming techniques to solve specific agricultural problems, including soil moisture and temperature monitoring, and precision farming.
- **CO3:** Utilize advanced problem-solving techniques and knowledge representation methods to address complex issues in agricultural systems.
- **CO4:** Design and implement robotic systems for agricultural applications, including the selection and integration of sensors, actuators, and control systems.
- **CO5:** Apply precision farming tools and technologies, including drones and smart irrigation systems, to enhance agricultural productivity and sustainability.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3		2				1				
CO2		2			3					1	
CO3			3	2					1		
CO4	2	3								1	
CO5			2	1				3			

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	2	1	2
CO2	3	1	2
CO3	2	2	2
CO4	2	2	2
CO5	2	2	2

UNIT – I

Fundamentals of Sensors

Introduction to sensors and transducers; Need for sensors in the agriculture; Sensor Classification; Units of measurements; Sensor characteristics, Active and passive sensors– static characteristics, dynamic characteristics- first and second order sensors; Photoelectric effect – Photo dielectric effect – Hall effect – Thermoelectric effect – Peizoresistive effect – Piezoelectric effect – Pyroelectric effect- Magneto mechanical effect (magnetostriction) – Magneto resistive effect. Basics of detector materials/ sensor type (Silicon diod, InGaAS- etc.) and their characteristics. Fundamentals of visual, NIR, IR and FTIR

spectroscopy, Remote sensing, data acquisition and their analysis; Training and validation of sensor and its results.

Practice:

1. Identify various sensors viz. Proximity sensors, ultrasonic sensors, optical sensors, electrochemical sensors and mechanical sensors.
2. Learning on open source image processing software for shape analysis and object detection.

UNIT – II

Sensors in different applications and Introduction to Artificial Intelligence

Occupancy and motion detectors; Position, displacement, and level; Velocity and acceleration; Force, strain, and tactile Sensors; Pressure sensors, Temperature sensors, Optical sensors and electromagnetic wave detector. Capacitance sensors; Weather sensors, imaging sensors and their application in agriculture. Principle and working of sensors for soil moisture, soil temperature, chlorophyll meter, colour sensor, spectral sensor, temperature sensor, humidity sensor, wind speed, motion sensors, position sensor etc. Biosensors, general components of biosensor, biomolecules in biosensors such as enzyme, DNA, antibody, Nanomaterials in biosensors- Quantum dots. Selection of sensors.

Overview: foundations, scope, problems, history and approaches of AI, Intelligent agents: reactive, deliberative, goal driven, utility-driven, and learning agents, AI programming techniques. Classical AI, concept of expert system, conflict resolution, multiple rules, forward chaining, backward chaining; Advantages and limitations of AI systems.

Practice:

1. Measurement of displacement, force and pressure using different sensors.
2. Use of load sensor on tractors to predict pulling requirements for ground engaging equipment.
3. Introduction to open source programming languages, advantages and drawbacks of open source programming.
4. Programming in Embedded- C, Concepts of C language.
5. Experiment using moisture, temperature and relative humidity sensors for automatic irrigation and protected cultivation.
6. Detection based spraying system using ultrasound for spraying operation using opens source hardware by programming with sensor and testing.
7. Detection based spraying system using ultrasound for spraying operation – installation on sprayer unit with actuator/sensor and testing.

UNIT – III

Problem-solving through Search and Knowledge Representation and Reasoning

Forward and backward, state-space, blind, heuristic, problem reduction, alpha-beta pruning, minimax, constraint propagation, neural, stochastic, and evolutionary search algorithms, bidirectional search, heuristic search, problems and examples.

Foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, sample applications. Planning: planning as search, partial order planning, construction and use of planning graphs.

UNIT – IV

Robotics

Introduction to Robotics-classification with respect to geometrical configuration (anatomy), selection based on the agriculture application; Hardware for robot, sensors and actuator in robot, control of robot, system interface and integration in robot; Communication- internal and external communications; Fundamentals of microprocessor architecture; Introduction to use of open source hardware (arduino & raspberry pi); robot programming, controlling algorithm- basic on neural network; Feedback system, safety sensors; Controlled system & chain type: Serial manipulator & Parallel Manipulator. Components of Industrial robotics-precession of movement-resolution, accuracy & Repeatability- Dynamic characteristics- speed of motion, load carrying capacity & speed of response.

Practice:

1. Identify various components in open source hardware (arduino & raspberry pi).
2. Visit to robot fabrication facilities/workshop.

UNIT – V

Application in Agriculture

Introduction to precision farming tools for implementation of precision agriculture; Application of sitespecific management - nutrient management, agro-chemicals and fertilizer management, weeds management; Application of drone- pesticides/ nutrient spraying, environmental monitoring; Yield monitoring and mapping, soil sampling and analysis; Protected cultivation - smart irrigation system; precision livestock farming, application in food processing; image processing- shape analysis, feature detection and object location; gas and chemical sensor for electronic nose and electronic tongue.

Practice:

1. Learning about the different applications of robots in agriculture.

Text Books:

1 Nikku, S. B. 2020. Introduction to Robotics – Analysis, Control, Applications, 3rd edition, John Wiley & Sons Ltd., 2020. ISBN: 978-1119527626.
2 Rich, Knight and Nair. Artificial Intelligence, , Tata McGraw Hill. ISBN:978-0070087705.

Reference Books:

1 Bräunl T. 2013. Embedded Robotics Mobile Robot Design and Applications with Embedded Systems, Springer Berlin Heidelberg. ISBN: 978- 3540034360.

2 Gonzalez and Wintz - Digital Image Processing 3rd Ed. ISBN: 978- 1292026138.

Web Links:

1 https://www.mdpi.com/2073-4395/14/6/1180
2 https://www.researchgate.net/publication/381091939_AI_Sensors_and_Robotics_for_Smart_Agriculture

Agricultural Structures & Environment Control

Semester: VI	L	T	P	C
Course Code: 241AE035	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Plan farm stead and explain environmental control factors, BIS standards.
CO2: Design of farm structures, green houses and estimate their cost.
CO3: Explain about grain storage structures and calculate pressure in bins.
CO4: Explain farm roads, water supply and sanitation and design of sewage system.
CO5: Estimate domestic power requirement and explain about various sources of power supply.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	1	1	1	2	2				2
CO2	3	2	1	3	1						
CO3	3	3	2	2	2						2
CO4	3	2	2	2	1	1	2				3
CO5	3	2	2	3	1						2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	1	2	-
CO2	2	2	-
CO3	-	2	-
CO4	2	3	-
CO5	1	2	-

UNIT – I

Farm and Farmstead

Farm and farmstead, farmstead planning and layout; Environmental control- scope, importance and need, physiological reaction of livestock, environmental control, systems and design, control of temperature, humidity and air ventilation; BIS standards for dairy, piggery and other farm structures.

Practice:

1. Measurement of environmental parameters, Temperature, Relative humidity, wind velocity, cooling load.

UNIT – II

Farm Structures

Farm structures- design, construction and cost estimation of farm structures, animal shelters, compost pit, fodder silo, farm fencing, implement shed, barn for cows, buffalo, poultry etc.; Green houses types, poly houses /shed nets, cladding materials, plant environment

interactions, design and construction of greenhouses, site selection, orientation, design for ventilation requirement using exhaust fan system, selection of equipment, greenhouse cooling and heating system.

Practice:

1. Design and layout of a dairy farm.
2. Design and layout of a poultry house.
3. Design and layout of a goat/sheep house.
4. Design and layout of a farm fencing system.
5. Design and layout of a feed/fodder system.
6. Design and layout of a green house.

UNIT – III

Grain Storage Structures

Grain storage structures- grain storage methods, moisture and temperature change in grain bins, traditional storage structures and their improvement, improved storage structures (CAP, hermitage storage, Pusa bin, RCC ring bin), design consideration for grain storage go-down, bag storage structure, shallow and deep bins, calculation of pressure in bins;Storage of seeds.

Practice:

1. Design and layout of a grain storage structure.
2. Design and layout of a bag storage structure.
3. Performance of domestic storage structure.
4. Design layout of a threshing floor.

UNIT – IV

Rural Housing and Development

Rural housing and development; Farm roads- types of roads in the farm, construction methods, repair and maintenance of rural roads; Water supply and sanitation- sources of water supply for human beings and animals, drinking water standards, water treatment for rural community, site selection and orientation of buildings for sanitation.

UNIT – V

Design of Sewage System

Sewage system and design, maintenance, septic tank for small family. Rural electrification-estimate of domestic power requirement, sources of power supply, electrification for rural housing.

Practice:

1. Design of a sewage system plant.

Text Books:

1. Pandey P H. Principles and practices of Agricultural Structures and Environmental Control. Kalyani Publishers, Ludhiana. ISBN: 978-9327238884.
2. Ojha T P and Michael A M. Principles of Agricultural Engineering. Vol. I, Jain Brothers, Karol Bag, New Delhi. ISBN: 9788183602129.

Reference Books:

1. Nathonson J A. Basic Environmental Technology. Prentice Hall of India, New Delhi. ISBN: 978-8120338364.
2. Rao P V.Text Book of Environmental Engineering. Prentice Hall of India, New Delhi. ISBN: 978-8120319301.

Web Links:

1. https://ecoursesonline.iasri.res.in/course/view.php?id=17
2. https://courseware.cutm.ac.in/wp-content/uploads/2020/05/Lecture-Notes.pdf

Bioenergy Systems: Design and Applications

Semester: VI	L	T	P	C
Course Code: 241AE036	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Comprehend biomass sources and fermentation processes
- **CO2:** Explore biomass production and preparation
- **CO3:** Analyze biomass conversion technologies
- **CO4:** Evaluate biofuel production processes and thermo-chemical degradation process
- **CO5:** Assess environmental and economic aspects of bio-energy

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	-	-	-	2	3	-	-	-	-	-
CO2	3	2	-	1	2	-	-	-	-	-	-
CO3	2	1	-	-	2	3	-	-	-	-	-
CO4	2	1	-	-	3	1	-	-	-	-	-
CO5	2	1	-	-	3	1	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	2	2	1
CO2	2	2	1
CO3	2	2	1
CO4	2	2	1
CO5	2	2	1

UNIT – I

Biomass sources and Fermentation

Biomass sources and characteristics. Fermentation processes and its general requirements. Aerobic and anaerobic fermentation processes and their industrial applications. Heat transfer processes in anaerobic digestion systems.

Practice:

1. Study of anaerobic fermentation system for industrial application.

UNIT – II

Biomass production and Preparation

Biomass production- wastelands, classification and their use through energy plantation. Selection of species, methods of field preparation and transplanting. Harvesting of biomass and coppicing characteristics. Biomass preparation techniques for harnessing (size reduction, densification and drying).

Practice:

1. Study of biomass densification technique (briquetting, palletization, and cubing).

UNIT – III

Biomass Conversion Technologies

Bio-energy- properties of biomass and conversion technologies, pyrolysis of biomass to produce solid, liquid and gaseous fuels. Biomass gasification, types of gasifiers, various types of biomass cook stoves for rural energy needs.

Practice:

1. Study of integral bio energy system for industrial application.
2. Study of bio energy efficiency in industry and commercial buildings.
3. Study of energy efficiency in building, study of Brayton, Striling and Rankine cycles.

UNIT – IV

Bio Gas Production Process

Thermo-chemical degradation. History of small gas producer engine system. Chemistry of gasification. Producer gas- type, operating principle. Gasifier fuels, properties, preparation, conditioning of producer gas. Applications, shaft power generation, thermal application and economics.

Practice:

1. Study of biomass improved cook-stoves.
2. Estimation of calorific value of biogas & producer gas.
3. Testing of diesel engine operation using dual fuels and gas alone.

UNIT – V

Production of Biodiesel

Trans-esterification for biodiesel production and application in CI engines. production process, properties and application of ethanol. Bio-hydrogen production routes. Environmental aspect of bio-energy. Assessment of greenhouse gas mitigation potential. Cost economics of bio-energy systems.

Practice:

1. Performance evaluation of biomass gasifier engine system (throat less & downdraft).
2. Study on producer gas- types, application, shaft power generation, thermal application and economics.
3. Study of cost economics of biofuel.

Text Books:

1. Basu P. 2018. Biomass Gasification, Pyrolysis and Torrefaction. Academic Press. ISBN:978-0128129920.
2. Butler S.Renewable Energy Academy Training wood energy professionals. ISBN 978-9390385638.

Reference Books:

1. Knothe G, Gerpen J V, Krahl J. (Eds.). The Biodiesel Handbook. AOCS Press.ISBN:1893997790.
2. Rai G D. Non-Conventional Energy Sources. Khanna Publishers, New Delhi. ISBN:8174090737.

Web Links

1. https://agrimoon.com/agricultural-engineering-icar-ecourse-pdf-books-free-download/
2. https://onlinecourses.nptel.ac.in/

Refrigeration and Air-conditioning

Semester: VI	L	T	P	C
Course Code: 241AE037	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Outline the pure substances, phases, and phase change processes.
CO2: Explain latent heat and phase change phenomena through proper diagrams and tables.
CO3: Explain working of refrigeration systems.
CO4: Utilize refrigerant properties and psychometric chart.
CO5: Determine working of air conditioners and cold storage plants.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	3	1	1							1
CO2	3	3	1	1	1						1
CO3	3	2	1	2	2						
CO4	3	2		2	2						
CO5	3	2	2	2	3						

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	2	-
CO2	-	2	-
CO3	-	3	-
CO4	-	3	-
CO5	-	3	-

UNIT – I
Introduction
Definition of pure substance, phases of a pure substance, phase change process of a pure substances; compressed liquid & saturated liquid, saturated vapour and superheated vapour, saturated temperature & saturated pressure; T-V diagram for heating of water at constant pressure.

UNIT – II
Latent Heat and Phase Change
Latent heat: latent heat of fusion, latent heat of vaporization; liquid vapour saturation curve; property diagram for phase change process, T-V diagram, P-V diagram, P-T diagram; property tables, state- liquid & vapour states, saturated liquid-vapour mixture, superheated vapour, compressed liquid.
Practice:
1. Study of P-V and T-S chart in refrigeration; Study P-h chart (or) Mollier diagram in refrigeration.

UNIT – III

Introduction to Refrigeration

Principles of refrigeration, units, terminology, production of low temperatures, air refrigerators working on Reverse Carnot Cycle and Bell Coleman cycle; Vapour refrigeration-mechanism, P-V, T-S, P-h diagrams, vapour compression cycles, dry and wet compression, super cooling and sub cooling; Vapour absorption refrigeration system.

Practice:

1. Study of vapour absorption refrigeration system.

UNIT – IV

Refrigerants

Common refrigerants and their properties; Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychometric chart and its use, elementary psychometric processes.

Practice:

1. Study of psychrometric chart and various psychrometric processes.
2. Solving problems on psychrometrics.

UNIT – V

Air Conditioning

Air conditioning: principles, type and functions of air conditioning, physiological principles in air conditioning, air distribution, factors considered for designing an air conditioning system; Room ratio line, sensible heat factor, by-pass factor; types of air conditioners and their applications; Cold storage plants; calculation of refrigeration load and cold storage design considerations.

Practice:

1. Study of domestic water cooler.
2. Study of domestic household refrigerator.
3. Study of cooling tower and to find its efficiency.
4. Study of heat pump test rig.
5. Study of Ice plant test rig.
6. Study of window air conditioner.
7. Study on repair and maintenance of refrigeration and air-conditioning systems.
8. Visit to chilling or ice making and cold storage plants.

Text Books:

1. Refrigeration and Air conditioning, C P Arora, McGraw Hill Education, 3rd edition. ISBN: 9651340164.
2. Outlines of Dairy Technology by Sukumar De., Oxford University Press, New Delhi. ISBN: 0195611946.

Reference Books:

1. A Textbook of Refrigeration and Air conditioning – R. S. Khurmi; J. K. Gupta/ S. Chand. ISBN: 9788121927819.
2. Principles of Food Science by Fennema O R, Marcel Dekkar Inc., New York. ISBN: 978-0824763220.

Web Links:

1. http://ecoursesonline.iasri.res.in/course/view.php?id=47
2. https://elearning.icar.gov.in/DisplayPG_ECoursesContent.aspx?CourseCode=ENmV oV QAP7x1!EE!GrPopA==#!

Post-harvest Engineering of Horticultural Crops

Semester: VI	L	T	P	C
Course Code: 241AE038	1	0	1	2

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain the importance of processing of horticultural crops and preservation methods.
- **CO2:** Distinguish different methods of sorting, grading, peeling and size reduction.
- **CO3:** Explain blanching, drying and canning processes.
- **CO4:** Design cold stores, explain chilling, freezing and cold chain logistics.
- **CO5:** Compare different packaging materials and machines available for horticultural crops.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1			1	1				
CO2	3	3	2	2	1						
CO3	3	3	3	3	2	1	2				
CO4	3	2	1	2	1	3	2				
CO5			3			3	2				

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	2	-
CO2	-	2	-
CO3	-	3	-
CO4	-	3	-
CO5	-	2	-

UNIT – I

Processing of Horticultural Crops

Importance of processing of fruits and vegetables, spices, condiments; characteristics and properties of horticultural crops important for processing; General methods of preservation of fruits and vegetables and their relative advantages and disadvantages; Flowcharts for preparation of different finished products.

Practice:

1. Preparation of different processed horticultural products.

UNIT – II

Unit Operations in Processing of Horticultural Crops

Sorting and grading methods specific to fruits and vegetables, shape and size sorting, weight sorting, image processing, colour sorting, sorting effectiveness; Peeling: different peeling methods and devices (manual, mechanical, chemical and thermal peeling); Minimal processing and pack house activities; Size reduction and juice extraction: equipment for slicing, shredding, crushing, chopping, juice extraction.

Practice:

1. Study of fruit graders.
2. Study of different types of peelers and slicers.
3. Study of juicer and pulper.
4. Study of minimal processing of vegetables.
5. Study of different activities in pack house.

UNIT – III

Blanching, Drying and Canning

Importance and objectives; effects on food (nutrition, colour, pigment, texture); blanching methods and equipment; Dryers for fruits and vegetables, osmo-dehydration, foam mat drying; advanced drying techniques; quality deterioration during drying of fruits and vegetables. Canning of fruits and vegetables: methods and equipment, types of cans, failures of cans.

Practice:

1. Study of blanching equipment, testing the adequacy of blanching.
2. Study of different dryers for fruits and vegetables.
3. Study of foam mat drying and osmotic dehydration processes.

UNIT – IV

Chilling and Freezing

Chilling requirements of different fruits and vegetables; Freezing of food, freezing time calculations, slow and fast freezing; Equipment for chilling and freezing (mechanical & cryogenic); Cold chain logistics and reefer containers; Cold storage heat load calculations and selection of matching equipment; Design of cold stores. Post-harvest management and equipment for spices; Post-harvest management and equipment for flowers.

Practice:

1. Cold storage heat load calculations and design.
2. Study of membrane modules and different types of membranes.
3. Study of hammer mill, pulveriser for grinding of spices to powder.

UNIT – V

Packaging and Storage

Packaging requirements (for containment, protection and other purposes); Characteristics of different packaging materials used for raw and processed fruits and vegetables products; bulk and retail packages; Modified atmosphere packaging, smart packaging; Packaging machines; Shrink packaging; Storage methods as low temperature storage, evaporatively cooled storage and controlled atmospheric storage.

Practice:

1. Study of different types of packaging materials; Study of CAS and MAP of vegetables,
2. Visit to fruit and vegetable processing/ spice processing plant.

Cornerstone Project

The cornerstone project in Post-Harvest Engineering of Horticultural Crops is intended to integrate theoretical knowledge with real time product development. Unlike laboratory experimentation, this cornerstone emphasizes problem definition, conceptual processing, product development, optimization, and performance analysis. Limited prototyping or measurements, where undertaken, are intended solely for validation and demonstration of developed value added food product. The project

enables students to address open-ended Food and Agricultural problems involving readily avalilable innovative food products.

Scope of Cornerstone Projects

Students shall select one of the following cornerstone project topics. Each project requires Product development procedure, optimization of process parameters, Quality analysis, and storage studies. Emphasis shall be placed on understanding the process under varying operating conditions and interpreting results accordingly.

Project 1: Development of osmotic dehydrated fruits

Project Objective

To develop and analyze the quality of osmotic dehydrated fruits.

Project Description

This project focuses on the application of Osmotic Dehydration as a preservation technique to reduce moisture content in fruits while maintaining their sensory and nutritional quality. Fruits are immersed in hypertonic sugar or salt solutions, allowing water removal through osmotic pressure while minimizing thermal damage. The study involves selecting suitable fruits, optimizing solution concentration, immersion time, and temperature to produce high-quality dehydrated products with extended shelf life.

Scope of Analysis

- Selection and preparation of raw fruits
- Optimization of osmotic solution concentration and process parameters
- Analysis of moisture loss and solid gain
- Evaluation of physicochemical properties (pH, TSS, water activity)
- Sensory evaluation (color, texture, taste, acceptability)
- Shelf-life studies and microbial stability
- Comparison with conventional drying techniques

Project 2: Development of sugar free millet based cookies.

Project Objective

To develop and evaluate the organoleptic quality of sugar free millet-based cookies.

Project Description

This project aims to develop functional bakery products using millets as a base and replacing refined sugar with alternative sweeteners. The study integrates nutritional benefits of millets with health-conscious formulations to cater to diabetic and fitness-oriented consumers. Various millet flours and sugar substitutes are tested to achieve desirable texture and taste.

Scope of Assessment

- Selection of millet varieties (e.g., Finger Millet, Pearl Millet)
- Formulation using natural or artificial sweeteners
- Dough rheology and baking optimization
- Nutritional analysis (fiber, protein, glycemic index estimation)
- Sensory evaluation (taste, texture, aroma, appearance)
- Shelf-life and storage stability
- Comparison with conventional cookies

Project 3: Optimization and development of healthy organic Tea

Project Objective

To identify the process parameters and optimize the perfect procedure to develop organic tea.

Project Description

This project involves the formulation and optimization of organic tea blends using natural ingredients such as herbs, spices, and tea leaves. The study emphasizes identifying optimal processing parameters (drying, blending ratios, infusion time) to maximize flavor, aroma, and health benefits while ensuring compliance with organic standards.

Scope of Assessment

- Selection of organic raw materials (tea leaves, herbs, spices)
- Optimization of blending ratios and drying conditions
- Evaluation of extraction efficiency during brewing
- Phytochemical analysis (antioxidants, polyphenols)
- Sensory profiling (flavor, aroma, color)
- Shelf-life and packaging studies
- Consumer acceptability testing

Project 4: Performing drying characteristics to vegetables for shelf-life extention

Project Objective

To dry vegetables under controlled conditions for preservation and reuse, at the time of food shortage.

Project Description

This project studies different drying techniques to preserve vegetables by reducing moisture content and inhibiting microbial growth. It evaluates drying kinetics and their impact on quality attributes, aiming to develop efficient drying protocols for long-term storage and food security applications.

Scope of Assessment

- Selection and pre-treatment of vegetables
- Application of drying methods (sun drying, tray drying, etc.)
- Study of drying kinetics and rate of moisture removal
- Evaluation of rehydration capacity
- Nutritional and physicochemical analysis
- Microbial load assessment
- Shelf-life evaluation under storage conditions

Project 5: Development of fortified squash (Beverage) from fruits

Project Objective

To fortify a fruit squash with highly nutritional ingredient to enhance its health benefit.

Project Description

This project focuses on developing a fruit-based squash enriched with functional or nutritional ingredients such as vitamins, minerals, or plant-based extracts. The goal is to enhance the health benefits of conventional beverages while maintaining acceptable taste, stability, and consumer appeal.

Scope of Assessment

- Selection of base fruit and fortifying agents
- Standardization of formulation and processing conditions
- Physicochemical analysis (pH, TSS, acidity, viscosity)
- Nutritional enhancement evaluation
- Stability studies (phase separation, color changes)
- Sensory evaluation and consumer acceptance
- Shelf-life and microbial safety assessment

Implementation Guidance:

1. Raw Material Selection

Choose fresh, high-quality raw materials (fruits, vegetables, millets, herbs) that are free from defects, contamination, and spoilage. Ensure uniformity in size, maturity, and variety to reduce variability in results.

2. Pre-Processing Operations
Carry out essential preliminary steps such as:

- Washing and cleaning
- Peeling, cutting, or slicing uniformly
- Blanching (if required for vegetables)
- Grinding or milling (for flour-based products)

3. Standardization of Formulation
Develop multiple trial formulations by varying ingredient ratios. Use a systematic approach (trial-and-error or experimental design) to identify the best combination based on desired quality attributes.

4. Process Optimization
Control and optimize key processing parameters such as:

- Temperature
- Time
- Concentration
- Drying or baking conditions

5. Controlled Experimental Conditions
Ensure all experiments are conducted under controlled and repeatable conditions. Maintain consistent environmental factors (temperature, humidity) to improve reliability of results.

6. Analytical Evaluation
Perform physicochemical analysis depending on the project:

- Moisture content
- pH and acidity
- Total soluble solids (TSS)
- Nutritional composition

7. Sensory Evaluation
Conduct organoleptic assessment using a semi-trained panel. Evaluate:

- Appearance
- Color
- Texture
- Taste
- Overall acceptability

8. Shelf-Life Studies
Store products under appropriate conditions (ambient/refrigerated) and monitor changes over time:

- Microbial growth
- Texture and flavor deterioration
- Chemical stability

9. Statistical Analysis

Analyze experimental data using statistical tools (mean, standard deviation, ANOVA if required) to validate results and identify significant differences between treatments.

11. Hygiene and Safety Practices

Follow strict food safety guidelines:

- Maintain clean equipment and workspace
- Use personal protective gear
- Avoid cross-contamination
- Adhere to basic principles of Food Safety.

Text Books:

1. **Fruits and Vegetable Preservation: Principles and Practices**, Srivastava, R.P. & Kumar, S. CBS Publishing, 3rd edition. ISBN: 8123924373.
2. **Food Science** by Potter N. and Hotchkiss J. H., An Aspen Publication, 5th edition. ISBN: 8123904726.

Reference Books:

1. **Fruits: Tropical and subtropical**, Bose T. K. & Mitre, S. K. Naya Prakash, 3rd edition. ISBN-13: 978-8185971810.
2. **Fruits and Vegetable processing**, Bhatti, S. and Varma U., 1st edition, CBS Publishers. ISBN: 9788123904047.

Web Links:

1. **https://onlinecourses.swayam2.ac.in/cec20_ag02/preview**
2. **http://ecoursesonline.iasri.res.in/course/view.php?id=164**

Note:

- The cornerstone project team size shall be 3 or 4 students.
- Students may select any one of the above prescribed projects or a project of their own choice with the prior permission of the Course instructor.
- The video presentation should consist of the working procedure of the project, along with the contribution of each student, for a minimum of 2 minutes.

Engineering Graphics and Design

Semester: VII	L	T	P	C
Course Code: 241AE041	0	0	2	2

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Ability to create and interpret 2D engineering drawings as per industry standards, including orthographic projections, sections, and detailed dimensioning.

CO2: Demonstrate the ability to design and develop 3D models of mechanical components using advanced CAD tools.

CO3: Apply knowledge to assemble mechanical parts in a virtual environment, ensuring proper constraints and relationships between components.

CO4: Perform static simulations to analyze and predict the behavior of engineering components under various load conditions.

CO5: Conduct motion analysis to simulate and evaluate the dynamic behavior of mechanical systems, providing insights into real-world functionality.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1										
CO2	3	2									
CO3	2	1	2								
CO4	2	1		2							
CO5	3	2									

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	3	-	-
CO2	2	-	-
CO3	1	-	-
CO4	1	-	-
CO5	3	-	-

INTEGRATED LAB WITH 2 CREDITS

Practice:

1. Overview of CAD Software interface and capabilities, Basic concepts in 3D modeling, Introduction to part modeling.
2. Introduction to sketching tools and constraints, Dimensioning and relations, Basic part features: Extrude, Revolve.
3. Advanced features: Sweep, Loft, Fillet, Chamfer, Editing features and design changes.
4. Introduction to assemblies, mates and assembly constraints.

5. Assembly tools: Patterns, Mirror, Interference detection and configurations in assemblies.
6. Basics of FEA (Finite Element Analysis), Introduction to static simulation in SolidWorks.
7. Different types of loads: Forces, pressures, torques, Boundary conditions: Fixed, roller/sliding.
8. Interpreting stress, displacement, and strain results, Factor of safety and design optimization.
9. Static simulation using contact sets and interactions.
10. Motion analysis of assemblies.
11. Guidelines for final project, Review of key concepts.
12. Presentation skills and report writing for engineering projects.

Additional Practice:
1. Calculation of linear, vector and trace path using motion analysis.

Cornerstone Project

The cornerstone project in Engineering Graphics and Design is intended to integrate theoretical knowledge with practical skills in manual engineering drawing, basic tool design, and visualization of agricultural equipment used in fundamental farming operations. This cornerstone focuses on developing the ability to represent and interpret agricultural tools through accurate 2D drawings and basic design concepts. Unlike CAD-intensive projects, this cornerstone emphasizes manual drafting techniques, standard drawing practices, and conceptual design of simple agricultural tools. Students will apply principles of engineering graphics to create detailed drawings of tools used in operations such as tilling, sowing, weeding, irrigation, and harvesting. The project enables students to understand the structure, function, and design aspects of commonly used agricultural tools, while improving their graphical communication, creativity, and problem-solving skills.

Scope of Cornerstone Projects

Students shall select cornerstone projects focused on the design and development of small-scale agricultural tools and equipment that improve efficiency, reduce manual effort, and support sustainable farming practices. Each project must involve engineering graphics, CAD modeling, and simulation-based validation.

Project 1: Plough (Primary Tillage Tool)

Project Objective

To design and represent a plough used in primary tillage tool for tillage operations and to analyze its functional characteristics through engineering drawing principles.

Project Description

The project involves conceptualizing a plough used for soil preparation after primary tillage. The tool consists of components such as blade, share, handle, and frame. The focus is on manual drafting and understanding soil interaction and tool geometry rather than fabrication.

Scope of Analysis

• Preparation of orthographic projections of the plough
• Detailed component and assembly drawings
• Proper dimensioning and sectioning
• Study of soil cutting and turning mechanism
• Basic ergonomic considerations

Project 2: Cultivator (Secondary Tillage Tool)

Project Objective

To design and represent a cultivator used for loosening soil and removing weeds during secondary tillage.

Project Description

The project involves conceptualizing a cultivator consisting of tines, frame, and handle arrangement. Emphasis is on manual drawing and understanding the working principle of soil stirring and weed removal.

Scope of Analysis

• Orthographic projections of the cultivator
• Component and assembly drawings
• Dimensioning and labeling
• Study of tine arrangement and soil interaction
• Evaluation of usability and efficiency

Project 3: Rotavator (Wet Land Preparation Tool)

Project Objective

To design and represent a rotavator used for wet land preparation and soil pulverization.

Project Description

The project involves conceptualizing a rotary tillage tool with blades mounted on a rotating shaft. Focus is on drawing representation and understanding the soil mixing mechanism.

Scope of Analysis

• Orthographic and sectional views
• Representation of rotating blade arrangement
• Dimensioning and detailing
• Study of soil pulverization mechanism
• Functional analysis of blade motion

Project 4: Sowing Implements

Project Objective

To design and represent a small-scale sowing implement for uniform seed placement.

Project Description

The project involves conceptualizing a hand-operated sowing device with hopper and seed dispensing mechanism. Emphasis is on manual drawing and functional understanding.

Scope of Analysis

• Orthographic projections of the implement
• Detailed component drawings
• Dimensioning and labeling
• Study of seed flow mechanism
• Ergonomic considerations

Project 5: Weeding Tools (Wheel Hoe / Khurpi)

Project Objective

To design and represent weeding tools used for removal of unwanted plants and soil loosening.

Project Description

The project involves conceptualizing tools like wheel hoe and khurpi with simple mechanical structure. Focus is on drawing accuracy and understanding manual operation.

Scope of Analysis

• Orthographic projections of tools
• Component-level drawings
• Proper dimensioning
• Study of cutting and uprooting mechanism
• Ease of handling and operation

Project 6: Spraying Tools

Project Objective

To design and represent spraying equipment used for application of fertilizers and pesticides.

Project Description

The project involves conceptualizing a manual spraying device consisting of tank and nozzle. Emphasis is on drawing and functional study.

Scope of Analysis

• Orthographic and sectional drawings
• Representation of components
• Dimensioning and labeling
• Study of spraying mechanism
• Functional evaluation

Project 7: Harvesting Tool (Sickle)

Project Objective

To design and represent a sickle used for manual harvesting operations.

Project Description

The project involves conceptualizing a simple cutting tool with curved blade and handle. Focus is on manual drafting and understanding cutting action.

Scope of Analysis

• Orthographic projections of the sickle
• Detailed blade and handle drawing
• Proper dimensioning
• Study of cutting mechanism
• Ergonomic evaluation

Implementation Guidance

i. Define the Problem Clearly

• Identify a specific problem related to agricultural tools (e.g., inefficient sowing, labor-intensive weeding).
• Explain its importance in terms of farming efficiency, cost, or ease of operation.
• Avoid selecting overly general or already well-optimized problems.

ii. Set Measurable Objectives

• Define 2–3 clear objectives for the selected tool.
• Each objective can be verified through drawings, calculations, or analysis.
• Focus on performance, usability, or design improvement.

iii. Review Existing Work

• Study traditional and modern agricultural tools related to the problem.
• Refer to standard designs, textbooks, or available resources.
• Identify limitations in existing tools to justify your proposed design.

iv. Develop the Engineering Model

• Define the working principle of the selected tool.
• Prepare design rules, proportions, and basic calculations if required.
• Clearly state assumptions, inputs (dimensions, forces), and expected outputs.

v. Implement Systematically

• Prepare neat manual engineering drawings (orthographic views, sections).
• Use proper drawing standards, dimensioning, and labeling.
• Maintain clear documentation of each step in the design process.

vi. Validate the Results
• Verify drawings with standard proportions or reference models.
• Cross-check dimensions and functionality of the tool.
• Ensure the design meets the intended agricultural application.

vii. Analyze and Interpret
• Explain how the tool performs its intended function.
• Discuss advantages, limitations, and possible improvements.
• Relate observations to the defined objectives.

viii. Conclude and Propose Next Steps
• Summarize key outcomes of the design and drawing work.
• Mention any constraints or simplifications made.
• Suggest improvements or modifications for better performance.

Text Books:

1. Rao P N. CAD/CAM Principles and Applications. McGraw-Hill Education Pvt. Ltd., New Delhi. ISBN:978-0070681934.
2. Sareen K and Grewal C D. CAD/CAM Theory and Practice. S. Chand & Company Ltd. New Delhi. ISBN:978- 8121928748.

Reference Books:

1. Mastering CAD/CAM with Engineering, Zeid Ibrahim. McGraw-HillEducation Pvt. Ltd. New Delhi. ISBN:978- 0070634343.
2. Principles of CAD/CAM/CAE Systems, Lee Kunwoo.Addison Vesley Longman, Inc. ISBN:978- 0201380361.

Web Links:

1. https://nptel.ac.in/courses/112/102/112102101/
2. https://www.wiziq.com/tutorials/engineering-drawing

Note:

- The cornerstone project team size shall be four (4) students.
- Students may select any one of the above prescribed projects or a project of their own choice with the prior permission of the Course instructor.
- The evaluation of the Cornerstone Project shall be based on the project implementation, oral presentation, 10-minute video presentation, report and viva voce.
- The video presentation should consist of the working procedure of the project along with contribution of each student for a minimum of 2 minutes.
- Finally, the Source code of the cornerstone Project has to be pushed into the Students GitHub repository (if applicable).

Food Quality and Safety

Semester: VII	L	T	P	C
Course Code: 241AE042	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Define and explain the basic concepts, objectives, and importance of food quality and safety, including quality and safety indices.
- **CO2:** Apply quality control tools and statistical methods to monitor and ensure food quality, and utilize appropriate sampling techniques and procedures for various food types.
- **CO3:** Measure food quality attributes such as color, flavor, viscosity, and texture using instrumental methods, and apply non-destructive techniques like NIR, FTIR, X-ray, CT, MRI, and ultrasound for quality inspection.
- **CO4:** Perform sensory evaluations using established methods, select and train sensory panels, and accurately interpret the results to assess food quality.
- **CO5:** Identify and manage food hazards, understand and implement food safety strategies and management systems (HACCP, GMP, etc.), and comply with national and international food laws and standards (FSSAI, ISO-22000, CAC).

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	0	-	-	-	1	2	-	-	-	-	-
CO2	0	0	-	1	1	-	1	-	-	1	-
CO3	0	-	1	1	-	-	2	-	-	2	-
CO4	2	-	-	-	2	2	2	-	-	-	-
CO5	1	2	2	2	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	1	-
CO2	-	2	-
CO3	-	2	-
CO4	-	2	-
CO5	-	2	-

UNIT – I

Fundamentals of Food Quality and Safety

Basics of food quality, safety and food analysis; Concept, objectives and need of food quality; definition, objective measurement of quality and quality and safety indices.

UNIT – II

Quality Control and Measurement

Quality control, quality control tools, statistical quality control; sampling (Chemical and Microbiological): purpose, sampling techniques, sampling procedures for liquid, powdered and granular materials.

Practice:

1. Study of statistical process control in food processing industry.
2. Study of sampling techniques, tools and protocols used in different types of food handling, processing, and marketing establishments.
3. Visit to a professional quality control laboratory.
4. Visit to food processing laboratory in an industry and study of records and reports maintained by food processing laboratory.

UNIT – III

Instrumental and Non-Destructive Methods

Instrumental method for testing food quality, measurement of colour, flavour, consistency, viscosity, texture and their relationship with food quality and composition; Non-destructive methods for evaluation of food quality. NIR, FTIR and chemometrics theory and application in food quality prediction. Theory and application of X-ray, CT, MRI, Ultrasound for internal quality inspection of fruits and vegetables. Sorting grading using external image analysis, internal biochemical analysis using spectroscopy.

Practice:

1. Determine the pH of any fruit beverage.
2. Determine the TSS of any fruit beverage.

UNIT – IV

Sensory Evaluation and Food Safety

Sensory evaluation methods, panel selection methods, interpretation of sensory results; food hazards and food safety, food borne infections, contaminants (physical, chemical, biological), adulteration, food safety strategies- Food Safety Management Systems, Good Agricultural Practices, Good Hygiene Practices, Good Manufacturing Practices, Total Quality Management, Total Quality Control; Hazards and Hazard Aanalysis Critical Control Points (HACCP), sanitation in food industry (SSOP).

Practice:

1. Determine the quality of fruits and vegetables using sensory evaluation techniques.
2. Detection of adulteration and examination of ghee for various standards of Agmark/FSSAI.
3. Detection of adulteration and examination of spices for Agmark/FSSAI standards.
4. Detection of adulteration and examination of milk and milk products for FSSAI standards.
5. Detection of adulteration in fruit products such as jam, jelly, marmalades as per FSSAI specification.

UNIT – V

Food Regulations and International Standards

Food Laws and Regulations, BIS, AGMARK, FSSAI; International Food Standards (ISO 22000, CAC); food recall, traceability; bio safety and bioterrorism; Sanitation in food industry.

Practice:

1. Study of registration process and licensing procedure under FSSAI; Examination of cereals, oilseeds, and pulses from go-downs and market shops in relation to specifications provided by standardization techniques.

Text Books:

1. Acharya K T. Everyday Indian Processed foods. National Book Trust. ISBN: 978-81-237-1035-8
2. Gupta V (Ed.). The Food Safety and Standards Act along with Rules & Regulations. Commercial Law Publishers (India) Pvt. Ltd. ISBN: 9789356038646

Reference Books:

1. Jha S N. Rapid Detection of Food Adulterants and Contaminants: Theory and Practice. Elsevier, USA, p266. ISBN: 9780124200845.
2. Mudambi S R, Rao S M and Rajgopal M V. Food Science. New Age International Publishers. ISBN: 978-8122417791.

Web Links:

1. http://ecoursesonline.iasri.res.in/course/view.php?id=185
2. http://www.fao.org/fao-who-codexalimentarius/en/

Watershed Planning and Management

Semester: VII	L	T	P	C
Course Code: 241AE043	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain concept, importance and characteristics of watershed.
CO2: Illustrate how to delineate, measure water yield from watershed and modes of people's participation.
CO3: Explain about budgeting of water and illustrate rainwater conservation and dry farming technologies.
CO4: Explain concept of Integrated watershed management and effects of cropping systems in a watershed.
CO5: Plan watershed management programme and cost-benefit analysis of watershed.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	1									
CO2							2				2
CO3	1				1		1				2
CO4	1						1				
CO5	1						1			1	

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	2
CO2	-	-	2
CO3	-	-	3
CO4	-	-	2
CO5	-	-	2

UNIT – I

Importance of Watershed Management

Watershed Management and Importance: Watershed- introduction and characteristics; Watershed management- concept, objectives, factors affecting watershed planning based on land capability classes, hydrologic data for watershed planning.

Practice:

1. Investigations on watershed for planning and development including PRA.
2. Analysis of hydrologic data for planning watershed management.

UNIT – II

Delineation of watershed

Watershed codification, delineation and prioritization of watersheds – sediment yield index Community mobilization and participatory institution building: participatory watershed management, role of watershed associations, user groups and self-help groups; Participatory Rural Appraisal, understanding gender in relation to agriculture.

Practice:

1. Delineation of watersheds using toposheets.
2. Surveying and preparation of watershed map.
3. Measurement of discharge and sediment in a watershed.
4. Prioritization of watersheds based on sediment yield index.

UNIT – III

Watershed management measures

Water budgeting in a watershed; Management measures - rainwater conservation technologies in-situ and ex-situ storage, water harvesting and recycling; Dry farming techniques - inter-terrace and interbund land management.

Practice:

1. Water budgeting of watersheds.
2. Study on components of earth embankments and its design.

UNIT – IV

Integrated watershed management

Integrated watershed management- concept, components, arable lands - agriculture and horticulture, non-arable lands- forestry, fishery and animal husbandry; Effect of cropping systems, land management and cultural practices on watershed hydrology; Use of remote sensing thematic maps and GIS in watershed planning.

Practice:

1. Study of thematic maps using remote sensing.
2. Study of watershed action plan using GIS.

UNIT – V

Watershed management projects

Watershed programme- execution, follow-up practices, maintenance, monitoring and evaluation; Planning and formulation of project proposal for watershed management programme including cost benefit analysis; Financial management and accounting procedure.

Practice:

1. Study of role of various functionaries in watershed development programmes.
2. Visit to watershed development project areas.

Text Books:

1. Hydrology and Soil Conservation Engineering: Including Watershed Management Ghanshyam Das. 2nd Edition, Prentice-Hall of India Learning Pvt. Ltd., N. ISBN: 978-8120335868.
2. Soil Conservation and Land Management. S. K. Datta, International Book Distr Dehradun. ISBN: 978- 8170892495.

Reference Books:

1. Soil and Water Conservation Engg. R. Suresh, Standard Publishers Distributors, Delhi-6, Reprint Edition. ISBN: 978- 8180141867.
2. Watershed Planning and Management. Singh, R.V. Yash Publishing House, Bikaner. ISBN: 978-8186882405.

Web Links:

1. http://ecoursesonline.iasri.res.in/course/view.php?id=10
2. https://nptel.ac.in/courses/105/101/105101010/

Sprinkler and Micro Irrigation Systems

Semester: VII	L	T	P	C
Course Code: 241AE044	1	0	1	2

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Assess the adaptability, problems, and prospects of different types of sprinkler irrigation systems.

CO2: Plan and design the layout of sprinkler irrigation systems, including the hydraulic design of lateral, sub-main, and main pipelines, and select appropriate pumps and power units.

CO3: Evaluate the performance of sprinkler irrigation systems by analyzing water distribution patterns, overlapping of sprinklers and laterals, uniformity coefficient, and pattern efficiency.

CO4: Explain the types, components, and advantages and disadvantages of micro irrigation systems (drip, spray, and bubbler), and design effective drip irrigation systems considering wetting patterns and irrigation requirements.

CO5: Perform proper operation and maintenance of micro irrigation systems, addressing issues like clogging, filter cleaning, flushing, and chemical treatment, and apply fertigation techniques, understanding their benefits, limitations, and best practices.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	0	-	-	-	1	-	-	-	-	-	-
CO2	2	0	1	-	2	-	-	-	-	-	-
CO3	0	-	-	-	1	-	-	-	-	-	-
CO4	2	-	1	-	2	-	-	-	-	-	-
CO5	-	2	-	-	1	1	-	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	2
CO2	-	-	2
CO3	-	-	2
CO4	-	-	2
CO5	-	-	2

UNIT – I

Introduction to Sprinkler Irrigation Systems

Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems;

Practice:

1. Field visit to a sprinkler irrigation project;

UNIT – II

Design and Components of Sprinkler Irrigation Systems

Design of sprinkler irrigation system: layout selection, hydraulic design of lateral, sub-main and main pipe line, design steps; Selection of pump and power unit for sprinkler irrigation system;

Practice:

1. Study of different components of sprinkler irrigation system;
2. Design and installation of sprinkler irrigation system;
3. Study of cost economics of sprinkler irrigation system;
4. Study on maintenance of sprinkler irrigation system;
5. Field visit to study foggers.

UNIT – III

Performance Evaluation and Micro Irrigation Systems

Performance evaluation of sprinkler irrigation system: water distribution pattern and overlapping of sprinklers and laterals, uniformity coefficient and pattern efficiency; Micro Irrigation systems: types- drip, spray, & bubbler systems, merits and demerits, different components.

Practice:

1. Study of wetting pattern of a sprinkler and requirement for overlapping of sprinkler.
2. Study of discharge and uniformity coefficient.
3. Field visit to micro irrigation system and evaluation of drip system.

UNIT – IV

Design and Operation of Drip Irrigation Systems

Design of drip irrigation system: general considerations, wetting patterns, irrigation requirement, emitter selection; Hydraulics of drip irrigation system, design steps; Necessary steps for proper operation of a drip irrigation system, maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment.

Practice:

1. Study of different components of drip irrigation.
2. Design and installation of drip irrigation system.
3. Determination of pressure discharge relationship and emission uniformity for given emitter.
4. Study of different types of filters and determination of filtration efficiency.
5. Study on removal of clogging of emitters.
6. Study on maintenance of drip irrigation system.
7. Study of cost economics of drip irrigation system.

UNIT – V

Fertigation in Micro Irrigation Systems

Fertigation: advantages and limitations of fertigation, fertigation frequency, duration and injection rate, methods of fertigation.

Practice:

1. Study of fertigation, types of liquid fertilisers, determination of rate of injection and calibration for chemigation/ fertigation.
2. Design of irrigation and fertigation schedule for crops.

Text Books:

1. Mane M S and Ayare B L. Principles of Sprinkler Irrigation system. Jain Brothers, New Delhi.ISBN: 978-8183600774.
2. Michael A M. Irrigation: Theory and Practice. Vikas Publishing, New Delhi. ISBN:978-8124927761.

Reference Books:

1. Suresh R. Micro Irrigation - Theory and Practices. Standard Publishers Distributors, Delhi. ISBN:978-8180141508.
2. Sivanappan R K. Sprinkler Irrigation. Oxford & IBH Publishing House, New Delhi. ISBN: 978-8120402324.

Web Links:

1. http://agritech.tnau.ac.in/agricultural_engineering/agriengg_swc_microirri_ferti.html
2. Course: Micro Irrigation Systems Design 3(2+1) (iasri.res.in)

Machine Design

Semester: VII	L	T	P	C
Course Code: 241AE045	2	0	0	2

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain the basic concept of machine design.
CO2: Design of shafts under torsion and combined bending and torsion.
CO3: Examine basic principles in designing of cotter joint, knuckle joint.
CO4: Differentiate bolted joints loaded in shear and subjected to eccentric loading.
CO5: Identify bearings used in machine design.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3										
CO2	1	2	3		1						
CO3	3	1	2	2							
CO4	2	2		1	3						
CO5	3				1						

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	2	-	-
CO2	3	-	-
CO3	3	-	-
CO4	3	-	-
CO5	2	-	-

UNIT – I
Introduction to Machine Design
Phases of design, design considerations; Common engineering materials and their mechanical properties; Types of loads and stresses, theories of failure, factor of safety.

UNIT – II
Design of Shaft
Selection of allowable stress, stress concentration, elementary fatigue and creep aspects; Design of shafts under torsion and combined bending and torsion.

UNIT – III
Design of Keys, Coupling Joints
Design of keys; Design of muff, sleeve, and rigid flange couplings; Cotter joints, design of socket and spigot cotter joint; knuckle joint.

UNIT – IV
Design of welded and bolted joints

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

UNIT – V

Design of Transmission unit & springs

Design of flat belt and V-belt drives and pulleys; Design of gears; Selection of anti-friction bearings Design of helical and leaf springs.

Text Books:

1. A Text Book of Machine Design. Khurmi R S and Gupta J K., S. Chand & Company Ltd., New Delhi. ISBN: 978-8121924372.
2. Machine Design. Jain R K., Khanna Publishers, 2-B Nath Market, Nai Sarak, New Delhi. ISBN: 978-81-7409-314-1.

Reference Books:

1. Design of machinery. Norton, R. L., & McCarthy, J. M. ISBN: 978- 0072423518.
2. Fundamentals of machine component design. Juvinall, R. C. ISBN: 978-1118012895.

Web Links:

1. https://nptel.ac.in/courses/112/105/112105124/
2. htttp://ecoursesonline.iasri.res.in/course/view.php?id=521

Electrical Machines

Semester: VII	L	T	P	C
Course Code: 241AE046	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain the concepts of magnetic circuits in the machines.
CO2: Analyze the performance of single-phase transformers.
CO3: Analyze the performance of DC machines by conducting various tests on DC machines.
CO4: Analyze the performance of single-phase induction motor.
CO5: Analyze the performance of three-phase induction motor.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2							1	1	
CO2	2	3	2	1					1	1	
CO3	3	2	2						1	1	
CO4	3	2							1	1	
CO5	2	3	2						1	1	

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	2	1	1
CO2	2	1	1
CO3	3	2	1
CO4	2	2	1
CO5	2	2	2

UNIT – I
Magnetic circuits
Concept of magnetic flux production, magneto motive force, reluctance, laws of magnetic circuits, determination of ampere-turns for series and parallel magnetic circuits, hysteresis and eddy current losses.

UNIT – II
Single phase Transformers
Principle of working, construction of single-phase transformer, EMF equation, phasor diagram with and without load, voltage regulation, efficiency, open circuit and short circuit tests.

UNIT – III
DC Machines
Principles operation and performance of DC machine (generator and motor), EMF and torque equations, excitation of DC generator and their characteristics, DC motor

characteristics, starting of shunt and series motor, starters, speed control methods (field and armature control).

UNIT – IV

Single Phase Induction Motor

Principle of operation, double field revolving theory, equivalent circuit, methods of starting, phase split, shaded pole motors, performance characteristics.

UNIT – V

Three Phase Induction Motor

Construction, operation, types, concept of slip; slip speed and slip frequency, torque equation, torque-speed and torque-slip characteristics, maximum torque for starting and running condition.

INTEGRATED LAB WITH 2 CREDITS

Practice:

1. Perform open circuit test on a single-phase transformer and determine its open circui parameters and iron losses.
2. Perform short circuit test on a single-phase transformer and determine copper losses equivalent circuit parameters, voltage regulation and efficiency.
3. Perform a test on DC shunt motor to control the speed using flux control method.
4. Perform a test on DC shunt motor to control the speed using armature voltage contro method.
5. Determine the performance curves of DC shunt motor using brake test.
6. Determine the load characteristics of DC Shunt generatorby conducting load test.
7. Determine the no load losses of 3- phase induction motor by conducting noloadtest.
8. Determine the full load losses and equivalent circuit parameters of 3-phase inductio motor by conducting blocked-rotor test.
9. Perform no load test on1-phase induction motor to determine its no-load losses.
10. Perform blockedrotor test on 1-phase induction motor and determine the equivalen circuit parameters.

Additional Practice:

1. Plot the torque-speed characteristic of 1-phase induction motor by conducting load-test.
2. Measure the start and run voltage and currents of 3-phase induction motor using star-delt starter.
3. Study different parts of DC/AC machines.

Text Books:

1. Electrical Machinery by P.S. Bhimbra, Khanna Publications, 7th edition. ISBN: 978-8174091734.
2. Electrical Machines by D. P. Kothari, I. J. Nagarth, McGraw Hill Publications, 5th edition. ISBN: 978- 9352606405.

Reference Books:

1. Electrical Machinery by Abijith Chakrabarthi and Sudhipta Debnath, McGraw Hill, 1st edition. ISBN: 978- 1249006456.
2. Basic Electrical Engineeringby Anwani M L., Dhanpat Rai & Co. (P) LTD, New Delhi. ISBN: 978- 8177000191.

Web Links:

1. https://nptel.ac.in/courses/108106071
2. https://archive.nptel.ac.in/courses/108/105/108105131/

Agricultural Statistics and Data Analysis

Semester: VII	L	T	P	C
Course Code: 241AE047	1	0	1	2

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Identify the data types,construct the frequency table and visualize using graphs and charts.
CO2: Compute the various Measures of central tendency.
CO3: Describe the basic concepts of probability.
CO4: Explain the probability distributions.
CO5: Apply the sampling techniques and study the testing of hypothesis.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2			1						
CO2	3	2			1						
CO3	3	2			1						
CO4	3	2			1						
CO5	3	2			1						

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	2	2	2
CO2	2	2	2
CO3	2	2	2
CO4	2	2	2
CO5	3	3	3

UNIT – I

Introduction to Statistics: Definition, advantages and limitations; Data- types of data, quantitative and qualitative; variable - discrete and continuous; Frequency distribution table: construction of frequencydistribution table (inclusive and exclusive)- number of classes, length of class, tally marks, frequency,class midpoint, cumulative frequencies, frequency curves, graphs and charts.

Practice (Using any computational tool):

1. Construction of frequency distribution tables
2. Construction of frequency curves and graphs.

UNIT – II

Measures of central tendency: Definition, characteristics of ideal average, different measures;arithmetic mean, median, mode, geometric mean and harmonic mean for grouped & ungrouped data,merits and demerits;

Measures of dispersion: Definition, different measures (absolute & relative);range, quartile deviation, mean deviation, standard deviation (SD), variance and coefficient ofvariation

Practice (Using any computational tool):

1. Computation of arithmetic mean, median and mode for un-grouped and grouped data
2. Computation of standard deviation (SD), Variance and coefficient of variation for un-grouped and grouped data

UNIT – III

Probability: Definition and concept of probability; Random variable: concept of random variable and expectation; Simple linear correlation: concept, Definition, types and its properties; Simple linearregression: concept, Definition and its properties.

Practice (Using any computational tool):

1. Calculation of correlation coefficient and its testing.
2. Calculation of regression coefficient, regression line

UNIT – IV

Probability Distributions :Normal distribution: Definition, density function,curve, properties, standard normal distribution (SND), properties including area under the curve (without proof); Binomial distribution: definition, density function and properties; Poisson distribution: definition, density function and properties

Practice (Using any computational tool):

1. Computation of binomial distribution
2. Computation of Poisson distribution

UNIT – V

Sampling and Testing of Hypothesis: Introduction to sampling: Definition of statistical population, sample, random sampling, parameter, statistic, sampling distribution, concept ofstandard error of mean;

Testing of hypothesis – hypothesis, null hypothesis, types of hypothesis, level of significance, degreesof freedom – statistical errors; Large Sample test (Z-test), small sample t-test (one tailed, two tailedand paired tests); Testing of significance through variance (F-test), Chi-square test: goodness of fit &testing of independence of attributes (2x2 contingency table)

Practice (Using any computational tool):

1. Standard normal distribution test for single samplemean (population SD known & unknown)
2. SND test for two samples means (population SD known &unknown)
3. Student'st-test for single sample mean, two sample means
4. F– test for equality for twosample variance test
5. Computation of Chi-square test: goodness of fit

Text Books:

1	A Text Book of Agricultural Statistics ,Rangaswamy R. . New Age Int. publications Ltd.2018. ISBN: 9788122407587.
2	Fundamental Applied Statistics. Sultan ,Gupta S C and Kapoor V K. 2019. Chand & Sons.ISBN: 978-81-8054-705-8.

Reference Books:

1. A Hand book of Agricultural Statistics ,Chandel S R S.. Achal Prakasan Mandir, Kanpur. ISBN: 9780012499754.
2. Statistics for Agricultural Sciences ,Nageswara Rao G.BS Publications. ISBN :9789387593886.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc21_ma74/preview
2. http://mathworld.wolfram.com/topics/ProbabilityandStatistics.html
3. https://onlinecourses.nptel.ac.in/noc20_cs46/preview
4. https://www.geeksforgeeks.org/statistics-with-python/
5. https://www.coursera.org/learn/inferential-statistical-analysis-python?specialization=statistics-with- python

Electives

Mechanics of Tillage and Traction

	L	T	P	C
Course Code: 241AE050	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain the fundamental concepts of tillage tools and engineering properties of soil.
CO2: Analyze soil perameters related to puddling and flotation.
CO3: Explain draft, slip and sinkage under different soil conditions.
CO4: Evaluate traction mechanics,load and fuel consumption of form operations.
CO5: Assess the impact of soil compaction on plant growth and utilize GIS for precision soil management.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2		4							
CO2	3	2	2								
CO3	2	3	1								
CO4	3			2	1						
CO5	2			1	3						

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	1	-	-
CO2	2	-	-
CO3	1	-	-
CO4	2	-	-
CO5	1	-	-

UNIT – I

Introduction to Mechanics of Tillage Tools and Soil Properties

Fundamental concepts of tillage tools and the engineering properties of soil. It covers the various types of tillage tools, their functions, and how they interact with different soil types. Key soil properties such as texture, structure, density, porosity, moisture content, shear strength, and plasticity will be discussed. Additionally, the principles and concepts underlying soil mechanics, including stress-strain relationships and the Mohr-Coulomb theory, will be examined.

Practice:

1. Measure and analyze static soil properties such as texture, density, moisture content, and porosity.
2. Measurement of dynamic soil parameters.

UNIT – II

Soil Parameters Related to Puddling and Flotation

Soil parameters related to puddling and flotation. Puddling, manipulation wet soil to create a smooth, impervious layer for, crop cultivation. Flotation with soil's bearing capacity and its resistance to sinkage under different moisture conditions, affecting machines performance and crop growth.

Practice:

1. Analyze soil parameters that affect puddling in wet soil conditions.
2. Evaluate soil parameters influencing flotation under different soil moisture levels.

UNIT – III

Draft, Slip, and Sinkage Analysis

Draft requirements of various tillage tools, including passive, rotary, and oscillating tools. The analysis of slip and sinkage under different soil conditions (dry and wet) and their implications on tool performance and soil structure.

Practice:

1. Measure the draft required for different passive tillage tools in dry soil conditions.
2. Evaluate the draft force for rotary and oscillating tillage tools.
3. Analyze wheel slip and sinkage in dry soil conditions.
4. Study wheel slip and sinkage in wet soil conditions.

UNIT – IV

Load, Fuel Consumption, and Tractor Stability

Load and fuel consumption of various farm operations, principles of weight transfer and tractor loading, and their impact on efficiency and performance. Use of traction aids and their effects on tractor stability and operation.

Practice:

1. Measure the load and fuel consumption for various farm operations such as ploughing, harrowing, and planting.
2. Study weight transfer and loading patterns on tractors.
3. Evaluate the impact of traction aids like dual tires, tracks, and ballast weights on tractor performance.

UNIT – V

Tyres, Tracks, and Soil Compaction

Explores the role of tires, tracks, and treads in agricultural machinery performance under different soil conditions. It examines the effects of soil compaction on plant growth and the strategies to mitigate compaction through appropriate tire and track selection and field operations. The application of GIS in soil management for precision agriculture is also discussed.

Practice:

1. Study various tires, tracks, and treads to understand their performance in different soil conditions.

Text Books:

1. Brixius, W.W. Tillage Machinery Design. American Society of Agricultural and Biological Engineers. ISBN: 978-3-0365-7295-6.
2. Upadhyaya, S.K., & McKyes, E. Soil Cutting and Tillage. American Society of Agricultural Engineers. ISBN:978-0444424485.

Reference Books:

1. Gill, W.R., & Vanden Berg, G.E. Soil Dynamics in Tillage and Traction. Agricultural Research Service, U.S. Department of Agriculture. ISBN:978-8172338039.
2. Söhne, W. Fundamentals of Pressure Distribution and Soil Compaction under Tractor Tires. Agricultural Engineering. ISBN: 58A0017839.

Web Links:

1. American Society of Agricultural and Biological Engineers (ASABE).
2. International Society for Terrain-Vehicle Systems (ISTVS).

Farm Machinery Design and Production

	L	T	P	C
Course Code: 241AE051	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain the basic concept of machine design.
CO2: Apply principles of design to mechanical power transmission elements.
CO3: Apply principles for in designing farm machinery and implements.
CO4: Explain the advanced manufacturing techniques by CNC tools and finishing tools.
CO5: Explain Industrial lay-out planning.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3										
CO2	1	2	3		1						
CO3	2	2	1		3					2	
CO4		1	2	2							1
CO5		2		1							

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	2	-	-
CO2	2	-	-
CO3	3	-	-
CO4	2	-	-
CO5	2	-	-

UNIT – I

Introduction to design parameters

Introduction to design parameters of agricultural machines & design procedure, characteristics of farm machinery design, research and development aspects of farm machinery.

Practice:

1. Familiarization with different design aspects of farm machinery and selected components.
2. Visit to agricultural machinery manufacturing industry, tractor manufacturing industry.

UNIT – II

Design of Power Transmission

Design of standard power transmission components used in agricultural machines: mechanical & hydraulic units; Introduction to safety in power transmission; Application of design principles to the systems of selected farm machines such as design of disc plough, cultivator, seed drill.

Practice:

1. Solving design problems on disc plough.
2. Solving design problems on cultivator.
3. Solving design problems on seed drill.

UNIT – III

Design of Harvesting and Threshing Machines

Application of design principles to the systems of selected farm machines such as design reaper, thresher and digger; Critical appraisal in production of agricultural machinery, advances in material used for agricultural machinery.

Practice:

1. Solving design problems on thresher.

UNIT – IV

Advanced Cutting Tools

Heat treatment of steels including pack carburizing, shot pining process, etc., limits, fits & tolerances, jigs & fixtures; Cutting tools including CNC tools and finishing tools.

Practice:

1. Case study for manufacturing of simple agricultural machinery.
2. Study of jigs and fixtures in relation to agricultural machinery.
3. Study of fits, tolerances and limits.

UNIT – V

Industrial lay-out planning

Industrial lay-out planning, quality production management, reliability; Economics of process selection, familiarization with project report.

Practice:

1. Layout planning of a small scale industry.
2. Problems on economics of process selection.
3. Preparation of a project report.

Text Books:

1. Farm Machinery Design Principles & Problems by Sharma D N, Jain Bros. ISBN: 978-8183601429.
2. Richey, C.B. Agricultural Engineering Handbook. ISBN: 978-0070526174.

Reference Books:

1. Design of machine elements, by Bhandari, McGraw Hill Education India Private Limited; Fourth edition. ISBN-13. 978-9339221126.
2. Chakrabarti NR. Data book for Machine Design. *ISBN:* 978-9387593879.

Web Links:

1. Agricultural machinery chapter 1 (slideshare.net)
2. Farm-Power-and-Machinery.pdf (agrimoon.com)

Tractor Design and Testing

	L	T	P	C
Course Code: 241AE052	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain stability and weight distribution of tractor.
- **CO2:** Analyze and design the traction systems, hydraulic lift, hitch systems.
- **CO3:** Evaluate and design clutch systems and steering mechanisms for agricultural tractors.
- **CO4:** Select appropriate engine components based on special design features.
- **CO5:** Design ergonomic seats, conduct comprehensive tractor testing.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	3								
CO2	3	3	2								
CO3	3	2	3		2						
CO4	3		2								2
CO5	2	2	3					2			

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	3	-	-
CO2	2	-	-
CO3	1	-	-
CO4	2	-	-
CO5	3	-	-

UNIT – I

Design and development of agricultural tractor

Procedure for design and development of agricultural tractor; Study of parameters for balanced design of tractor for stability & weight distribution.

Practice:

1. Visit to tractor testing centre/ industry.
2. Selection of tractor tires.
3. Determining the turning space, turning radius and brake test.

UNIT – II

Design of Hydraulic and Transmission System

Traction theory, hydraulic lift and hitch system design; Design of mechanical power transmission in agricultural tractors.

Practice:

1. Design of gear box (synchromesh/constant mesh).
2. Variable speed constant mesh drive.

3. Design and selection of hydraulic pump.
4. Hydraulic pump performance test and air cleaner and noise measurement test.

UNIT – III:

Design of Clutch and Steering systems.

Single disc, multi disc and cone clutches; Rolling friction and anti-friction bearings; Design of Ackerman Steering and tractor hydraulic steering.

Practice:

1. Design problem of tractor clutch (single/multiple disc clutch).
2. Problem on design of governor.

UNIT – IV

Study of special design features of tractor

Study of special design features of tractor engines and their selection, viz. cylinder, piston, piston pin, crankshaft, etc.,

Practice:

1. Engine testing as per BIS code.

UNIT – V

Design of Tractor seat

Design of seat and controls of an agricultural tractor; Tractor Testing..

Practice:

1. Drawbar performance in the lab.
2. PTO test and measure the tractor power in the lab/field.

Text Books:

1. Liljedahl J B, Turnquist P K, Smith D W and Hoki M. Tractors and their Power Units. CBS Publishers and Distributors Pvt. Ltd. ISBN:978-8123905013.
2. Singh K. Automobile Engineering – Vol I and Vol II. Standard Publishers and Distributors. New Delhi. ISBN:978-8180142420.

Reference Books:

1. Richey C B. Agricultural Engineering Handbook. McGraw-Hill Inc., US. ISBN-13. 978-0070526174.
2. Mehta M L, Verma S R, Mishra S K and Sharma V K. Testing & Evaluation of Agricultural Machinery. National Agricultural Technology Information Centre. Ludhiana. ISBN:978-8170354161.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc24_ag03/preview
2. https://agrimoon.com/wp-content/uploads/FARM-POWER-AND-MACHINERY.pdf

Hydraulic Drives and Controls

	L	T	P	C
Course Code: 241AE053	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain the basic principles of hydraulics and their applications in hydraulic systems.
CO2: Design and analyze hydraulic circuits and components, including pumps, actuators, and valves.
CO3: Identify troubleshoot problems in hydraulic systems and suggest appropriate remedial actions.
CO4: Interpret hydraulic circuit diagrams and ensure compliance with industry standards and symbols.
CO5: Apply hydraulic and pneumatic technologies to enhance the efficiency and productivity of agricultural systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2		1							
CO2	3	3	2								
CO3		2	3	1							
CO4	1		2	3							
CO5	2	3	1	3							

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	3	-	-
CO2	2	-	-
CO3	2	-	-
CO4	1	-	-
CO5	3	-	-

UNIT – I

Fundamentals of Hydraulics

The foundational principles of hydraulics Pascal's Law, flow, energy, work, and power. Basic hydraulic systems and components. Reservoirs, strainers, filters, filtering materials, and elements. Role of accumulators, pressure gauges, and volume meters in maintaining system efficiency.

Practice:

1. Introduction to hydraulic systems
2. Study of hydraulic pumps

UNIT – II

Hydraulic Components and Circuit Design

Design and operation of hydraulic circuits. Hydraulic fittings and connectors, pumps and classifications (gear, vane, and piston pumps), and their performance and displacement characteristics. Design, construction, and application of pumps. Hydraulic actuators, including cylinders, motors, and their construction, applications, and maintenance.

Practice:

1. Study of hydraulic actuators
2. Study of hydraulic motors

UNIT – III

Hydraulic Control and Valve Systems

Types of hydraulic valves, including pressure-control, directional-control, and flow-control valves. Valve installation, potential failures, troubleshooting techniques, and valve assembly processes. Practical applications and ensuring system reliability through proper valve management.

Practice:

1. Study of hydraulic valves
2. Study of valve installation and troubleshooting

UNIT – IV

Hydraulic Circuit Diagrams and Standards

Interpretation of hydraulic circuit diagrams, USA Standards Institute (USASI) symbols. Design analysis of circuits, comparision industry standards. Creating and troubleshooting hydraulic circuits using standard symbols and conventions.

Practice:

1. Study of color coding in hydraulic circuits
2. Study of building simple hydraulic circuits
3. Study of hydraulic circuit diagrams

UNIT – V

Agricultural Applications of Hydraulics in Agriculture

Application of hydraulic and pneumatic systems in agricultural machinery, including tractor hydraulics and nudging systems. of Automatic Draft and Depth Control (ADDC). Various hydraulic and pneumatic drives used in agricultural systems. Implementation and benefits of these technologies in modern agriculture.

Practice:

1. Study of hydraulics in tractors
2. Study of introduction to pneumatics
3. Study of pneumatics in agriculture

Text Books:

1. Esposito, Anthony. Fluid Power with Applications. Pearson Education.ISBN: 978-013511366904.
2. Majumdar, S.R. Oil Hydraulic Systems: Principles and Maintenance. Tata McGraw-Hill Education. ISBN:978-0074637487.

Reference Books:

1. Johnson, R. Introduction to Fluid Power. Cengage Learning. ISBN: 978-0766823655.
2. Parr, Andrew. Hydraulics and Pneumatics: A Technician's and Engineer's Guide Elsevier.ISBN:978-0080966748.

Web Links:

1. Hydraulic System Basics
2. Introduction to Hydraulics for Industry Professionals

Human Engineering and Safety

	L	T	P	C
Course Code: 241AE054	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Identify human factors in system development.
CO2: Explain about the information input processes.
CO3: Explain human control of systems.
CO4: Explain anthropometric principles for work space design.
CO5: Demonstrate safety measures using different machines.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1			1						
CO2	3	2				1					
CO3	3	2			1						
CO4	2		3								
CO5	3	2					1				

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	1	2	1
CO2	2	2	1
CO3	2	2	1
CO4	3	2	1
CO5	2	2	1

UNIT – I
Human factors in system development
Human factors in system development concept of systems, basic processes in system development, performance reliability, human performance.
Practice:
1. Calibration of the subject in the laboratory using bi-cycle ergo-meter.
2. Study and calibration of the subject in the laboratory using mechanical treadmill.

UNIT – II
Information input process
Information input process, visual displays, major types and use of displays, auditory displays; Speech communications.
Practice:
1. Use of respiration gas meter from human energy point of view.
2. Use of heart rate monitor.

UNIT – III

Biomechanics

Biomechanics of motion, types of movements, range of movements, strength and endurance, speed and accuracy, human control of systems; Human motor activities, controls, tools and related devices.

Practice:

1. Familiarization with the noise measurements.
2. Familiarization with the vibration equipment.

UNIT – IV

Anthropometry

Anthropometry arrangement and utilization of work space, atmospheric conditions, thermo-regulation in human, thermal comfort, environmental factors, air pollution.

Practice:

1. Study of general fatigue of the subject using Blink ratio method.
2. Anthropometric measurements of a selected subject.
3. Optimum work space layout and locations of controls for different tractors.
4. Case study on design of work space.

UNIT – V

Regulation, Safety, and Rehabilitation for Agricultural Machinery and Operations

Dangerous machine (Regulation) act, rehabilitation and compensation to accident victims; Safety gadgets for spraying, threshing, chaff cutting and tractor & trailer operation, etc.

Practice:

1. Familiarization with safety gadgets for various farm machines.
2. Studies on drudgery of farm women in manual drawn equipment.

Text Books:

1. Chapanis A. Human Factors in System Engineering. John Wiley & Sons, New York. ISBN: 978-0471-13782-5.
2. Dul J and Weerdmeester B. Ergonomics for Beginners. A Quick Reference Guide. Taylor and Francis, London. ISBN: 0-203-21209-6.

Reference Books:

1. Mathews J and Knight A A. Ergonomics in Agricultural Equipment Design. National Institute of Agricultural Engineering. ISBN: 9780850040098.
2. Mark S S and McCormick E J. Human Factors in Engineering and Design. Mc Hill Corporation, New York. ISBN: 978-0070549012.

Web Links:

1. ag-ergo.ucdavis.edu/.
2. https://nptel.ac.in/courses/107103004/www.ansi.org.

Precision Agriculture and System Management

	L	T	P	C
Course Code: 241AE055	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain the principles and need for precision agriculture and its impact on resource conservation.
- **CO2:** Demonstrate the use and maintenance of various precision agriculture equipment.
- **CO3:** Apply GIS technology for spatial data analysis and decision-making in agriculture.
- **CO4:** Utilize sensors for data generation and integrate this data into farm management systems.
- **CO5:** Implement system approaches and techniques like PERT and CPM for effective farm machinery management.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1	2							
CO2	2	3	2	1							
CO3	3	2	1	2							
CO4	2	3	2	1							
CO5	3	2	1	2							

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	2	-	2
CO2	2	-	2
CO3	2	-	2
CO4	2	-	2
CO5	2	-	2

UNIT – I

Introduction to Precision Agriculture

Precision agriculture to enhance crop yield and efficiency. Need for precision agriculture, optimizing the use of inputs to increase productivity and sustainability. Integration of various technologies like GPS, GIS, and sensors to monitor and manage farm operations. Problems related to natural resources, emphasizing sustainable practices and resource conservation.

Practice:

1. Identifying the precision agriculture problems and issues
2. Study of resource conservation machines

UNIT – II

Equipment for Precision Agriculture

Types of equipment used in precision agriculture. Operation and application of sowing and planting machines, power sprayers. Laser-guided land levelers, straw-choppers, straw-

balers, and grain combines. Technical specifications, usage and maintenance of machines to ensure efficient agricultural practices.

Practice:

1. Familiarization with various machines for resource conservation
2. Solving problems related to machine capacities and efficiency patterns

UNIT – III

GIS-Based Precision Agriculture and Applications

Geographic Information Systems (GIS) and their role in precision agriculture. GIS technology for collect, manage, and analyze spatial and geographic data to improve agricultural decision-making. Applications of GIS in soil mapping, crop monitoring, yield prediction and importance in modern agriculture.

Practice:

1. Estimation cost analysis in precision agriculture
2. Identifiying problems related to equipment selection and replacement

UNIT – IV

Sensors and Data Generation in Precision Agriculture

Types of sensors used in precision agriculture, including soil moisture sensors, temperature sensors, and nutrient sensors. Application sensors for real-time data generation and utilized to optimize farming practices. Integration of sensors data into farm management systems.

Practice:

1. Analyzing inflation and its impact on precision agriculture
2. Evaluating break-even analysis in agricultural equipment
3. Application of sensors for farming practices

UNIT – V

Farm Machinery Management and Optimization

System approach in farm machinery management. Selection, maintenance, and scheduling of operations. Application of Project Evaluation and Review Technique (PERT) and Critical Path Method (CPM) in machinery system management. Problems related to machinery selection and operational planning to enhance efficiency and productivity in agricultural operations.

Practice:

1. Understanding the time value of money in farm machinery management
2. Integrating system limitations into precision agriculture solutions
3. Maintenance and scheduling of farm machinery

Text Books:

1. Precision Agriculture by John V. Stafford. ISBN: 9781351114592.
2. Fundamentals of Agricultural and Field Robotics by Manoj Karkee, Qin Zhang. ISBN:978-3030703998.

Reference Books:

1. Precision Agriculture Technology for Crop Farming by Qin Zhang. ISBN: 978-1482241074.
2. Precision Agriculture for Sustainability and Environmental Protection by Margaret Oliver, Thomas Bishop, Ben Marchant. ISBN:978-1138364158.

Web Links:

1. Precision Agriculture from the USDA
2. Precision Agriculture Research at Purdue University

Photovoltaic Technology and Systems

	L	T	P	C
Course Code: 241AE056	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain the fundamental principles and current status of solar PV technology, and conduct a SWOT analysis of PV systems.
- **CO2:** Analyze the structure and function of solar PV modules and arrays, and understand the impact of environmental factors on their performance.
- **CO3:** Design and estimate the cost of solar PV systems for various applications.
- **CO4:** Evaluate the types and characteristics of batteries and charge controllers used in solar PV systems.
- **CO5:** Apply knowledge of solar PV systems to real-world applications, including home lighting, water pumping, and integration into smart grids.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2			2						
CO2	3	2	3	2							
CO3	2	3	3		2						
CO4	3	2		2							
CO5	2		2	2	3						

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	3	-	1
CO2	3	-	1
CO3	2	-	1
CO4	1	-	1
CO5	2	-	1

UNIT – I

Introduction to Solar PV Technology

Fundamental aspects of solar photovoltaic (PV) technology. Advantages, limitations, and the current status of PV technology globally. SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) of PV technology. Different types of solar cells, wafer-based silicon cells, thin-film amorphous silicon cells, thin Cadmium Telluride (CdTe) cells, Copper Indium Gallium Selenide (CIGS) cells, and thin-film crystalline silicon solar cells.

Practice:

1. Measurement and Analysis of V-I Characteristics of a Solar PV Module
2. Conducting a SWOT Analysis of Solar PV Technology

UNIT – II

Solar Photovoltaic Modules and Systems

Components and configurations of solar PV modules and systems. Structure and function of a solar cell, solar module, and solar array. Series and parallel connections of cells, mismatch in cells, and the concept of fill factor. Effects of solar radiation and temperature on the power output of modules, I-V and power curves. Balance of system (BoS) components.

Practice:

1. Investigation of series and parallel connections of solar cells
2. Impact of solar radiation and temperature on solar pv module performance
3. Plotting and analyzing the I-V and power curves of a solar PV module

UNIT – III

Solar PV System Design and Cost Estimation

Design principles and cost estimation for solar PV systems. Sizing and designing solar PV systems for various applications. Cost estimation techniques for both small-scale and large-scale solar PV installations.

Practicals:

1. Design and implementation of a domestic solar lighting system
2. Cost analysis and estimation for solar PV systems

UNIT – IV

Batteries and Charge Controllers in Solar PV Systems

Batteries of solar PV systems. Battery classification, types, and characteristics. Lead-acid batteries and Nickel-Cadmium (NiCd) batteries. Ypes and functions of charge controllers, PWM (Pulse Width Modulation) and MPPT (Maximum Power Point Tracking) charge controllers.

Practice:

1. Performance comparison of lead-acid and nickel-cadmium batteries in solar PV systems
2. Evaluating the performance of PWM and MPPT charge controllers

UNIT – V

Applications of Solar PV Systems

Applications of solar PV systems, solar home lighting systems, solar lanterns, solar fencing, solar street lights, solar water pumping systems, and rooftop solar photovoltaic power plants. The integration of solar PV systems into smart grids, benefits and challenges.

Practice:

1. Exploring smart grid technology and integration of solar PV systems
2. Study of manufacturing techniques for solar arrays
3. Safe measurement of electrical characteristics and commissioning of solar PV systems

Text Books:

1. Solar Photovoltaics: Fundamentals, Technologies and Applications" by Chetan Singh Solanki. ISBN:978-8120351110.
2. Principles of Solar Engineering" by D. Yogi Goswami and Frank Kreith. ISBN:978-1560327141.

Reference Books:

1. Photovoltaic Systems" by James P. Dunlop. ISBN:978-0826913081.
2. Solar Engineering of Thermal Processes" by John A. Duffie and William A. Beckman. ISBN:978-0470873663.

Web Links:

1. https://onlinecourses.nptel.ac.in/
2. https://agrimoon.com/agricultural-engineering-icar-ecourse-pdf-books-free-download/

Wind Power Technology and Systems

	L	T	P	C
Course Code: 241AE057	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain the aerodynamic principles and operations of wind turbines.
CO2: Design wind turbine rotors and estimate of power generation.
CO3: Compare different types of wind energy systems.
CO4: Analyze the economics of wind energy systems.
CO5: Discuss the control and monitoring systems of wind farms.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									
CO2	3	2									
CO3	3	2			1						
CO4	3	2									
CO5	3	2	1		1						

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	3	-	1
CO2	3	-	1
CO3	2	-	1
CO4	3	-	1
CO5	3	-	1

UNIT – I
Aerodynamic Properties of Wind Turbine
Aerodynamic operations of wind turbines; Wind energy extraction and wind turbine power generation.
Practice:
1. Case study on wind map of India and analysis.
2. Visit to a wind farm.

UNIT – II
Design of Wind Turbine
Design of wind turbine rotors, estimation of wind turbine power rating, selection of optimum wind energy generator.
Practice:
1. Detailed drawing of wind turbine.
2. Detailed design of wind turbine.

UNIT – III
Wind Energy Conversion

Types of wind energy systems, wind to electrical energy conversion alternatives, grid interfacing of a wind farm, grid connection, energy storage requirements with wind energy system.

Practice:

1. Study of horizontal axis wind turbine.
2. Study of vertical axis wind turbine.
3. Study of variation of wind speed with elevation.

UNIT – IV

Economics of Wind Power Generation

Economics of wind energy system; Modes of wind power generation; standalone mode, wind diesel hybrid system, solar wind hybrid system.

Practice:

1. Study of validation of Weibull probability density function.
2. Study of wind power density duration curve.

UNIT – V

Control and Monitoring Wind Farm

Control and monitoring system of a wind farm, wind farm sitting; Wind map of India, wind-electric energy stations in India.

Practice:

1. Electrical characteristics aero-generator wind power system.
2. Electrical commissioning of complete aero-generator wind power system.
3. Case study on wind turbine.

Text Books:

1. Rai G D. Non-conventional Sources of Energy. Khanna Publisher, New Delhi. ISBN 10-8173195633.
2. Tiwari G N and Ghosal M K. Renewable Energy Resources: Basic Principles and Applications. Narosa Publishing House, New Delhi.ISBN: 10-9788174090737.

Reference Books:

1. Powar A G and Mohod A G. Fundamentals of wind energy utilization. Jain Brother Publisher, Karol Bagh, New Delhi. ISBN: 978-8183601337.
2. Kothari D P, Singal K C and Ranjan R. Renewable energy sources and emerging technologies. PHI Learning Private Limited. New Delhi. ISBN: 978-9389347890.

Web Links:

1. https://agrimoon.com/agricultural-engineering-icar-ecourse-pdf-books.
2. https://nptel.ac.in/courses/107103004/www.ansi.org.

Waste and By-products Utilization

	L	T	P	C
Course Code: 241AE058	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Overview the types, formation, and magnitude of waste generation in various food processing industries and their potential uses.
- **CO2:** Explain the concept, scope, and methods of waste management, including effluent treatment, and the importance of various waste parameters.
- **CO3:** Apply knowledge of waste utilization techniques in industries, including the use of agricultural wastes for fuel, electricity generation, and other purposes.
- **CO4:** Analyze and design effective waste treatment and disposal systems, including biogas plants and composting methods.
- **CO5:** Evaluate and ensure the environmental performance of food industries to comply with standards like ISO-14001.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2	1							
CO2	2	3	2	2		2					
CO3	2	3	3	2	2		1				
CO4	2	2	3	2			3			1	
CO5	2	3	2	2	2			1			2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	2	-
CO2	-	2	-
CO3	-	2	-
CO4	-	2	-
CO5	-	2	-

UNIT – I

By-Products and Waste Formation

Theory: By-products and waste in food processing industries include various forms such as solid, liquid, and gaseous wastes. The magnitude of waste generation varies significantly across different sectors like rice mills, sugarcane processing, and oil mills. This unit explores the types and formation of these by-products, highlighting potential uses such as animal feed, compost, and industrial raw materials.

Practice:

1. Determination of temperature, pH, and turbidity of wastewater.
2. Determination of solid content in wastewater.

UNIT – II

Waste Management and Effluent Treatment

Theory: This unit covers the principles of waste management, focusing on the concept, scope, and maintenance of waste management systems and effluent treatment. Key waste parameters like temperature, pH, oxygen demands (BOD, COD), and the content of fats, oils, and grease are examined for their importance in effective waste management. The microbiology of waste and the presence of harmful residues like insecticides and pesticides are also discussed.

Practice:

1. Determination of BOD and COD of wastewater.
2. Determination of ash content in agricultural wastes.

UNIT – III

Waste Utilization Techniques

Theory: Students will learn about various techniques for utilizing waste in different industries, including the use of agricultural waste in furnaces, boilers, and briquetting for fuel. The production of charcoal briquettes, electricity generation using surplus biomass, and producer gas generation and utilization are also explored.

Practicals:

1. Determination of unburnt carbon in ash.
2. Study of briquetting of agricultural residues.

UNIT – IV

Waste Treatment and Disposal

Theory: This unit discusses the design, construction, operation, and management of biogas plants, both at institutional and family sizes, as well as vermi-composting. Pre-treatment methods like sedimentation, coagulation, flocculation, and flotation are explored alongside secondary treatments, such as biological and chemical oxygen demands for different food plant wastes. Tertiary treatments involving advanced wastewater treatment processes are also covered.

Practice:

1. Estimation of excess air for better combustion of briquettes.
2. Study of extraction of oil from rice bran.

UNIT – V

Environmental Performance and Compliance

Theory: Assessment, treatment, and disposal of solid waste are essential for maintaining environmental performance. This unit focuses on effluent treatment plants and ensuring that food industries comply with environmental standards such as ISO-14001. Techniques for removing phosphorous, sulphur, nitrogen, and heavy metals from wastewater are discussed.

Practice:

1. Study on bioconversion of agricultural wastes.
2. Recovery of germ and germ oil from by-products of cereals.
3. Visit to industries utilizing waste and food by-products.
4. Determination of insecticide, pesticide, and fungicide residues in wastewater.

Text Books:

1. Joshi, V. K., & Sharma, S. K. Food Processing Waste Management: Treatment & Utilization Technology. New India Publishing Agency. ISBN: 9389992373.

2. Garg, S. K. Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering. Khanna Publishers, New Delhi. ISBN: 8174092304.

Reference Books:

1. USDA. Agricultural Waste Management Field Handbook. USDA, Washington DC.

2. Bhatia, S. C. Environmental Pollution and Control in Chemical Process Industries. ISBN:978-8174091062.

Web Links:

1. Food and Agriculture Organization of the United Nations
2. United States Environmental Protection Agency (EPA)

Floods and Control Measures

	L	T	P	C
Course Code: 241AE059	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Analyze the causes, classifications, and methods of flood estimation.
- **CO2:** Apply statistical methods and flood frequency analysis to hydrological data.
- **CO3:** Evaluate flood routing techniques and flood control measures.
- **CO4:** Design gully erosion control structures and earthen embankments.
- **CO5:** Develop and assess the stability and economic feasibility of earthen dams and flood control projects.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2		1	1		1				
CO2	2			3	1				1		
CO3			3	1			2				1
CO4			2	1			3				1
CO5			3				1				3

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	2
CO2	-	-	2
CO3	-	-	3
CO4	-	-	3
CO5	-	-	2

UNIT – I

Introduction to Floods and Flood Estimation

Floods - Causes of occurrence; Flood classification: probable maximum flood, standard project flood, design flood; Flood estimation: methods of estimation; Estimation of flood peak: rational method, empirical methods, unit hydrograph method.

Practice:

1.Determination of flood stage-discharge relationship in a watershed.
2.Determination of flood peak-area relationships.
3.Determination of probable maximum flood, standard project flood and spillway design flood.

UNIT – II

Statistics in Hydrology and Flood Frequency Analysis

Statistics in hydrology; Flood frequency methods:Log normal distribution, Gumbel's extreme value distribution, Log-Pearson type-III distribution, Depth-area duration analysis; Flood forecasting

Practice:

1. Determination of frequency distribution functions for extreme flood values using Gumbel's method.
2. Determination of confidence limits of the flood peak estimates for Gumbel's extreme value distribution.
3. Determination of frequency distribution functions for extreme flood values using log-Pearson Type-III distribution.

UNIT – III

Flood Routing and Control Measures

Flood routing:Channel routing, Muskingum method, Reservoir routing, Modified Pul's method; Flood control:History of flood control, Structural and non-structural measures, Storage and detention reservoirs, Levees, Channel improvement.

Practice:

1. Design of levees for flood control.
2. Designing, planning and cost benefit analysis of a flood control project.
3. Input-output-storage relationships by reservoir routing.
4. Study of reservoir rule curve.

UNIT – IV

Gully Erosion and Earthen Embankments

Gully erosion and its control structures: design and implementation, Earthen embankments:Functions and classification, Types of dams: hydraulic fill, rolled fill,homogeneous, zoned, diaphragm type, Foundation requirements, Grouting, Seepage through dams: flow net and its properties, seepage pressure, seepage line in composite earth embankments, Drainage filters, Piping and its causes.

Practice:

1. Design of earthen dams.
2. Determination of the position of phreatic line in earth dams for various conditions, stability analysis of earthen dams against head water pressure, foundation shear, sudden draw down condition.
3. Stability of slopes of earth dams by friction circle and other methods.
4. Construction of flow net for isotropic and anisotropic media.
5. Determination of settlement of earth dam.

UNIT – V

Design and Stability of Earthen Dams and Flood Control Projects

Design and construction of earthen dams, Stability of earthen embankments:Failure by tension, overturning, sliding, etc., Stability of slopes: analysis of failure by different methods, Planning of flood control projects and their economics.

Practice:

1. Computation of seepage by different methods.
2. Visit to earthen dam and flood control reservoir.

Text Books:

1. Michael A M and Ojha T P. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi. ISBN: 978-8183601849.
2. Murthy V V N. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi. ISBN:978-9327287356.

Reference Books:

1. Suresh R. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi. ISBN: 978-8180141867.
2. Mutreja K N. Applied Hydrology. Tata McGraw-Hill Publishing Co., New York, Delhi. ISBN:0074517775.

Web Links:

1. https://nidm.gov.in/PDF/modules/flood.pdf
2. https://www.coursera.org/learn/decision-making-and-governance-of-natural-disaster-risk

Remote Sensing and GIS Applications

	L	T	P	C
Course Code: 241AE060	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Illustrate the fundamental principles of remote sensing, its advantages and limitations, and its applications in assessing and monitoring land and water resources, along with gaining knowledge of the electromagnetic spectrum and energy interactions in the atmosphere and with the earth's surface.
- **CO2:** Demonstrate atmospheric windows, applications of various wavelengths, spectral reflectance of natural features, spectral signatures, sensor types, contrast issues, and principles of aerial photography, including stereoscopic techniques.
- **CO3:** Explain air-photo interpretation elements, photogrammetric measurement techniques, ground control for aerial photography, and the principles and applications of satellite remote sensing, including multispectral scanning methods.
- **CO4:** Illustrate various types of resolutions, digital image analysis techniques, image restoration and enhancement, information extraction, image classification methods, key considerations for training area identification, vegetation indices, and microwave remote sensing.
- **CO5:** Demonstrate GIS components, spatial data sources and entities, map projections, GIS data input and editing, spatial data models and structures, attribute data management, data integration, and the application of remote sensing and GIS in land and water resource management.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2								2
CO2	2	3	2						1		2
CO3	2	2	3						2		2
CO4	2	2	2	3					1		2
CO5	2	2	2		3			2	2		2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	3
CO2	-	-	3
CO3	-	-	3
CO4	-	-	3
CO5	-	-	3

UNIT – I

Remote Sensing Fundamentals and Applications in Natural Resource Assessment

Basic component of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources; Electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface.

Practice:
1. Familiarization with remote sensing and GIS hardware.

UNIT – II

Remote Sensing Spectral Characteristics and Aerial Photography Techniques

Major atmospheric windows, principal applications of different wavelength regions, typical spectral reflectance curve for vegetation, soil and water; Spectral signatures, different types of sensors and platforms, contrast ratio and possible causes of low contrast, aerial photography; Types of aerial photographs, scale of aerial photographs, planning aerial photography- end lap and side lap, stereoscopic vision, requirements of stereoscopic photographs.

Practice:
1. Interpretation of aerial photographs and satellite imagery.

UNIT – III

Air Photo Interpretation, Photogrammetry, and Satellite Remote Sensing Techniques

Air-photo interpretation- interpretation elements; Photogrammetry- measurements on a single vertical aerial photograph, measurements on a stereo-pair- vertical measurement by the parallax method; Ground control for aerial photography; satellite remote sensing, multispectral scanner - whiskbroom and push-broom scanner.

Practice:
1. Use of software for image interpretation.
2. Scanning, digitization of maps and data editing.

UNIT – IV

Digital Image Analysis and Microwave Remote Sensing

Different types of resolutions; analysis of digital data- image restoration; image enhancement; Information extraction, image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices; Microwave remote sensing.

Practice:
1. Study of various artificial ground water recharge structures.
2. Determination of various parameters on groundwater quality.

UNIT – V

GIS Fundamentals, Spatial Data, and Applications in Resource Management

GIS and basic components, different sources of spatial data, basic spatial entities, major components of spatial data; Basic classes of map projections and their properties; Methods of data input into GIS, data editing, spatial data models and structures, attribute data management, integrating data (map overlay) in GIS; Application of remote sensing and GIS for the management of land and water resources.

Practice:
1. Basic GIS operations such as image display.
2. Study of various features of GIS software package.
3. Data base query and map algebra.
4. GIS supported case studies in water resources management.

Text Books:

1. Reddy A M. Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad. ISBN: 9788186318496.
2. Elangovan K. GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi. ISBN: 9788186458224.

Reference Books:

1. George J. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad. ISBN: 9788173715358.
2. Jensen J R. Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education Limited, UK. ISBN: 9781292020915.

Web Links:

1. Course: Remote Sensing & GIS Applications 3(2+1) (iasri.res.in)
2. Dr_K_Anitha_Course Material_Remote Sensing and GIS.pdf (kanchiuniv.ac.in)

Information Technology for Land and Water Management

	L	T	P	C
Course Code: 241AE061	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain the fundamental concepts of Information Technology and its applications in natural resources management.
- **CO2:** Utilize multimedia, internet, and web technologies for effective information management.
- **CO3:** Develop and manage databases for natural resources management.
- **CO4:** Apply remote sensing, GIS, and decision support systems in natural resources management.
- **CO5:** Implement agricultural information management and communication systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3				2					1	1
CO2	1				3				1	2	
CO3			3	1	2				1		
CO4				3	2		1				1
CO5			2		3				1	1	

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	3
CO2	-	-	2
CO3	-	-	2
CO4	-	-	2
CO5	-	-	2

UNIT – I

Introduction to Information Technology (IT) and Natural Resources Management

Unit 1: Introduction to Information Technology (IT) and Natural Resources Management Concept of Information Technology (IT) and its application potential, Role of IT in natural resources managementExisting system of information generation, Organizations involved in the field of land and water management.

Practice:

1. Multimedia production;
2. Handling and maintenance of new information technologies and exploiting their potentials;

UNIT – II

Multimedia, Internet, and Web Technology

Application and production of multimedia, Internet application tools and web technology, Networking system of information, Problems and prospects of new information and communication technology

Practice:

1. Internet applications: E-mail, voice mail, web tools and technologies;
2. Multimedia production using different softwares;

UNIT – III

Database Management for Natural Resources

Development of database concept for effective natural resources management, Rational database management system, Object-oriented approaches

Practice:

1. Exercises on database management using database and spreadsheet programs;

UNIT – IV

Remote Sensing, GIS, and Decision Support Systems

Application of remote sensing, geographic information system (GIS), and GPS, Information system, Decision support systems and expert systems

Practice:

1. Exercises on simple decision support and expert systems for management of natural resources;
2. Usage of remote sensing, GIS and GPS survey in information generation and processing;

UNIT – V

Agricultural Information Management and Communication

Agricultural information management systems: use of mathematical models and programs, Application of decision support systems, Multi-sensor data loggers, Overview of software packages in natural resource management, Video-conferencing of scientific information.

Practice:

1. Exercises on running computer software packages dealing with water balance, crop production, land development, land and water allocation, watershed analysis etc;
2. Exercises on development of information system on selected theme(s);
3. Video-conferencing of scientific information.

Text Books:

1. Sarvanan R. Information and Communication Technology for Agriculture and RuralDevelopment. New India Publishing Agency, New Delhi. ISBN: 978-9380235882)

2. Soam S K, Sreekanth P D and Rao N H (Eds.). Geospatial Technologies for NaturalResources Management. New India Publishing Agency, Delhi.ISBN:978-9381450802.

Reference Books:

1. FAO. Land and Water Resources Information Systems. FAO Land and Water Bulletin7, Rome.ISBN:978-9388399401.

2. Loucks D P and Beek E V. Water Resources Systems Planning and Management – AnIntroduction to Methods, Models and Applications. UNESCO, Paris. ISBN:92-3-103998-9.

Web Links:

1. https://www.itu.int/dms_pub/itu-t/oth/23/01/2.3010000100003PDFE.pdf
2. https://www.smsfoundation.org/the-role-of-technology-in-water-management/

Wasteland Development

	L	T	P	C
Course Code: 241AE062	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain the concepts and classifications of land degradation and wastelands.
CO2: Plan and implement conservation structures for wasteland development.
CO3: Apply afforestation techniques and land use strategies for sustainable development.
CO4: Develop region-specific strategies for wasteland development and reclamation.
CO5: Promote sustainable development and participatory approaches in wasteland management.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1					3	2		1		
CO2			3				2		1		1
CO3			3		1		2		1		
CO4				3			2		1		1
CO5						2	3		1	1	

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	3	-	3
CO2	2	1	2
CO3	2	1	2
CO4	2	2	2
CO5	1	-	1

UNIT – I
Concepts and Classification of Land Degradation and Wastelands
Land degradation: concept and classification, Arid, semiarid, humid, and sub-humid regions, Troll's climatic classification, Denuded rangeland and marginal lands, Wastelands: factors causing wastelands, Classification and mapping of wastelands.
Practice:
1. Mapping and classification of wastelands.
2. Identification of factors causing wastelands.

UNIT – II
Planning and Conservation Structures for Wasteland Development
Planning of wasteland development: constraints, agro-climatic conditions, development options, contingency plans, Conservation structures, Gully stabilization, Ravine rehabilitation, Sand dune stabilization, Water harvesting and recycling methods.
Practice:
1. Planning and design of engineering measures for reclamation of wastelands.

2. Design and estimation of different soil and water conservation structures under arid, semiarid and humid conditions.

UNIT – III

Afforestation and Land Use Strategies

Afforestation: agro-horti-forestry-silvipasture methods, Forage and fuel crops, Socioeconomic constraints, Shifting cultivation and optimal land use options.

Practice:

1. Estimation of vegetation density and classification.

UNIT – IV

Specific Strategies for Different Regions and Conditions

Wasteland development:Hills, semi-arid, coastal areas, water-scarce areas, Reclamation of waterlogged and salt-affected lands, Mine spoils: impact, land degradation, reclamation, and rehabilitation, Slope stabilization and mine environment management.

Practice:

1. Planning and design of micro-irrigation in wasteland development.
2. Study on utilization of fly-ash in hydraulic structures.
3. Study on mine spoil areas by plantation.
4. Study on mine spoil areas by back filling of fly-ash.
5. Study on environmental impact assessment (EIA) of mine spoil areas.

UNIT – V

Sustainable Development and Participatory Approaches

Micro-irrigation in wastelands development, Sustainable wasteland development:, Drought situations, Socio-economic perspectives, Participatory approach in wasteland management, Preparation of proposals for wasteland development and benefit-cost analysis.

Practice:

1. Cost estimation of the various wasteland development measures.
2. Study on PRA exercise on wasteland management.
3. Preparation of DPR of wasteland development projects.
4. Visit to wasteland development project sites.

Text Books:

1. Abrol I P and Dhruvanarayana V V. Technologies for Wasteland Development. ICAR, New Delhi. ISBN: 978-8185211190.
2. Ambast S K, Gupta S K and Singh G (Eds.). Agricultural Land Drainage - Reclamation of Waterlogged Saline Lands. Central Soil Salinity Research Institute, Karnal, Haryana. ISBN:978-93-88812-29-0.

Reference Books:

1. Yadav H R. Management of Wastelands. Concept Publishing Company. New Delhi. ISBN:978-8180699436.
2. Malliva R and Missimer T. Arid Lands Water Evaluation and Management. Springer Heidelberg, New York. ISBN:978-3642291036.

Web Links:

1. https://bbsbec.edu.in/wp-content/uploads/2020/01/wasteland-development-ppt.pdf
2. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=26226

Minor Irrigation and Command Area Development

	L	T	P	C
Course Code: 241AE063	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Evaluate the types and performance factors of irrigation projects and systems.
- **CO2:** Design and assess lift and tank irrigation systems.
- **CO3:** Construct and maintain earthen dams with effective seepage control.
- **CO4:** Implement Command Area Development (CAD) programs and promote farmers' participation.
- **CO5:** Apply advanced irrigation management techniques for optimized water use.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3			2			1		1		
CO2			3						1	1	2
CO3			3	1			2		1		
CO4						3			2	1	1
CO5									1		

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	2
CO2	-	-	3
CO3	-	-	2
CO4	-	-	3
CO5	-	-	2

UNIT – I

Irrigation Projects and Systems

Major, medium, and minor irrigation projects, Factors affecting the performance of irrigation projects, Types of minor irrigation systems in India: surface water and groundwater projects.

Practice:

1. Preparation of command area development layout plan
2. Irrigation water requirement of crops of command area
3. Preparation of irrigation schedules

UNIT – II

Lift and Tank Irrigation Systems

Lift irrigation systems:Feasibility, Type of pumping stations and their site selection, Design of lift irrigation systems, Tank irrigation:Grouping of tanks, Storage capacity, Supply works and sluices.

Practice:

1. Design of surplus weir of tanks

2. Determination of storage capacity of tanks
3. Design of intake pipe and pump house

UNIT – III

Earthen Dams and Seepage Control

Earthen dams:Components, Types, Methods of construction, Causes of failure, Seepage control.

Practice:

1. Design and cost estimation of earthen dams for minor irrigation project
2. Estimation of seepage in field channels

UNIT – IV

Command Area Development (CAD)

Command Area Development (CAD) programme:Components, Need, scope, and development approaches, Historical perspective, Command Area Development Authorities: objectives, functions, and responsibilities, On-farm development works:Design of lined and unlined field channels, Cost estimation, Farmers' participation in CAD:Participatory Irrigation Management (PIM), Water Users' Association (WUA).

Practice:

1. Planning and design of OFD works
2. Cost estimation of OFD work
3. Study of crossdrainage works
4. Visit to a command area and study of OFD works

UNIT – V

Advanced Irrigation Management and Optimization

Reclamation works, Cross drainage works, Use of remote sensing techniques for CAD works, Rotational irrigation system, Warabandi: prerequisites and implementation, Conjunctive use of water, Optimum utilization of water, Water productivity: concepts and measures for enhancement.

Practice:

1. Study of reclamation of waterlogged areas inside command area
2. Visit to a minor irrigation project
3. Planning and layout of water conveyance system

Text Books:

1. Arora K R. Irrigation, Water Power and Water Resources Engineering. StandardPublishers Distributors, Delhi. ISBN:978-8180140075.
2. Garg S K. Irrigation Engineering and Hydraulic Structures. Khanna Publishers, NewDelhi. ISBN:978-81-7409-047-8.

Reference Books:

1. Michael A M. Irrigation: Theory and Practice. Vikas Publishing House New Delhi. ISBN:8124918677.
2. Sahasrabudhe S R. Irrigation Engineering and Hydraulic structures. SK Kataria & Sons,Reprint 2015. ISBN:978-93-5017-131-1.

Web Links:

1. http://ecoursesonline.iasri.res.in/course/view.php?id=69
2. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=128479

Management of Canal Irrigation System

	L	T	P	C
Course Code: 241AE064	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Apply the knowledge on canal classification and its alignment.
CO2: Determine duty, delta, base period relationships and canal capacity.
CO3: Design channels using Kennedy's theory and Lacey's regime theory.
CO4: Differentiate between lined and unlined channels.
CO5: Explain different irrigation structures.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2					3		1			
CO2	2	1			1						
CO3		1	2								
CO4							1				
CO5						1	1				

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	3
CO2	-	-	2
CO3	-	-	2
CO4	-	-	2
CO5	-	-	2

UNIT – I
Components of Canal Irrigation System
Typical network of canal irrigation system and its physical components; Canal classifications based on source of water, financial output, purpose, discharge and alignment; Canal alignment: general considerations; Different parts of canal sections, performance indicators for canal irrigation system evaluation.
Practice:
1. Layout of canal alignments on topographic maps.
2. Drawing of canal sections in cutting.

UNIT – II
Water requirement for canal command areas
Estimation of water requirements for canal command areas and determination of canal capacity; Base period, water duty and delta, relationship between base period, duty and delta; factors affecting duty and method to improve duty.
Practice:
1. Estimation of water requirement of canal commands.
2. Determination of canal capacity.

UNIT – III

Design of channels

Silt theory: Kennedy's theory, design of channels by Kennedy's theory, Lacey's regime theory and basic regime equations, design of channels by Lacey's theory.

Practice:

1. Design of canal by full banking and partial cutting.
2. Determination of longitudinal section (L-section) of canals.
3. Design of irrigation canals based on silt theories (unlined canal).
4. Design of lined canals.

UNIT – IV

Canal water distribution systems

Maintenance of unlined irrigation canals, measurement of discharge in canals; Rostering (canal running schedule) and warabandi, rotational irrigation, pre-requisite of warabandi; Necessity of canal lining: advantages and disadvantages, types of canal lining and desirable characteristics for the suitability of lining materials, design of lined canals.

Practice:

1. Formulation of warabandi system in canal command areas.

UNIT – V

Canal water regulating components

Functions of distributary head and cross regulators; Canal falls, their necessity and factors affecting canal fall, types of canal falls; Sources of surplus water in canals and types of canal escapes; Requirements of a good canal outlet and types of outlet; Participatory irrigation management (PIM), water user's association: necessity, structure, function and duties.

Practice:

1. Study of various types of canal outlet and canal regulators.
2. Study of canal escapes and canal falls.
3. Visit to a canal off taking site, canal command area and discussion with functionaries of water user association.

Text Books:

1. Irrigation, Water Power and Water Resources Engineering. Arora, K.R. Standar Publishers Distributors. ISBN : 9788180140075.
2. Irrigation Engineering and Hydraulic Structures. Garg, S.K.Khanna Publishers Nev Delhi. ISBN: 978-81-7409-047-8.

Reference Books:

1. Irrigation Engineering and Hydraulic structures. Sahasrabudhe, S.R. SK Kataria & Son Reprint. ISBN:978-9350141311.
2. Irrigation Theory and Practice by A M Michael, Second Edition, Vikas Publishing hous Pvt Ltd., New Delhi. ISBN:9788124918677.

Web Links:

1. https://www.swayamprabha.gov.in/index.php/program/archive/12
2. https://elearning.icar.gov.in/eLearning_ContentDisplayUG.aspx?CourseCode=jTQ9YVeeNYzqdHebu+MdQ==&Cou

Water Quality and Management Measures

	L	T	P	C
Course Code: 241AE065	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Analyze natural factors and anthropogenic sources affecting the quality of surface water and groundwater.
- **CO2:** Evaluate water quality objectives for domestic, industrial, and agricultural use based on established standards.
- **CO3:** Differentiate between point and non-point sources of water pollution and their impact on water contamination.
- **CO4:** Investigate the effects of agricultural chemicals, industrial activities, and other sources on water contamination and explore remediation techniques.
- **CO5:** Apply water decontamination technologies and management practices to improve water quality for various uses, including irrigation with poor quality water.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3		2				1				
CO2					3			2	1		
CO3			2							1	3
CO4	1		2	3							
CO5		3						2			1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	2
CO2	-	-	2
CO3	-	-	2
CO4	-	-	2
CO5	-	-	2

UNIT – I

Natural Factors

Natural factors affecting quality of surface water and groundwater, sources and pollution of Groundwater.

Practice:

1. Soil chemical analysis and estimation of lime and gypsum requirements.
2. Study of turbidity of water through turbidity meter.

UNIT – II

Objectives of water quality in various sectors

Water quality objectives in relation to domestic, industrial and agricultural activities, drinking water quality standards, irrigation water quality classification as per USSL and AICRP criteria.

Practice:

1. Water quality analysis and classification according to USSL and AICRP criteria.
2. Study of salinity development under shallow and deep water table conditions.
3. Study of saline water ingress in coastal areas.

UNIT – III

Point and non-point water pollution sources

Point and non-point water pollution sources; Water contamination due to inorganic and organic compounds.

Practice:

1. Study of contamination movement and transport in soil profile.

UNIT – IV

Water contamination

Water contamination related to agricultural chemicals, food industry, hydrocarbon and synthetic organic compounds. Arsenic and fluoride contamination in groundwater and remedial measures.

Practice:

1. Field visit to industrial effluent disposal sites.

UNIT – V

Water decontamination technologies

Water decontamination technologies; Cultural and management practices for using poor quality water for irrigation.

Practice:

1. Study of different water decontamination techniques.
2. Study of different cultural and management practices for using poor quality water for irrigation.
3. Visit to a water treatment plant.
4. Visit to a water quality laboratory.

Text Books:

1. Environmental Engineering-I: Water Supply Engineering, S. K. Garg, 30th Edition, Khanna Publishers, New Delhi. ISBN: 978-81-7409-120-8.
2. Hussain S K. Text Book of Water Supply and Sanitary Engineering. Oxford & IBH Publishing Co. New Delhi. ISBN:978-8120416833.

Reference Books:

1. McGauhey P H. Engineering Management of water quality. McGraw Hill Book Company, New York. ISBN: 978-0070449756.
2. FAO. Control of water pollution from agriculture - FAO irrigation and drainage paper55. ISBN: 978-9241038758.

Web Links:

1. https://nptel.ac.in/courses/105104102
2. https://nptel.ac.in/courses/120108005

Landscape Irrigation Design and Management

	L	T	P	C
Course Code: 241AE066	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Illustrate various conventional and modern methods of landscape irrigation, including their merits and demerits.
- **CO2:** Evaluate the suitability of different irrigation methods for various types of landscapes and determine their water requirements.
- **CO3:** Analyze the components of landscape irrigation systems, including pipes, pressure ratings, and automation systems.
- **CO4:** Apply design principles and use AutoCAD for the development of modern landscape irrigation systems.
- **CO5:** Demonstrate practical skills in the installation, operation, and maintenance of landscape irrigation systems, including automation and IoT applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	2			2					2
CO2	2	3	2			2		2	1		2
CO3	2	2	3		2	2		2	1		2
CO4	2	2	3		3	2		2	2		2
CO5	2	2	2		3	2		3	2		2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	3
CO2	-	-	3
CO3	-	-	3
CO4	-	-	3
CO5	-	-	3

UNIT – I

Landscape Irrigation Techniques: Conventional and Modern Methods

Conventional method of landscape irrigation- hose irrigation system, and portable sprinkler with hose pipes; Modern methods of landscape irrigation- pop-up sprinklers, spray pop-up sprinkler, shrub adopter, drip irrigation and bubblers.

Practice:

1. Study of irrigation equipment for landscapes.

UNIT – II

Comparative Analysis of Irrigation Systems and Water Management in Different Landscapes

Merits and demerits of conventional and modern irrigation systems; Types of landscapes and suitability of different irrigation methods, water requirement for different landscapes.

Practice:
1. Design and installation of irrigation system for landscape.
2. Determination of water requirement.

UNIT – III

Components and Selection Criteria of Modern Landscape Irrigation Systems

Segments of landscape irrigation systems, main components of modern landscape irrigation systems and their selection criteria.

Practice:
1. Determination of power requirement, pump selection.

UNIT – IV

Pipes, Pressure Ratings, Automation Systems, and Controllers in Landscape Irrigation

Types of pipes, pressure ratings, sizing and selection criteria; Automation system for landscape irrigation- main components, types of controllers and their application;

Practice:
1. Irrigation scheduling of landscapes.
2. Study of irrigation controllers and other equipment.
3. Study of blocks & symbols, head layout, zoning and valves layout, pipe sizing, pressure calculations, etc.

UNIT – V

Advanced Technologies in Landscape Irrigation: Sensors, IoT, AutoCAD, Design, Operation, and Maintenance

Use of sensors for irrigation automation and use of IOT in landscape irrigation; Use of AutoCAD in irrigation design; Design of modern landscape irrigation systems, operation and maintenance of landscape irrigation systems.

Practice:
1. Use of AutoCAD in irrigation design.
2. Study of various types of sensors for irrigation automation.
3. Study of IOT in landscaping irrigation.
4. Visit to landscape irrigation system and its evaluation.

Text Books:

1 Michael A M. Irrigation: Theory and Practice. Vikas Publishing House, New Delhi. ISBN: 9788124951158.
2 Singh N P. Landscape Irrigation and Floriculture Terminology. Bangalore. ISBN: 9781441659828.

Reference Books:

1 Smith S W. Landscape Irrigation: Design and Management. John Wiley and Sons, Inc., New York, United States. ISBN: 9780471038245.
2 Majumdar D K. Irrigation Water Management Principles. PHI learning Private Limited, New Delhi. ISBN: 9788120317291.

Web Links:

1 Landscape Irrigation: Design and Management - Stephen W. Smith - Google Books
2 Landscape Irrigation Design Process – RainBird Services

Artificial Intelligence

	L	T	P	C
Course Code: 241AE067	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain the foundational concepts, history, and evolution of Artificial Intelligence, along with the role of agents and environments.

CO2: Formulate and solve AI-related problems using production systems, control strategies, and various search algorithms, including both uninformed and heuristic approaches.

CO3: Analyze problem-solving methods, including local search algorithms, constraint satisfaction, optimization problems, and game-playing strategies.

CO4: Apply knowledge representation techniques using predicate logic, structured representation, and advanced planning systems to model AI-driven solutions.

CO5: Evaluate the architecture and roles of expert systems and their applications, particularly in robotics, while understanding current trends in intelligent systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3		1	2							
CO2	2	3			2						
CO3	1	3	2								
CO4	2		3	1							
CO5			3	2							

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	2	2	2
CO2	2	2	2
CO3	2	2	2
CO4	2	3	3
CO5	3	3	3

UNIT I

Introduction

What Is AI? The Foundations of Artificial Intelligence, The History of Artificial Intelligence, The State of the Art, Agents and Environments, Good Behaviour: The Concept of Rationality, The Nature of Environments, The Structure of Agents.

Practice

1. **Introduction to LISP :**
   To demonstrate simple recursive functions and list manipulation in LISP

2. **Introduction to Prolog :**
   Provide a brief introduction to Prolog syntax, including facts, rules, and queries.

UNIT II

Problem formulation

Problem Definition -Production systems, Control strategies, Search strategies. Problem characteristics, Problem-Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Informed (Heuristic) Search Strategies.

Practice:

1. Implementation of DFS for water jug problem using LISP/PROLOG
2. Implementation of BFS for tic-tac-toe problem using LISP/PROLOG

UNIT III

Problem solving methods

Problem graphs, Matching, Indexing and Heuristic functions - Local Search Algorithms and Optimization Problems, Searching with Nondeterministic Actions, , Constraints satisfaction – Measure of performance and analysis of search algorithms. Game playing.

Practice:

1. Implementation of TSP using heuristic approach using LISP/Prolog
2. Implementation of Hill-climbing to solve 8- Puzzle Problem

UNIT IV

Knowledge representation

Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic-Structured representation of knowledge- Basic plan generation systems – Strips -Advanced plan generation systems – K strips -Strategic explanations -Why, why not and how explanations.

Practice:

1. Design a semantic network to represent knowledge about a specific domain, such as animals or transportation systems. Experiment with different node types, relationships, and attributes to encode information effectively. Implement a Python / LISP code for this program.

2. Create a frame-based representation for a simple domain like a restaurant. Define frame templates for entities like menu items, customers, and orders, along with slots for attributes such as price, ingredients, and customer preferences.

UNIT V

Expect Learning

Expert systems – Architecture of expert systems, Roles of expert systems – Knowledge Acquisition – Meta knowledge, Heuristics, Robotics, AI application to robotics; Current trends in intelligent systems.

Practice:

1. Using PYTHON / LISP **,** develop an expert system to help users plan travel itineraries, including transportation, accommodation, and activities. Utilize knowledge about travel destinations, transportation options, and user preferences to generate personalized travel plans.
2. Using PYTHON / LISP **,** create an expert system to assist students in selecting courses, majors, or career paths based on their interests, skills, and academic performance. Use knowledge about educational programs, career prospects, and academic requirements to make personalized recommendations.

Textbooks:

1. Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig ,3rd Edition, Pearson. ISBN:978-9332443515.

2. Artificial Intelligence: Structures and Strategies for Complex Problem Solving" by George F. Luger. ISBN:978-0321545893.

Reference Books:

1. Artificial Intelligence, SarojKaushik, Cengage Learning India. ISBN: 9789355730428.

2. Artificial Intelligence, Elaine Rich and Kevin Knight, Tata McGraw Hill. ISBN: 978-0070087705.

Web Links:

1. https://nptel.ac.in/courses/106105077

2. https://nptel.ac.in/courses/106106126

3. https://aima.cs.berkeley.edu

4. https://ai.berkeley,edu/project_overview.html

5. http://www.zuj.edu.jo/download/machine-learning-tom-mitchell-pdf/

6. https://vlab.spit.ac.in/ai/#/experiments/3/simulation - Virtual labs in Sardar Patel institute of Technology

7. https://cse22-iiith.vlabs.ac.in/List%20of%20experiments.html – Virtual labs in IIT Hyderabad.

Advances in Automation and Robotics in Agriculture

	L	T	P	C
Course Code: 241AE068	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain application of robotics and its importance in agriculture.
CO2: Explain various sensors for automation in agriculture.
CO3: Address various robotics application in agriculture.
CO4: Monitor the robots in agriculture.
CO5: Design of robot for agricultural operations.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2								
CO2	3	2	1								
CO3	3	2	2								
CO4	3	1	1								
CO5	3	2	2								

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	3	-	2
CO2	2	2	2
CO3	3	-	2
CO4	2	-	2
CO5	1	-	2

UNIT – I

Introduction to Robotics and its Importance in Agriculture

Sensors and sensor-driven robot Control, Robot Sensors, Proximity sensors- Infrared sensors, Ultrasonic sensor, Laser range finder, Robot Vision sensors- RGB camera, Thermal Camera, Multispectral sensor, Hyperspectral sensor, Stereo vision system, Optical flow sensor, GPS sensor-RTK, PPK. Sensor noise and uncertainty- Sensor uncertainty, Non-observability, Action uncertainty. Introduction to Robotics and its importance in Agriculture, classification of robots (Anatomy), Automation and Robotics in Intelligent Environments, History of Robotics, Robot manipulators, Mobile robots, Walking Robot, Humanoid Robots, Autonomous Robots, Traditional Industrial Robots, Requirements for Robots in Intelligent Environments.

Practice:

1. Demonstration of different types of robots and their use in agricultural operations; Robot mechanisms, forward kinematics, inverse kinematics calculations and modeling.
2. PID control of actuators and their calibration for precise control.
3. Practical on robot actuator control systems for determination of mass, inertia, friction, and forces.

UNIT – II

Sensors for Automation in Agriculture

Status and scope in Agriculture; Modeling of robot mechanisms, Kinematics, Dynamics, Robot sensor selection, Active and passive proximity sensors, Low-level control of actuators, Closed-loop control, Control architectures, Traditional planning architectures, Behavior-based control architectures, and Hybrid architectures. Modeling the Robot Mechanism, Forward kinematics, Inverse kinematics, Jacobian calculation, and Mobile Robot Odometry. Robot Actuator Control system, Mass, inertia, friction and force, frequent actuators, control approach Proportional, PI, and PID control, Actuators- DC motor, BLDC motor, Linear actuator, Servomotor, Stepper motor, Drivers and control algorithms.

Practice:

1. Calibration of PID controllers for close-loop controls of the system; Mission planning and computation of trajectory for a robot through Python coding and other software.
2. Sensor-driven robot control for obstacle avoidance using different sensors; Calibration of GPS sensors and 3-D fixing for precise control.
3. Robot control architecture design, control, and behavior study; Robot-supervised learning for sensory patterns to detect leaves, flowers, fruit, animal, human body etc.,

UNIT – III

Robotics Application in Agriculture

Ground Control station system, Transmitters, and receivers, PWM, PPM signal, telemetry system, band, and frequency. Transmitter, receiver, PWM, PPM, Telemetry system, band and frequency; Robot Navigation, Path planning addresses and computing a trajectory, Algorithms, and control navigation, mission planning and control, Geofencing, Triggering.

Software for robot control and navigation, Probabilistic Robot Localization-Localization,

Mapping, and Model Building; Robot Control Architectures, Deliberative Control Architecture- Perception, modeling, planning, task execution and motor control, Advantages, and disadvantages.

Practice:

1. Robot design consideration for sowing and transplanting operation; Robot design for weeding operation.
2. Robotic arm design for fruit detection and harvesting; Robotic prime mover design for greenhouse operations for selected crops.

UNIT – IV

Monitoring of Robots in Agriculture

Behavior-Based Robot Control Architectures, Reactive, Behavior-Based Control Architectures, Hybrid Control Architectures, Intuitive Robot Interfaces-Graphical programming interfaces, Deictic (pointing) interfaces, Voice recognition and reaction. AI adaptation and Learning for Robots-Supervised learning, Learning Sensory Patterns -Neural networks, Decision trees, Reinforcement Learning, AI programming techniques. Classical AI, the concept of expert system, conflict resolution, multiple rules, forward chaining, and backward chaining. Advantages and disadvantages of expert system.

Practice:

1. Automation of machines for food packaging; Robots for food control and cleaning in cattle and poultry farms.
2. Robots for variable rate application of agricultural inputs.

UNIT – V

Design of Robot for Agricultural Operations

Robot design and considerations for agricultural operations, Robots for Seedbed preparation, sowing and transplanting, weeding operation-mechanical and chemical, fruit harvesting, robots for greenhouse application, moisture management, post-harvest losses management, dairy and food packaging, humanoid robots, cattle and poultry farm management, VRT robots, Driverless Autonomous tractor.

Practice:

1. Driverless and autonomous tractor for straight control calibration of movement.
2. Control of humanoid robots for selected agricultural operations and active voice command control.

Text Books:

1. Ben-Ari, Mordechai, and Francesco Mondada. Elements of robotics. Springer Nature. ISBN:978-3319624324.
2. Mark R. Miller and Rex Miller, Robots and Robotics, Principles, Systems, and Industrial Applications. McGraw-Hill Education. ISBN:978-1249859786.

Reference Books:

1. T. Bräunl, Embedded Robotics Mobile Robot Design and Applications with Embedded Systems, Springer Berlin Heidelberg. ISBN:978-3540034360.
2. Zhang, Dan, and Bin Wei, eds. Robotics and mechatronics for agriculture. CRC Press. ISBN:9781315203638.

Web Links:

1. https://www.frontiersin.org/journals/robotics-and-ai/articles.
2. https://www.mdpi.com/journal/agriengineering.

Environmental Engineering

	L	T	P	C
Course Code: 241AE069	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain the principles and importance of a safe water supply system, including water demand and sources.
- **CO2:** Analyze and design water transportation systems, including the selection and efficiency of pumps and pipelines.
- **CO3:** Comprehend drinking water quality standards and water treatment methods.
- **CO4:** Evaluate and design domestic wastewater treatment systems, including septic tanks and sewer systems.
- **CO5:** Explain the principles of air pollution, solid waste management, and their environmental impact.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2	1			3				
CO2	2	3	2	2			3				
CO3	2	2	3	1			2				
CO4	2	3	2	2			2				
CO5	3	2	2	2			3				

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	2	-	2
CO2	2	-	2
CO3	2	-	2
CO4	2	-	2
CO5	2	2	2

UNIT – I

Water Supply Systems

The importance of a safe water supply system; water requirements for urban and rural areas; domestic, industrial, and commercial demand; per capita demand; variation in demand; population estimation; design period; population forecasting methods; sources of water supply; surface and sub-surface sources of water; surface sources include lakes, rivers, and reservoirs.

Practice:

1. Study of population forecasting problems.
2. Determination of turbidity, pH, and electrical conductivity (EC) of water.

UNIT – II

Water Transportation Systems

Intakes and transportation of water; various types of conduits, including gravity conduits such as canals, flumes, and aqueducts; pressure conduits; design of pressure pipes as gravity mains; Darcy-Wesbach, Manning, Hazen-William formula; flow in pipe systems; forces acting on pressure conduits; types of pipes: cast iron, steel, RCC, PVC, asbestos, and concrete; laying and testing of pipes; selection of pumps; efficiency of pumps; economic diameter of pumping mains.

Practice:

1. Study of suspended solids, dissolved solids, and total solids.
2. Study of temporary and permanent hardness.

UNIT – III

Water Quality and Treatment

Drinking water quality: Indian standards of drinking water; introduction to water treatment; purification of water supply; sedimentation; filtration; coagulation; water softening; water treatment methods.

Practicals:

1. Determination of fluorides and chlorides in drinking water.
2. Determination of dissolved oxygen, COD, and BOD of water.

UNIT – IV

Wastewater Treatment

Importance of sanitation; domestic wastewater: quantity, characteristics, disposal in urban and rural areas; types of sewers; design discharge and hydraulic design; introduction to domestic wastewater treatment; design of septic tanks; sewerage systems: domestic and municipal wastes; storm sewage; flow through sewers; design of sewers; manholes; sewage characteristics; BOD, COD, dissolved oxygen, nitrogen.

Practice:

1. Study of hydraulics of pipelines and distribution network design.
2. Design of septic tank, sewer pipelines, and waste disposal measures.

UNIT – V

Air Pollution and Solid Waste Management

Solid waste collection and disposal; solid waste quantity, characteristics, and disposal for urban and rural areas; introduction to air pollution; types of pollutants; properties and their effects on living beings; BIS standards for pollutants in air and their abatement.

Practice:

1. Collection of air samples and their analysis.
2. Visit to a water treatment plant.
3. Visit to a sewage treatment plant.
4. Visit to a municipal solid waste management plant.

Text Books:

1. Garg S. K. Environmental Engineering, Vol I and II. Khanna Publishers, Delhi. ISBN: 978-8174092304.
2. Rao P. V. Textbook of Environmental Engineering. Prentice Hall of India Pvt. Ltd. ISBN:978-8120319301.

Reference Books:

1. Chatterjee A. K. Water Supply, Waste Disposal & Environmental Engineering. Khanna Publishers, Delhi. ISBN: 978-8174092441.
2. Metcalf & Eddy Inc.Wastewater Engineering: Treatment and Reuse. McGraw Hill Education. ISBN:978-0070495395.

Web Links:

1. Environmental Protection Agency (EPA)
2. Water Environment Federation

Development of Processed Food Products

Course Code: 241AE070	L	T	P	C
	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

CO 1: Develop new products and value-added products from cereals, pulses and oil seeds.

CO 2: Develop value added products from fruits, vegetables and spices.

CO 3: Apply technologies related to food beverages and forest products.

CO 4: Apply technologies related to food meat production.

CO 5: Develop products related to functional and organic foods.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1	1	3						
CO2	3	2	1	1	3						
CO3	3	2	1	1	3						
CO4	3	2	1	1	3						
CO5	3	2	1	2	3						

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	3	-
CO2	-	2	-
CO3	-	3	-
CO4	-	2	-
CO5	-	3	-

Unit - I

New product development

Process of new product development; Process flow chart with mass and energy balance; Unit operations and equipment for processing; Technologies for value addition of cereals, pulses and oil seeds- milled, puffed, flaked, roasted and malted products, bakery products, snack food, extruded products.

Practice:

1. Process design and preparation of process flow chart.
2. Preparation of different value added products.
3. Evaluate the milling efficiency of rice mill.
4. Demonstrate the sieve separator based on size of food grains.
5. Seperation of food grains based on spiral separator.
6. Visit to roller flour mill and study of operations and machinery.
7. Visit to rice mill and study of operations and machinery.
8. Visit to dal, oil mill and study of operations and machinery.

Unit - II

Value addition of fruits, vegetables and spices

Technologies for value added products from fruits, vegetables and spices as canned foods, frozen foods, dried foods, fried foods, fruit juices, sauce, sugar-based confectionery, candy, fermented products, spice extract.

Practice:

1. Visit to spice grinding mill and study of operations and machinery.
2. Visit to fruit/ vegetable processing plant and study of operations and machinery.
3. Visit to sugar mill and study of operations and machinery.

Unit - III

Value addition of liquids, forest produce

Technologies for value addition of liquid foods such as milk, sugarcane juice, etc.; Technologies for value addition of forest produce as mahua and tamarind.

Practice:

1. Visit to milk plant and study of operations and machinery.

Unit - IV

Processing of Animal produce

Technology for processing of animal produce, viz. meat, poultry, fish, egg products.

Unit - V

Processing of Functional foods

Technologies for preparation of health foods, nutraceuticals and functional food; Organic food processing.

Text Books:

1. Carl.W. Hall. Processing Equipments for Agrl.Products. McGraw Hill Pub.Co. ISBN : 9780870552700.
2. Girdhari Lal, G.S. Siddappa & G.L. Tandon. Preservation of Fruits and Vegetables ICAR, New Delhi. ISBN : 978-81-7164-090-4.

Reference Books:

1. Kessle, H.G. Food Engineering and Dairy Technology. U.A. Kessler Freising, Germany. ISBN:9783980237857.
2. Matz,S.A. Cereal Technology. AVI Publishers. ISBN: 0870550713.

Web Links:

1. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=793
2. https://onlinecourses.swayam2.ac.in/cec20_ag06/preview

Food Packaging Technology

	L	T	P	C
Course Code: 241AE071	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Identify the factors affecting the shelf life of food and the principles of controlling spoilage agents.
CO2: Comprehend the types and manufacturing processes of various food packaging materials.
CO3: Analyze and apply different packaging systems and materials for various food products.
CO4: Evaluate the nutritional labeling, environmental considerations, and disposal/recycling of packaging materials.
CO5: Perform various tests on packaging materials to assess their properties and suitability for food packaging.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	1	2	1	2					
CO2	3	2	1	2	1	1					
CO3	3	3	2	3	1						
CO4	3	3	3	3	2	1					
CO5	3	2	2	3	2	1					

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	2	-
CO2	-	2	-
CO3	-	3	-
CO4	-	3	-
CO5	-	3	-

UNIT – I

Factors Affecting Shelf Life and Spoilage Control

Factors affecting the shelf life of food material during storage, interactions of spoilage agents with environmental factors such as water, oxygen, light, pH, etc., and general principles of control of the spoilage agents; differences between food infection, food intoxication, and allergy.

Practice:

1. Identification of different types of packaging materials.
2. Determination of tensile/compressive strength of given material/package.

UNIT – II
Types and Manufacturing of Packaging Materials

Packaging of foods: requirement, importance, and scope, environmental considerations; packaging systems, types: flexible and rigid, retail and bulk, levels of packaging; different types of packaging materials, their key properties, and applications; metal cans- manufacture of two-piece and three-piece cans; plastic packaging- different types of polymers and laminations used in food packaging and their barrier properties; manufacture of plastic packaging materials, profile extrusion, blown film/sheet extrusion, blow molding, extrusion blow molding, injection blow molding, stretch blow molding, injection molding; glass containers- types of glass used in food packaging, manufacture of glass and glass containers, closures for glass containers; paper and paperboard packaging- paper and paperboard manufacture process, modification of barrier properties and characteristics of paper/boards.
Practice:

1. To perform different destructive and non-destructive tests for glass containers.
2. Vacuum packaging of agricultural produces.

UNIT – III
Packaging Systems and Materials
Relative advantages and disadvantages of different packaging materials, effect of these materials on packed commodities; nutritional labeling on packages; controlled atmosphere storage (CAS) and modified atmosphere packaging (MAP), shrink and cling packaging, vacuum and gas packaging; active packaging, smart packaging; packaging requirements for raw and processed foods and selection of packaging materials.
Practice:

1. Determination of tearing strength of paperboard.
2. Measurement of thickness of packaging materials.

UNIT – IV
Environmental Considerations and Waste Management
Disposal and recycling of packaging waste; environmental considerations in packaging; impact of packaging materials on the environment and strategies for reducing environmental footprint.
Practice:

1. To perform grease-resistance test in plastic pouches.
2. Determination of bursting strength of packaging material.

UNIT – V
Package Testing and Quality Control
Package testing- testing methods for flexible materials, rigid materials, and semi-rigid materials; tests for paper (thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply bond test, surface oil absorption test, etc.), plastic film, and laminates (thickness, tensile strength, gloss, haze, burning test to identify polymer, etc.), aluminum foil (thickness, pinholes, etc.), glass containers (visual defects, color, dimensions, impact strength, etc.), metal containers (pressure test, product compatibility, etc.).
Practice:

1. Determination of water-vapour transmission rate.
2. Shrink wrapping of various horticultural produce.
3. Testing of chemical resistance of packaging materials.
4. Determination of drop test of food package and visit to relevant industries.

Text Books:

1. Coles R., McDowell D., & Kirwan M. J. Food Packaging Technology. Blackwell Publishing Co. ISBN: 978-1-4051-8910-1.
2. John P. J. A Handbook on Food Packaging. Narendra Publishing House. ISBN: 978-8170356493.

Reference Books:

1. Gosby N. T. Food Packaging Materials. Applied Science Publication. ISBN:9780853349266.
2. Robertson G. L. Food Packaging: Principles and Practice. Second Edition. Taylor and Francis. ISBN:978-0849337758.

Web Links:

1. Institute of Food Technologists (IFT)
2. Food Packaging Forum

Food Plant and Equipment Design

	L	T	P	C
Course Code: 241AE072	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Analyze the criteria for food plant location, selection of processes, plant capacit and layout.
CO2: Analyze the design requirements for plant buildings, components, and flow diagram
CO3: Select appropriate equipment, processes, and control mechanisms for various foo processing industries.
CO4: Apply design engineering principles for processing equipment, including materi specification and optimization for efficiency, energy, and cost.
CO5: Design specific food processing equipment such as heat exchangers, conveyor dryers, and milling equipment.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2	1							
CO2	2	3	2	2							
CO3	3	2	1	2	2						
CO4	3	3	2	0	2	2					
CO5	3	2	3	1	2						

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	2	-
CO2	-	3	-
CO3	-	3	-
CO4	-	3	-
CO5	-	3	-

UNIT – I
Introduction to Food Plant Design
Overview of food plant location and selection criteria; factors influencing plant location; selection of processes and plant capacity; initial plant building requirements and components.
Practice:
1. Study of salient features and layout of preprocessing houses.

UNIT – II
Plant Layout and Flow Diagrams
Objectives and principles of food plant layout; types of plant layout; flow diagrams and their importance in plant design.
Practice:
1. Study of salient features, design, and layout of milk and milk product plants.
2. Study of salient features, design, and layout of a modern rice mill.

UNIT – III

Equipment Selection and Controls

Selection of equipment, processes, and controls; salient features of processing plants for cereals, pulses, oilseeds, horticultural and vegetable crops, poultry, fish, and meat products.

Practice:

1. Study of salient features, design, and layout of bakery plants.
2. Study of salient features, design, and layout of fruits and vegetables processing units.
3. Evaluation of a given plant layout.

UNIT – IV

Design Engineering for Processing Equipment

Application of design engineering principles for processing equipment; material specification and types; design codes; design of cleaners, tubular heat exchangers, shell and tube heat exchangers, and plate heat exchangers.

Practice:

1. Design of pressure vessel.
2. Design of cleaners.
3. Design of tubular heat exchanger.

UNIT – V

Optimization and Computer-Aided Design (CAD)

Optimization of design with respect to process efficiency, energy, and cost in food plant and equipment design.

Practice:

1. Design of shell and tube type heat exchanger.
2. Design of plate heat exchanger.
3. Design of grain dryer.
4. Design of belt conveyor, bucket elevator, screw conveyor.

Text Books:

1. Bhattacharyya B C. Introduction to Chemical Equipment Design. CBS Publishers and Distributors. ISBN : 9788123909455.

2. Lopez Antonio Gómez. Food Plant Design. T&F India. ISBN : 9781420027419.

Reference Books:

1. Maroulis Z B and Saravacos G D. Food Plant Economics. Taylor and Francis, LLC. ISBN: 9780849340215.

2. Robberts Theunis C. Food Plant Engineering Systems. CRC Press, Washington. ISBN: 9781138199392.

Web Links:

1. FAO: Milk Plant Layout

2. Design Codes for Food Processing Equipment

Emerging Technologies in Food Processing

	L	T	P	C
Course Code: 241AE073	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Overview the emerging technologies in food processing.
- **CO2:** Apply thermal processing technologies in food preservation.
- **CO3:** Utilize advanced processing technologies for food preservation and safety.
- **CO4:** Implement innovative non-thermal processing technologies.
- **CO5:** Explore the applications of nanotechnology in food processing.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1		2	1					1
CO2	3	2	3	1	2		1		1		
CO3	3	3	3	1	2		1		1		
CO4	3	2	3	1	2					1	
CO5	3	2	1		2		1				1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	3	-
CO2	-	3	-
CO3	-	2	-
CO4	-	2	-
CO5	-	2	-

UNIT – I

Introduction to Emerging Technologies

Introduction to emerging technologies in food processing, Scope and applications of various emerging technologies

UNIT – II

Thermal Processing Technologies

Thermal Processing Technologies, Principles, equipment, and applications of:, Ohmic heating, Infrared heating, Dielectric heating, Microwave heating systems, Radio frequency heating equipment, Combined microwave vacuum drying, New hybrid drying technologies

UNIT – III

Advanced Processing Technologies

Principles and equipment for:Vacuum processing, High pressure processing, Pulsed electric field processing, Ultrasonication, Gamma irradiation/ionizing radiation, Ultraviolet radiation processing, Pulsed X-ray processing, Pulsed light processing

UNIT – IV

Innovative Non-Thermal Processing Technologies

Principles and equipment for:Cold plasma processing, Ozone treatment, Electron beam processing, Static and oscillating magnetic fields, Dense phase carbon dioxide, High voltage arc discharge

UNIT -V

Nanotechnology in Food Processing

Nanomaterial utilization in food processing, Manufacture of nanomaterials, Applications of nanomaterials in food processing

Text Books:

1. Dash S K, Chandra P and Kar A. Food Engineering principles and practices. CRC Press. ISBN:9781003285076.
2. Passos and Ribeiro, Innovation in Food Engineering – New Techniques and Products, CRC Press. ISBN: 97804291148637.

Reference Books:

1. Sun Da-Wen Thermal Food Processing – New technologies and Quality Issues, CRC Press. ISBN: 978-0429121203.
2. Tewari and Juneja, Advances in Thermal and Non-Thermal Food Preservation, Blackwell. ISBN:978-0-470-27789-8.

Web Links:

1. https://pubmed.ncbi.nlm.nih.gov/22129381/#:~:text=High%20hydrostatic%20pressure%20(HHP)%2C,food%20industry%20or%20related%20sectors.
2. https://www.foodprocessing.com/on-the-plant-floor/technology/article/11287870/four-emerging-technologies-for-processing-food-in-2022

Processing of Livestock, Fish and Marine Products

	L	T	P	C
Course Code: 241AE074	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain the production, economics, and processing scenarios of meat, fish, and poultry.

CO2: Analyze the unit operations involved in processing poultry products and various fish products.

CO3: Comprehend the preservation techniques for eggs, meat, and fish, including dehydration, freezing, pickling, curing, cooking, smoking, and ionizing radiation.

CO4: Evaluate the eating quality of meat, including factors affecting texture, tenderness, water-holding capacity, and juiciness, and the utilization of by-products.

CO5: Demonstrate practical skills in the processing of fish, meat, and eggs, and the preparation of value-added products.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2	1		3					
CO2	2	3	2	2		3					
CO3	2	2	3	1		2					
CO4	2	3	2	2		2					
CO5	3	2	2	2		3					

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	2	-
CO2	-	2	-
CO3	-	2	-
CO4	-	2	-
CO5	-	2	-

UNIT – I

Production and Processing Overview

Production, economics, and processing scenarios of meat, fish, and poultry; differences between food infection, food intoxication, and allergy; abattoir design, layout, meat plant sanitation, safety, and by-products utilization.

Practice:

1. Hands-on exercise on the processing of fish, meat, and eggs.
2. Visit to processing plants.

UNIT – II

Poultry Processing

Unit operations for various poultry products; preservation techniques for poultry products.

Practice:

1. Processing of poultry products.
2. Preparation of value-added poultry products.

UNIT – III

Fish Processing

Unit operations for various fish products; preservation techniques for fish products.

Practice:

1. Processing of fish products.
2. Preparation of value-added fish products.
3. Visit to fish processing and storage plant.

UNIT – IV

Meat Preservation Techniques

Preservation of meat by dehydration, freezing, pickling, curing, cooking, smoking, ionizing radiation, antibiotics, and chemical additives.

Practice:

1. Preservation of meat by dehydration, freezing, and smoking.
2. Preservation of meat using ionizing radiation and chemical additives.

UNIT – V

Meat Quality and Utilization

Eating quality of meat; factors affecting texture, tenderness, water-holding capacity, and juiciness; utilization of meat by-products.

Practice:

1. Evaluation of meat quality: texture, tenderness, and juiciness.
2. Utilization of meat by-products.
3. Visit to poultry plant.

Text Books:

1. Bechtel P. J. Muscle as Food. Academic Press. ISBN: 0120841912.
2. Lawrie R. A., & Ledward D. Lawrie's Meat Science. Woodhead Publishing. ISBN: 0323984539.

Reference Books:

1. Hui Y. H. Handbook of Meat and Meat Processing. CRC Press. ISBN-13. 978-1439836835.
2. Stadelman W. J., & Cotterill O. J. Egg Science and Technology. CRC Press. ISBN: 9781560228554.

Web Links:

1. Food and Agriculture Organization of the United Nations (FAO) - Livestock
2. World Aquaculture Society

Food Business Management and Entrepreneurship Development

	L	T	P	C
Course Code: 241AE075	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Illustrate key concepts and definitions in project management and entrepreneurship, including project formulation and work breakdown structure.
- **CO2:** Apply network scheduling techniques such as CPM and PERT for efficient project scheduling and resource planning.
- **CO3:** Estimate project costs, conduct earned value analysis, and evaluate the techno-economic viability of projects, with a focus on the food processing sector.
- **CO4:** Analyze government policies for entrepreneurship promotion in food processing, and develop skills in enterprise launching, organization, market assessment, and feasibility study.
- **CO5:** Demonstrate resource mobilization, financial institution roles in entrepreneurship promotion, and supply chain management through case studies in the food business sector.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	2			2				2	2
CO2	2	3								2	2
CO3	2	2	3		2					2	2
CO4	2	2	2	3		2		2		2	2
CO5	2	2						3	2	2	2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	2	-
CO2	-	1	-
CO3	-	2	-
CO4	-	3	-
CO5	-	3	-

UNIT – I

Project Management

Introduction and definitions related with project management and entrepreneurship; Fundamentals of project management and entrepreneurship development; Project formulation: market survey techniques, project identification, project selection, project proposal, work breakdown structure.

UNIT – II

Network scheduling techniques

Network scheduling: activity, networks, use of CPM, PERT in project scheduling. Resource planning, resource allocation, project scheduling with limited resources.

UNIT – III

Estimation of Project Costs

Estimation of project costs, earned value analysis, project techno-economic viability, break-even analysis. Identification of business opportunity in food processing sector.

UNIT – IV

Government Policies for Promotion of Entrepreneurship in Food Processing

Government policies for promotion of entrepreneurship in food processing; Launching and organizing an enterprise, enterprise selection, market assessment, feasibility study, SWOT analysis.

UNIT – V

Resource Mobilization in Entrepreneurship

Resource mobilization. Financial institution in promoting entrepreneurship; Supply chain management; Case study of a food business.

Text Books:

1. Awasthi D and Jaggi R. Entrepreneurship and Management inputs for entrepreneurs in Food Processing Sector, Ahmedabad EDII. ISBN: 0070585806.
2. Bell G F and Balkwill J. Management and Engineering, Prentice Hall International. ISBN: 9780132339339.

Reference Books:

1. Bharatia C R Food Technology and Entrepreneurship Management, Surendra Publications. ISBN: 9789380014654.
2. Jordan Lisa, Food Industry: Food Processing and Management, 2 edition, Callisto. ISBN: 9781632393388.

Web Links:

1. http://ecoursesonline.iasri.res.in/course/view.php?id=20
2. http://ecoursesonline.iasri.res.in/course/view.php?id=26

Natural Fibres: Extraction & Properties

	L	T	P	C
Course Code: 241AE076	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Describe the definition, classification of natural fibres.
CO2: Identify and explain the types, morphology, physical and chemical properties, grading, marketing of cotton.
CO3: Discuss the cultivation, extraction, physical and mechanical properties of jute flax, sisal, pineapple leaf, maize, banana, and hemp.
CO4: Analyze the types of silk, cultivation of mulberry, grading, marketing, processing methods.
CO5: Evaluate the physical and mechanical properties of natural fibres.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2	1		1					
CO2	3	3	2	2		1					
CO3	3	2	3	1		2					
CO4	3	3	2	2		1					
CO5	3	3	3	3	1	1					

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	2	1
CO2	-	3	-
CO3	1	2	1
CO4	1	2	1
CO5	-	2	-

UNIT – I

Introduction to Natural Fibres

Natural fibres definition, Detailed Classification; Natural fibres– physical and chemical properties, Advantages and disadvantages of Natural Fibres; Plant Fibres; Animal Fibres; Applications of Natural Fibres. Identification, characterization and quality management of natural textile fibres.

Practice:

1. Determination of mechanical properties.
2. Determination of insulation properties.

UNIT – II

Cotton

Types, Morphology, Physical & Chemical properties, grading and marketing, Organic & Bt cotton, processing and utilization; Wool: types, Morphology, Physical and Chemical Properties, grading and marketing processing and application.

Practice:

1. Identification of natural fibres; Extractions of cotton.
2. Identification of natural fibres; Extractions of sisal.

UNIT – III

Jute

Cultivation- Extraction & Retting methods, physical and mechanical properties, grading and marketing, significance of Jute in Packaging. diversified application of jute; Other (Natural) Textile Fibres: Long Vegetables fibres, Cultivation and extraction of Flax, Sisal, Pineapple leaf, Maize, banana, hemp; Physical and Chemical Properties, grading and marketing, processing and end use application.

Practice:

1. Identification of natural fibres; Extractions of jute.
2. Identification of natural fibres; Extractions of flax.
3. Identification of natural fibres; Extractions of banana.

UNIT – IV

Silk

Types of Silk, Cultivation of mulberry, production of silk cocoon, storage, Sorting, cooking, brushing, reeling (Methods and Machines), morphology, Physical and Chemical Properties, grading and marketing, processing-degumming and weighting.

Practice:

1. Identification of natural fibres; Extractions of ramie.
2. Retting of Jute.
3. Retting of Flax.

UNIT – V

Physical Properties of Natural fibres

Fibre Morphology; Fibre length, diameter, l/b ratio and itssignificance; concept of denier and tex; colour an lustre, Fibre defects and root content; cross sectional study of fibres; yarn coun, moisture regain, thermal behavior; Mechanical Properties: Stress-stain curve, tenacity, elongation, tensile modulus, bundle strength, compressional and resilience properties.

Practice:

1. Quality evaluation of jute.
2. Quality evaluation of jute other fibres.

Text Books:

1. Cook J G. Hand Book of Textile Fibers. Wood Head Publishers, London, Vol 1 & 2. ISBN:978-1855734845.
2. Gohl & Vilensky. Textile Science. 2nd ed.Mahajan Book Publishers. ISBN: 8177580760.

Reference Books:

1. Shenai V A. Technology of Textile Processing- Textile Fibers. Sevak Publications.
2. Tammanna and Son walkar N. Handbook of Silk Technology. Wiley Eastern Limited, New Delhi. ISBN:978-8122404951.

Web Links:

1. Plant-Based Natural Fibre Reinforced Composites: A Review on Fabrication, Properties and Applications (MDPI).
2. Extraction, Applications, and Characterization of Plant Fibers (IntechOpen - Open Science Open Minds).

Natural Fibre Applications in Agriculture

	L	T	P	C
Course Code: 241AE077	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain the principles, design, and application of natural fibre-based agrotextiles and evaluate their impact on crop yield and soil properties.

CO2: Analyze and characterize natural fibre-based geotextiles for soil and water conservation, understanding their role in mitigating soil erosion.

CO3: Evaluate the properties and applications of natural fibre-based sustainable packaging for agricultural and horticultural produce, including their environmental impact.

CO4: Assess the potential of natural fibres as a renewable energy source, understanding the methods of energy conversion and their economic and environmental implications.

CO5: Examine the role of natural fibres in organic and soilless farming, including waste management and composting methods, and evaluate their impact on crop yield and sustainability.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	3		2		1		1		
CO2	3	2	3		2		1		1		
CO3	3	2	3		2		1		1		
CO4	3	2	3		2		1		1		
CO5	3	2	3		2		1		1		

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	2
CO2	-	-	2
CO3	2	2	-
CO4	2	2	-
CO5	2	2	-

UNIT – I

Natural Fibre-based Agrotextiles

Overview of agrotextiles, technical textiles, non-woven technology, design principles for natural fibre-based agrotextiles, tensile and hydro-physical properties, estimation techniques, applications as crop mulch, effects on soil properties, soil hydrothermal regime, crop yield, soil moisture retention, weed population, applications as shade net, biodegradability, life cycle and environmental impact, economic evaluation.

Practice:

1. Preparation of woven and nonwoven agrotextile fabrics.
2. Estimation of tensile properties of agrotextiles.
3. Field trial of natural fibre-based agrotextiles as crop mulch.

UNIT – II

Natural Fibre-based Geotextiles

Overview of geotextiles in soil and water conservation, woven technology, design principles for natural fibre-based geotextiles (coir, jute, bamboo), blended geotextiles applications, tensile and hydro-physical properties, estimation techniques, applications as soil savers, soil degradation properties, factors affecting soil erosion, rainfall erosivity and indices, Wischmeier's equation, isoerodent map of India, soil erodibility and measurement, soil loss estimation methods (USLE & RUSLE), water erosion prediction (WEPP), sediment transport equations, runoff measurement, sediment measurement, integrated watershed management, role of RS & GIS, bioengineering, role of geotextiles in soil conservation, reinforcement, biodegradability, life cycle and environmental impact, economic evaluation.

Practice:

1. Characterization of tensile and hydro-physical properties of geotextiles.
2. Field experiment on the application of geotextiles for soil conservation.
3. Measurement of runoff and sediment transport in geotextile-applied areas.

UNIT – III

Natural Fibre-based Sustainable Packaging

Overview of the packaging industry, principles behind packaging perishable crops, characteristics and properties of natural fibres for packaging, natural fibre-based green composites, design principles, natural fibre-based reaper binder, advantages and limitations, biodegradable plastics for packaging, life cycle assessment, environmental impact analysis, government policies and regulations related to sustainable packaging.

Practice:

1. Preparation and testing of natural fibre-based packaging materials.
2. Comparison of mechanical properties of natural fibre-based and synthetic packaging.
3. Life cycle assessment of natural fibre-based packaging materials.

UNIT – IV

Natural Fibres as Renewable Energy Source

Characteristics of natural fibres, methods of converting natural fibres into energy (combustion, gasification), economic and environmental analysis, comparison with other renewable energy sources, government policies and incentives related to renewable energy.

Practice:

1. Experimental setup for combustion of natural fibres.
2. Gasification of natural fibres and energy output measurement.
3. Economic analysis of natural fibre-based energy systems.

UNIT – V

Role of Natural Fibre in Organic and Soilless Farming

Overview of organic and natural farming, soilless farming, natural fibre waste, characterization, compost preparation methods, role of fibre waste as compost, characteristics of natural fibres as soilless media, effect on crop yield, biodegradability, life cycle and environmental impact, economic evaluation.

Practice:

1. Characterization of natural fibre waste for composting.
2. Preparation and testing of compost from natural fibre waste.
3. Evaluation of natural fibres as soilless media for crop cultivation.

Text Books:

1. Ryszard M. Kozłowski (Ed). Handbook of Natural Fibres. Volume Processing and Applications. Woodhead Publishing Limited. ISBN: 978-1-84569-698-6.
2. Hakeem, K. R., Jawaid, M., & Alothman, O. Y. (Eds.). (2019). Biomass and Bioenergy: Processing and Properties. Springer. ISBN: 978-981-13-8562-2.

Reference Books:

1. Fangueiro, R., & Rana, S. (Eds.). Natural Fibre Composites in Geotextiles: Design and Applications. Woodhead Publishing. ISBN: 978-0-08-100215-7.
2. Cheng, H. N., Byron, A. E., & Okos, M. R. (Eds.). Sustainable Fiber-Based Packaging. John Wiley & Sons. ISBN: 978-1-119-17306-4.

Web Links:

1. FAO - Agricultural Textiles
2. International Jute Study Group

Processing of Natural Fibres

	L	T	P	C
Course Code: 241AE078	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain principles and systems of spinning, including hand spinning and modern spinning technologies.
- **CO2:** Analyze the preparatory processes of weaving and knitting, including winding, warping, sizing, and knitting techniques.
- **CO3:** Evaluate yarn and fabric properties through testing methods, including count, twist, tensile strength, and fabric structure analysis.
- **CO4:** Explore the chemical composition of natural fibers and their pre-treatment processes, including scouring, bleaching, and dyeing techniques.
- **CO5:** Apply knowledge of coloration methods, dyeing techniques, and textile finishing processes to enhance natural fiber products.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2				2					2
CO2	2	3				2			1		2
CO3	2	2	3	3		2			1		2
CO4	2	2				2			1		2
CO5	2	2				2		2	2		2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	2	1	1
CO2	1	1	1
CO3	-	1	-
CO4	-	1	-
CO5	-	1	-

UNIT – I

Introduction to Spinning

Concept of spinning: Hand spinning system; Charkha spinning system; Concepts and working principles of ginning, opening, cleaning and blending;

Concept of Yarn Manufacture: cotton system, woolen system, worsted system, jute system, flax (wet) system: Blow room, Carding (Flat type and roller-clearer), Drawing machine, Roving machine, Ring spinning, Rotor spinning; Modern developments in spinning; Principle of ring doubler and two-for- one twister; Fibre packing density of yarn; Yarn twist and its relation to yarn properties. Stress-strain relation, Mass irregularity.

Practice:

1. Basic concepts of spinning.
2. Manufacture of yarn from natural fibres.

UNIT – II

Preparatory Weaving

Preparatory weaving: Winding, Warping, Sizing, beaming, drawing and denting; Weaving: Concept of weaving, Handloom, Primary and secondary motions of loom; shedding, picking, Beat -up, Loom timing, Take-up and Let-off motions; Type of sheds; Tappet, dobby and jacquard Warp and weft stop motions; Warp protector motion. Shuttle loom, Shuttle-less looms, Basic designs; Basic woven fabric structure and design; Knitting: Concept of knitting, Warp knitting, weft knitting, advances in knitting; Nonwoven: Concept of nonwoven and classification of nonwoven, advances in non-woven preparation.

Practice:

1. Practical on weaving and knitting.
2. Preparation of warp and weft yarns for weaving.
3. Hands-on operation of shuttle and shuttle-less looms.

UNIT – III

Basic Yarn Testing

Basic Yarn testing: Count, Twist, tensile strength, CSP, Hairiness, Fabric testing: GSM, EPI, PPI, Tensile strength, tearing strength, Bursting strength, Crease recovery angle, Stiffness, Air permeability, Thermal conductivity; Fabric hand and comfort; Wetting and wicking; Water-vapour transmission.

Practice:

1. Yarn and fabric testing.

UNIT – IV

Chemical Composition of Plant and Animal Fibers

Chemical composition of plant and animal fibres - Natural and added impurities; Pre-treatment of natural fibre for surface cleaning/ removing impurities – Desizing; Scouring ; Degumming; Bleaching- reductive, oxidative; combined scouring and bleaching; Woollenization; Mercerization; fluorescent brightening agents; de-pigmentation; cottonisation; Carbonization, Felting of wool.

Practice:

1. Pre-treatments of natural fibres.
2. Bleaching processes for jute and flax fibres.

UNIT – V

Introduction to Dyes and Pigments

Value-addition of natural fibre by colouration- Introduction to dyes and pigments; Classification of dyes based on the source and application; Colouration of natural fibres- Direct, Acid, basic, Reactive, Vat, Sulphur, Solubilized and Natural dyes; Measurement of colour parameters; Evaluation of colour fastness against washing, light, bleaching, solvent; Dyeing machine; Dyeing of different textile forms- Hank yarn, Cone, Loose fibre, woven fabric, knitted fabrics and nonwoven fabric; Finishing: Physical, mechanical, physico-mechanical and chemical finishing; temporary and permanent finishing.

Practice:

1. Bleaching and dyeing of natural fibres.
2. Finishing of natural fibres.
3. Dyeing of wool using acid dyes.
4. Finishing of cotton fabrics using chemical finishing agents.

Text Books:

1. Booth J. E. Principles of textile testing: An introduction to physical methods of testing textile fibres, yarns and fabrics (6th Ed.). London: Newnes Butterworths. ISBN: 9780408000026.
2. Brown, R. Weaving, spinning and dyeing book. London: Routledge and Kegan Paul. ISBN: 9780710086374.

Reference Books:

1. Cegarra, J. P. and Valladperas, J. The dyeing of textile manual, the scientific bases and the techniques of application. Italy: NecovaOflito. ISBN: 1870812481.
2. Corbman, B. P. Fibre to Fabric step by step weaving (6th Ed.) New York: McGraw Hill. ISBN: 9780070662360.

Web Links:

1. Textile Learner
2. Textile Today

Agricultural Marketing and Trade

	L	T	P	C
Course Code: 241AE079	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain the fundamental concepts of agricultural marketing, including market structures and market segmentation.

CO2: Analyze demand and supply determinants for farm products and understand the implications of producer's surplus.

CO3: Develop pricing strategies and promotion plans suitable for agricultural commodities.

CO4: Evaluate the marketing process, including the roles of different marketing functions and functionaries.

CO5: Critically assess the role of government, risk management strategies, and international trade policies in agricultural marketing.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1	1							
CO2	2	3	2	1							
CO3	2	2	3	2							
CO4	1	2	2	3							
CO5	3	2	2	1							

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	2	-
CO2	-	2	-
CO3	-	2	-
CO4	-	2	-
CO5	-	2	-

UNIT – I

Concepts and Definitions

This unit delves into fundamental concepts and definitions critical to understanding agricultural marketing. Key topics include the definition and scope of market, marketing, and agricultural marketing. It covers market structure, marketing mix, and market segmentation, along with the classification and characteristics of agricultural markets. Students will explore the nature and determinants of demand and supply for farm products, including producer's surplus, marketable surplus, and marketed surplus, and the factors affecting these surpluses.

Practice:

1. Plotting and Study of Demand and Supply Curves
2. Calculation of Elasticities

UNIT – II

Pricing and Promotion Strategies

This unit focuses on various pricing considerations and strategies essential for agricultural commodities. It examines cost-based and competition-based pricing approaches. Additionally, the unit discusses different market promotion techniques such as advertising, personal selling, sales promotion, and publicity, highlighting their meanings, merits, and demerits.

Practice:

1. Study of Relationship Between Market Arrivals and Prices
2. Computation of Marketable and Marketed Surplus

UNIT – III

Marketing Process and Functions

Students will learn about the marketing process, including concentration, dispersion, and equalization. The unit covers exchange functions like buying and selling, physical functions such as storage, transport, and processing, and facilitating functions including packaging, branding, grading, quality control, and labelling (e.g., Agmark).

Practice:

1. Study of Price Behaviour Over Time
2. Construction of Index Numbers

UNIT – IV

Market Functionaries and Marketing Channels

This unit examines the types and importance of various agencies involved in agricultural marketing, the meaning and definition of marketing channels, and the different channel levels. It also looks into marketing channels for various farm products, market integration, marketing efficiency, marketing costs, margins, and price spread, and factors affecting the cost of marketing, including reasons for higher marketing costs and ways to reduce them.

Practice:

1. To study various marketing functions performed by different agencies.
2. To identify marketing channels for selected commodities.
3. To analyze marketing costs, margins, and price spread for selected commodities.

UNIT – V

Government Role, Risk Management, and Trade

This unit discusses the role of government in agricultural marketing, focusing on public sector institutions like CWC, SWC, FCI, CACP, and DMI, and their objectives and functions. It covers cooperative marketing in India and types of risk in marketing, speculation, hedging, and futures trading. Additionally, the unit provides an overview of agricultural prices and policy, including the need for innovations, international trade concepts, theories of absolute and comparative advantage, current status, and prospects of international trade in agro-commodities, WTO, Agreement on Agriculture (AoA), and its implications on Indian agriculture, and IPR.

Practice:

1. To understand the organization and functioning of market institutions.
2. To apply the principles of comparative advantage to agricultural commodities.
3. To present findings from market visits and data collection.

Text Books:

1. Cramer, G.L., Jensen, C.W., & Southgate, D.D. (2018). Agricultural Economics and Agribusiness. Wiley. ISBN: 10-9332449332456962.
2. Shepherd, G.S. Marketing Farm Products: Economic Analysis. Iowa State University Press. ISBN: 13-978-9387688061.

Reference Books:

1. Acharya, S.S., & Agarwal, N.L. Agricultural Marketing in India. Oxford & IBH Publishing Co. ISBN: 9788120416369.
2. Kohls, R.L., & Uhl, J.N. Marketing of Agricultural Products. Pearson. . ISBN: 9789332456966.

Web Links:

1. National Agricultural Cooperative Marketing Federation of India (NAFED)
2. Food Corporation of India (FCI)

Operations Research

	L	T	P	C
Course Code: 241AE080	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain and apply the principles of linear programming to formulate and solve optimization problems.
- **CO2:** Analyze and solve transportation and assignment problems to optimize logistics and resource allocation.
- **CO3:** Implement inventory control models to manage stock levels and minimize costs in operations.
- **CO4:** Utilize replacement theory and sequencing problem techniques to improve operational efficiency and decision-making.
- **CO5:** Apply queuing theory and network analysis methods, including CPM and PERT, for effective project planning and management.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	3	1		2					
CO2	3	2	3	1		2					
CO3	3	2	3	1		2					
CO4	3	2	3	1		2					
CO5	3	2	3	1		2					

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	2	2	2
CO2	2	3	2
CO3	1	3	2
CO4	3	2	2
CO5	3	2	3

UNIT – I

Introduction to Operations Research and Linear Programming

Introduction to operations research, elementary concepts and objectives, applications in decision-making, linear programming problem (LPP), mathematical formulation of LPP, graphical solution, simplex method for maximizing and minimizing, mixed constraints, duality theory, and primal-vs-dual solutions.

Practice:

1. Formulation of linear programming problems.
2. Graphical solution of LPP.
3. Solving LPP using the simplex method.

UNIT – II

Transportation and Assignment Problems

Transportation problem, definition and mathematical formulation, initial basic feasible solution, optimal solution, assignment problem, introduction, mathematical formulation, and solution.

Practice:

1. Solving transportation problems using the North-West Corner method.
2. Optimal solution of transportation problems using the stepping stone method.
3. Solving assignment problems using the Hungarian method.

UNIT – III

Inventory Control

Introduction to inventory control, general notations, economic lot size models with known demand.

Practice:

1. Calculation of economic order quantity (EOQ).
2. Inventory control model with known demand.
3. Simulation of inventory control scenarios.

UNIT – IV

Replacement Theory and Sequencing Problems

Introduction to replacement theory, elementary concepts, replacement of items deteriorating with time, sequencing problem, introduction, general notations, and solution methods.

Practice:

1. Solving replacement problems for deteriorating items.
2. Sequencing problems for n jobs on one machine.
3. Sequencing problems for n jobs on two machines.

UNIT – V

Queuing Theory and Project Planning

Introduction to queuing theory, classification of queues, solution of queuing models, project planning and network analysis, introduction, basic definitions in network analysis, rules for drawing network diagrams, Critical Path Method (CPM), Project Evaluation and Review Technique (PERT).

Practice:

1. Analysis of queuing models.
2. Drawing and analyzing CPM network diagrams.
3. Drawing and analyzing PERT network diagrams.

Text Books:

1. Hillier, F. S., & Lieberman, G. J. Introduction to Operations Research. McGraw-Hill. ISBN: 9789339221850.
2. Ravindran, A., Phillips, D. T., & Solberg, J. J. Operations Research: Principles and Practice. Wiley. ISBN: 978-8126512460.

Reference Books:

1. Winston, W. L. Operations Research: Applications and Algorithms. Indian University. ISBN:9780534423629.
2. Taha, H. Operations Research. Macmillan Publishing Company. *ISBN* :9780134444017.

Web Links:

1. INFORMS - Institute for Operations Research and the Management Sciences
2. Operations Research Society

Mechatronics

	L	T	P	C
Course Code: 241AE081	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain the fundamental concepts of mechatronics, including measurement and control systems.
- **CO2:** Analyze and apply various sensors and transducers in mechatronics systems.
- **CO3:** Utilize actuators and mechanical actuation systems, including hydraulic, pneumatic, and electrical systems.
- **CO4:** Develop and model dynamic systems using control modes and PID controllers.
- **CO5:** Implement microprocessor-based controllers and robotics applications in mechatronics systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2	1	2						
CO2	3	2	3	1	2	2					
CO3	3	2	3	1	2	2					
CO4	3	2	3	1	2	2					
CO5	3	2	3	1	2	2					

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	2	2	2
CO2	2	3	2
CO3	2	3	2
CO4	2	2	2
CO5	3	3	2

UNIT – I

Introduction to Mechatronics

Definition of mechatronics, measurement systems, control systems, microprocessor-based controllers, and mechatronics approach.

Practice:

1. Study of different types of transducers.
2. Selection of sensor for a particular application from catalogue and internet.

UNIT – II

Sensors and Transducers

Performance terminology, displacement, position & proximity sensors, photo-electric transducers, flow transducers, optical sensors, and transducers.

Practice:

1. Application of mechatronics for enhancing product values.

2. Study of electrical actuation systems with A.C. Motor.

UNIT – III

Actuators and Mechanical Actuation Systems

Hydraulic and pneumatic actuation systems, measurement systems, electrical actuation systems, A.C. motor, D.C. motor, stepper motor, signal conditioning process, filtering digital signal, data acquisition system, multiplexers, digital signal processing, pulse modulation, data presentation systems.

Practice:

1. Study of electrical actuation systems with D.C. Motor.
2. Study of electrical actuation systems with Stepper Motor.

UNIT – IV

System Modelling & Control

Mathematical models, engineering systems, electro-mechanical & hydraulic-mechanical systems, modeling dynamic systems, transfer functions, control modes, and PID controller.

Practice:

1. Study of the PID Controller.
2. Study of the hardware and software of mechatronics kit.

UNIT – V

Microprocessor & Computer Applications

Computer and interfacing, micro-computer structure, micro-controllers, application of microcontrollers, PLC, robotics, robot classification and specification, robot components, work envelopes, other basic parameters of robots, robot applications, robot applications in manufacturing, material transfer and machine loading/unloading, processing operations like welding & painting, assembly operations, inspection, automation, future applications.

Practice:

1. Study of pulse modulation, data presentation systems.
2. Moving a table in X-direction within the range of proximity sensors using Control-X software.
3. Running a motor with PLC.
4. Running a conveyor with computer.
5. Study of the movement of actuating cylinders and sensors.

Text Books:

1 Doeblin, E. O. Measurement Systems. McGraw-Hill Inc. ISBN:978-0070699687.

2 Malvino, A. P. Digital Computer Electronics. McGraw-Hill Inc.ISBN: 978-0074622353.

Reference Books:

1 Bolton, W. Mechatronics. Pearson Education Asia. *ISBN:* 978-9353065881 .

2 Stadler, W. Analytical Robotics and Mechatronics. McGraw-Hill Inc. *ISBN:* 978-0070606081.

Web Links:

1 Mechatronics Online

2 Robotics and Mechatronics on Coursera

Machine Learning

	L	T	P	C
Course Code: 241AE094	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain the evolution, paradigms, stages, and techniques of Machine Learning.
- **CO2:** Apply nearest neighbor-based models, covering proximity measures, distance metrics, classification algorithms.
- **CO3:** Demonstrate classification and regression models, including impurity measures, properties, bias-variance trade-off.
- **CO4:** Analyze linear discriminants in machine learning, perceptron classifiers; support vector machines (SVMs) and multi-layer perceptrons (MLPs) with back propagation for training.
- **CO5:** Apply clustering techniques on given data, find similarity of classes.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	2	1							1
CO2	3	3	2	2							2
CO3	3	2	1	2							1
CO4	2	2	1	1							1
CO5	2	3	1	2							2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	1	2	2
CO2	2	2	2
CO3	2	2	2
CO4	2	2	2
CO5	2	3	2

UNIT – I

Introduction to Machine Learning, Preliminaries, what is machine learning; varieties of machine learning, learning input/output functions, bia, sample application. Boolean functions and their classes, CNF, DNF, decision lists.

Practice:

1. Implementing and Analyzing Boolean Functions, CNF, DNF, and Decision Lists
2. Exploring Different Types of Machine Learning and Sample Applications

UNIT – II

Version spaces for learning, version graphs, learning search of a version space, candidate elimination methods. Statistical Learning, background and general method, learning belief networks, nearest neighbor. Decision-trees, supervised learning of uni-variance decision trees, network equivalent of decision trees, over fitting and evaluation.

Practice:

1. Constructing and Visualizing Version Spaces and Version Graphs
2. Implementing Candidate Elimination Methods for Learning
3. Implementing and Evaluating Decision Trees for Supervised Learning
4. Exploring Nearest Neighbor Algorithms and Learning Belief Networks

UNIT – III

Inductive Logic Programming, notation and definitions, introducing recursive programs, inductive logic programming vs decision tree induction; Computational learning theory, fundamental theorem, Vapnik Chernonenkis dimension, linear dichotomies and capacity.

Practice:

1. Inductive Logic Programming: Learning Recursive Programs
2. Exploring Computational Learning Theory and Vapnik Chernonenkis Dimension

UNIT – IV

Unsupervised learning, clustering methods based on Euclidian distance and probabilities, hierarchical clustering methods. Introduction to reinforcement and explanation-based learning.

Practice:

1. Implementing Clustering Methods for Unsupervised Learning and Introduction to Reinforcement Learning

UNIT-V

Neural Networks, threshold logic units, linear machines, networks of threshold learning units, Training of feed forward networks by back propagations, neural networks vs. knowledge-based systems.

Practice:

1. Building and Training a Simple Neural Network Using Threshold Logic Units
2. Implementing Backpropagation for Training Feedforward Neural Networks
3. Comparing Neural Networks with Knowledge-Based Systems

Text Books:

1. Andreas, C. Muller. 2009. Introduction to Machine Learning with Python- A guide for data scientists, Sarah Guido, O'Reilly. ISBN: 978-1449369415.

2. Alpaydin Ethem. 2009. Introduction to Machine learning, Third Edition, MIT Press. ISBN: 978-0262028189.

3. Mueller J. P. and Massaron L. 2021. Machine learning for dummies, 2nd Edition, Weily. ISBN: 978-1119541045.

Reference Books:

1. "Machine Learning in Action",Peter Harrington, DreamTech. ISBN: 978-1617290180.
2. "Introduction to Data Mining", Pang-Ning Tan, Michel Stenbach, Vipin Kumar, 7th Edition. ISBN: 978-0321321367.

Web Links:

1. https://nptel.ac.in/courses/106105077
2. https://www.kaggle.com
3. https://aima.cs.berkeley.edu
4. https://ai.berkeley,edu/project_overview.html
5. http://www.zuj.edu.jo/download/machine-learning-tom-mitchell-pdf

Python Programming

	L	T	P	C
Course Code: 241CS072	**1**	**0**	**2**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Develop programs using python fundamentals
- **CO2:** Make use of control statements and strings for devloping applications
- **CO3:** Develop applications using data structures and functions
- **CO4:** Apply OOPs concepts and files for devloping programs
- **CO5:** Make use of Exception Handling to handle runtime errors

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	1		2				3	1	2
CO2	1	2	3		2				2	1	2
CO3	1	3	2		2				2	1	2
CO4	1	2	3		2				2	1	2
CO5	1	2	3		2				2	1	2

UNIT – I

History of Python-Getting Started with Python-Programming style and Documentation-Identifiers-Variables-Assignment statements-Expressions- Data Types-Operators-Precedence-Comments-Type Conversions- Common Python Functions-Introduction to Methods and Strings.

UNIT – II

Control Statement: Definite iteration for Loop Formatting Text for output, Selection if and if else Statement, Conditional Iteration The While Loop, Strings and Text Files: Accessing Character and Substring in Strings.

UNIT – III

Lists, Defining Simple Functions, Dictionaries, Design with Function: Functions as Abstraction Mechanisms, Problem Solving with Top Down Design, Design with Recursive Functions, Case Study Gathering Information from a File System.

UNIT – IV

Reading config files in python, Writing log files in python, Understanding read functions, read(), readline() and readlines(), Understanding write functions, write() and writelines(), Manipulating file pointer using seek, Programming using file operations Object Oriented Programming: Concept of class, object and instances, Constructor, class attributes and destructors, Real time use of class in live projects, Inheritance , overlapping and overloading operators.

UNIT – V

Errors and Exceptions: Syntax Errors, Exceptions, Handling Exceptions, Raising Exceptions, User-defined Exceptions, Defining Clean-up Actions, Redefined Clean-up Actions. Graphical User Interfaces: The Behavior of Terminal Based Programs and GUI - Based, Programs.

INTEGRATED LAB WITH 2 CREDITS

Practice:

1.1) Write a program that asks the user for a weight in kilograms and converts it to pounds. There are 2.2 pounds in a kilogram.
1.2) Write a program that asks the user to enter three numbers (use three separate input statements). Create variables called total and average that hold the sum and average of
the three numbers and print out the values of total and average.

2.1) Write a program that uses a for loop to print the numbers 8, 11, 14, 17, 20, . . . , 83, 86, 89.
2.2) Write a program that asks the user for their name and how many times to print it. The program should print out the user's name the specified number of times.
2.3) Generate a random number between 1 and 10. Ask the user to guess the number and print a message based on whether they get it right or not.

3.1) Split a string into array of characters in Python
3.2) Python program for slicing a string
3.3) Python program to repeat M characters of a string N times
3.4) Python program to swap characters of a given string

4.1) write a Python program to sum all the items in a list.
4.2) write a Python program to get the largest number from a list.
4.3) write a Python program to get the largest number from a list.
4.4) write a Python program to remove an item from a set if it is present in the set.

5.1) Write a Python program to calculate the nth Fibonacci number using a function.
5.2) Write a Python program to count the number of vowels or consonants in a string using a function.

5.3) Write a Python program to capitalize the first letter of each word in a string using a function

6.1) Write a Python program to read data from a file, perform some operation using a function, and write the result to another file.
6.2) Write a Python program to count the number of lines, words, and characters in a file using functions.
6.3) Write a program to count frequency of characters in a given file

7.1)Write a Python program that defines a Car class with attributes like make, model, and year, and methods like start() to start the car and stop() to stop it.
7.2) Write a Python program that demonstrates inheritance by creating a base class Animal and derived classes like Dog, Cat, etc., each with their specific behaviors.
7.3) Define a base class called Animal with a method make_sound(). Implement derived classes like Dog, Cat, and Bird that override the make_sound() method to produce different sounds. Demonstrate polymorphism by calling the method on objects of different classes.

8.1)Write a Python program that demonstrates method overriding by creating a base class Shape with a method area() and a derived class Circle that overrides the area() method to calculate the area of a circle.
8.2) Write a Python program that demonstrates error handling using the try-except block to handle division by zero.
8.2) Write a Python program that reads data from a file named "data.txt", counts the number of words in the file, and prints the result.

9.1) Write a Python program to create a simple calculator GUI application using functions for arithmetic operations.
9.2) Write a Python program to build a todo list GUI application with functions for adding, deleting, and updating tasks.

10.Create a program to manage student records including their name, roll number, marks, and attendance. Allow functionalities like adding new students, updating records, and generating reports.

11.Create a quiz game with multiple-choice questions on various topics such as science, history, geography, etc. Implement features like keeping track of scores, displaying correct answers, and providing feedback.

12.Create a simple to-do list application where users can add, edit, and delete tasks. Implement features like marking tasks as completed and sorting tasks by priority or due date.

Additional Practice:

1. Write a program to find the greatest number that can be formed by using given set of numbers.
2. Write a program to find sum of digits of a number till you get single digit sum.

Example:
Input : 142 (Hint: 1+4+2=7)
Output : 7
Input : 4683 (Hint: 4+6+8+3=21 =>2+1=3)
Output : 3

3.Write a program to count how many times each word present in a file.

Text Books:

1. Python for Everybody Exploring Data in Python 3, Charles Russell Severance, SueBlumenberg. ISBN:978-1530051120.
2. Code with Python: Suresh Sundaradasu,S.Rama Sree ISBN: 978-9355017574

Reference Books:

1. Automate the Boring Stuff with Python: Practical Programming for Total Beginners,Al Sweigart, ISBN: 978-1593275990.
2. Python Crash Course: A Hands-On, Project-Based Introduction to Programming Eric Matthes,ISBN: 978-1593279288.
3. Python Programming, Dr.Maganti Venkatesh,Monelli Ayyavaraiah,Niveditha Ravindra Pandey, NeethumolSabu,Charulatha Publications ISBN:978-93-5577-695-6.

Web Links:

1. https://www.hackerrank.com/
2. https://www.codechef.com/
3. https://www.topcoder.com/
4. https://code-cracker.github.io/

241Course Code	Multi-Disciplinary Courses (MDC)						Marks			Pre-requisite
	Course Name	Level	L	T	P	C	CIE	SEE	Total	
241AE002	Crop Production and Protection Technologies	FC	3	0	1	4	50	50	100	-
241AE009	Farming Based Livelihood Systems	FC	2	0	1	3	50	50	100	-
241AE024	Entrepreneurship Development and Business Management	IC	2	0	1	3	50	50	100	-
	Total		7	0	3	10				

Crop Production and Protection Technologies

Semester: I	L	T	P	C
Course Code: 241AE002	3	0	1	4

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Apply agronomic principles, crop management techniques, and sustainable farming practices.
- **CO2:** Explain soil-water-plant relationships, crop water requirements, weed management, and various cropping systems.
- **CO3:** Demonstrate soil formation, classification, physical and chemical properties, nutrient availability, soil fertility, and irrigation water quality.
- **CO4:** Explain essential plant nutrients, deficiency symptoms, inorganic fertilizers, soil reactions, sodic soil reclamation, and liquid fertilizer properties.
- **CO5:** Demonstrate horticultural crop types, propagation methods, planting techniques, orchard management, and pest and disease control.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1						1		
CO2	2	3	2						1		
CO3	3	2	3								
CO4	2	3	2	3							
CO5	3	2	3	2		2			1		

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	3
CO2	-	-	3
CO3	-	-	3
CO4	-	-	3
CO5	-	-	3

UNIT – I

Introduction to Agronomy

Introduction and scope of agronomy; Classification of crops; Effect of different weather parameters on crop growth and development; Principles of tillage, tilth and its characteristics; Crop seasons; Time and method of sowing of major field crops, seed rate for important crops; Methods and time of application of manures and fertilizers, fertigation; Basic principles of natural farming, organic farming and sustainable agriculture.

Practice:

1. Identification of crops and their varieties of seeds.
2. Study of different fertilizer application methods.

UNIT – II

Agricultural Practices and Soil Management

Soil-water-plant relationship, crop coefficients, water requirement of crops and critical stages for irrigation; Weeds and their management in crops; Crop rotation, cropping systems, cropping scheme, relay cropping, mixed cropping and intercropping. Quality of irrigation water.

Practice:

1. Determination of bulk density, particle density and porosity of soil.
2. Study of weed control methods.

UNIT – III

Soil Science and Fertility

Soil forming processes; Classification and composition of soil, soil taxonomy orders; Important soil physical properties and their importance; soil particle distribution; soil inorganic colloids– their composition, properties and origin of charge; ion exchange in soil and nutrient availability; soil organic matter– its composition and decomposition, effect on soil fertility; Soil reaction – acidic, saline and sodic soils.

Practice:

1. Identification of rocks and minerals.
2. Study of soil profile in the field.

UNIT – IV

Plant Nutrition

Essential plants nutrients- their functions and deficiency symptoms in plants; Important inorganic fertilizers and their reactions in soils; Gypsum requirement for reclamation of sodic soils and neutralizing RSC; Liquid fertilizers and their solubility and compatibility.

Practice:

1. Identification of nutrient deficiency symptoms of crops in the field.
2. Determination of gypsum requirement of sodic soils.

UNIT – V

Horticultural Practices

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

Practice:

1. Study of different garden tools.
2. Preparation of nursery bed.
3. Practices of pruning and training in some important fruit crops.
4. Study of cultural operations for vegetable crops (sowing, fertilizer application, mulching, irrigation and weed control).

Text Books:

1. Reddy S R. 2020. Principles of Agronomy. Kalyani Publisher. ISBN: 978-9327297942.
2. Biswas T. D., and Mukharjee S. K. A text book of soil science. Tata McGraw-Hill publishing Co. Ltd. ISBN: 9780074517855.
3. Ahamad S, Anwar Ali and Sharma P K (Eds.). 2018. Plant disease management in Horticultural crops. Daya Publishing House, Delhi. ISBN: 9789388173229.

Reference Books:

1. Brady N C and Ray R Weill. The nature and properties of soil. Pearson Education Inc. New Delhi. ISBN: 9780130167637.
2. Chadha K L. Hand Book of Horticulture. ICAR Publication, New Delhi. ISBN No: 9788171640614.

Web Links:

1. http://ecoursesonline.iasri.res.in/Courses/Introduction%20to%20Soil%20Science/SSAC121/Start%20to%20read%20the%20Course.html
2. http://ecoursesonline.iasri.res.in/Courses/Principles%20of%20Agronomy%20&%20agrcltrl%20Meteorology/AGRO101/Start%20to%20read%20the%20Course.html

Farming Based Livelihood Systems

Semester: II	L	T	P	C
Course Code: 241AE009	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Outline the status of agriculture in India, income patterns of farmers and rural people, and livelihood concepts and indicators in urban and rural areas.
- **CO2:** Comprehend agricultural livelihood systems, farming systems, and prevalent farming systems in India that contribute to livelihood.
- **CO3:** Analyze different traditional and modern farming systems, their components, and the integration of various enterprises for livelihood.
- **CO4:** Evaluate the feasibility of different farming systems for various agro-climatic zones, and study commercial farming-based livelihood models and case studies.
- **CO5:** Assess the risk and success factors in farming-based livelihood systems, government schemes and programs

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1						3			3		3
CO2						2			2		2
CO3						2			2		2
CO4						2					
CO5						2					

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	1	2
CO2	-	1	2
CO3	-	1	2
CO4	-	1	2
CO5	-	1	2

UNIT – I

Agriculture and Livelihoods in India: Status, Income, and Patterns

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban & rural areas, Different indicators to study livelihood systems.

Practice:

1. Analysis of Agricultural Productivity
2. Survey on Farmer Income.

UNIT – II

Agricultural Livelihood Systems: Framework and Farming Systems in India

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.

Practice:

1. Survey of farming systems and agricultural based livelihood enterprises.

UNIT – III

Traditional and Modern Farming Systems: Components and Livelihood Integration

Types of traditional & modern farming systems. Components of farming system/ farming-based livelihood systems- Crops and cropping systems, Livestock, (Dairy, Piggery, Goatry, Poultry, Duckry etc.), Horticultural crops, Agro -forestry systems, Aqua culture 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.

Practice:

1. Study of components of important farming based livelihood models/ systems in different agro-climatic zones.
2. Study of production and profitability of crop based, livestock based, processing based and integrated farming based livelihood models.
3. Field visit of innovative farming system models.
4. Visit of Agri-based enterprises & their functional aspects for integration of production, processing & distribution sectors.

UNIT – IV

Agro-climatic Feasibility and Commercial Farming Models for Livelihoods

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.

Practice:

1. Study of agri-enterprises involved in industry and service sectors(Value Chain Models),
2. Learning about concept of project formulation on farmingbased livelihood systems along with cost & profit analysis,
3. Case study of Start-Ups in agri-sectors.

UNIT – V

Risk and Success Factors in Farming-Based Livelihood Systems: Government Schemes, Circular Economy, and Digitalization

Risk & success factors in farming-based livelihood systems, schemes & programmes by Central & State Government, Public & 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 & changing life style.

Practice:

1. Study of schemes & programmes by central & state government.
2. Study the impact of Climate Change on Farming Livelihoods.

Text Books:

1. Agarwal, A. & Narain, S. Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India. ISBN: 9788185040480.
2. Dixon, J. and A. Gulliver with D. Gibbon. Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO & World Bank, Rome. ISBN: 9789241046277.

Reference Books:

1. Reddy, S.R. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi. ISBN: 9789327223524.
2. Walia, S. S. and U. S. Walia, 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan. ISBN: 9788194312033.

Web Links:

1. https://www.slideshare.net/slideshow/farming-based-livelihood-systems-2-1-theory-note/274649851
2. http://www.fmtcndl.iari.res.in/Division/UGcourse/124.pdf

Entrepreneurship Development and Business Management

Semester: IV	L	T	P	C
Course Code:241AE024	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Identify and explain the motivational, social, and environmental factors influencing the development of entrepreneurship.
- **CO2:** Explain the concept and need for environmental scanning in entrepreneurship and its role in opportunity identification.
- **CO3:** Analyse the sequential steps involved in the functioning and establishment of an enterprise.
- **CO4:** Prepare a viable project report by applying enterprise planning and production management principles.
- **CO5:** Apply personal, financial, marketing, and crisis management techniques for effective entrepreneurial venture management.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2				2		2			
CO2	2	3		2			2				
CO3	2	3	2								2
CO4	2	3	3		2				2	2	3
CO5		2	3		2	2		2	3	3	3

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	1	-	1
CO2	1	-	1
CO3	1	-	1
CO4	1	-	1
CO5	1	-	1

UNIT – I

Development of Entrepreneurship

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development.

Practice:

1. Initiation and Preparation of project proposal for funding by different agencies.

UNIT – II

Environment scanning and opportunity

Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development.

Practice:

1. Visit to small scale industries/agro-industries

UNIT – III

Role of financial institutions

Role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution.

Practice:

1. Interaction with successful entrepreneurs/ Agric- entrepreneurs.

UNIT – IV

Planning of an Enterprise

Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control.

Practice:

1. Visit to financial institutions and support agencies

UNIT – V

Personal Management

Personal management – manpower planning, labour turn over, wages / salaries. Financial management /accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, bookkeeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management, market types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practice:

1. Project report submission

Text Books:

1. Charantimath P.M. Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi. ISBN: 978-9353066260.
2. Desai V. Entrepreneurship: Development and Management, Himalaya Publishing House. ISBN: 978-93-5299-133-4.

Reference Books:

1. Singhal R.K. Entrepreneurship Development & Management, Katson Books. ISBN: 978-81-89757-00-7.
2. Tripathi P C & Reddy P N. Principles of Management. Tata McGraw Hill. ISBN-13. 978-9354600630.

Web Links:

1. https://archive.nptel.ac.in/courses/110/106/110106141/
2. https://ocw.mit.edu/courses/15-351-managing-innovation-and-entrepreneurship-spring-2008/resources/03_lec/

Course Code	Ability Enhancement Courses (AEC)						Marks			Pre-requisite
	Course Name	Level	L	T	P	C	CIE	SEE	Total	
241PE002	NSS/ NCC- I	FC	0	0	1	1	100	-	100	-
241CS071	Computer Programming and Data Structures	IC	0	0	2	2	50	50	100	-
241EN001	Essential Cognitive Skills for Engineers	FC	0	0	1	1	100	-	100	-
241EN002	Advanced Cognitive Skills for Engineers	FC	0	0	1	1	100	-	100	-
241PE003	NSS/ NCC- II	FC	0	0	1	1	100	-	100	-
241PE004	Physical Education, First Aid and Yoga Practice	FC	0	0	2	2	100	-	100	-
241UC012	Personality Development	FC	1	0	1	2	100	-	100	-
	Total		1	0	9	10				

NSS/NCC-I

Semester: I	L	T	P	C
Course Code: 241PE002	0	0	1	1

1. Physical Training:
Includes exercises, drills, and workouts focusing on improving physical fitness, strength, and endurance.

2. First Aid Training:
Instruction on basic first aid techniques such as CPR, wound care, and emergency response.

3. Navigation and Orienteering:
Learning how to use maps, compasses, and GPS devices for navigation in outdoor environments.

4. Campcraft and Survival Skills:
Teaching essential skills for outdoor survival, including shelter building, fire starting, and foraging.

5. Sports and Games:
Participation in various sports and games to develop teamwork, coordination, and sportsmanship.

Computer Programming and Data Structures

Semester: II	L	T	P	C
Course Code: 241CS071	0	0	2	2

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Develop simple applications in C using basic constructs
- **CO2:** Design and implement applications using functions, pointers and Structures
- **CO3:** Explore the applications of linear and non-linear data structures
- **CO4:** Learn to represent data using tree and graph data structure.
- **CO5:** Compare and select effective sorting and searching algorithms.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2									
CO2	2	2									
CO3	3	1									
CO4	2	2									
CO5	2	2									

INTEGRATED LAB WITH 2 CREDITS

Practice

1: Basic Structure and Familiar with IDE's
a. Basic Linux environment and its editors like Vi, Vim & Emacs etc.
b. Exposure to Turbo C, gcc
c. Basic C Program compilation
d. Explore to Hacker Rank or any other Online coding platform and compiler envi

Develop C program for the following:
2: I/O statement and Operators
a. Conversion of Fahrenheit to Celsius and vice versa.
b. Distance travelled by an object.
c. Calculate Simple interest and compound interest.

3: Conditional operators
a. Find the Square root of a given number.
b. Find the area of circle, square, rectangle and triangle.
c. Find the maximum of three numbers using conditional operator.

4: Continue for operators
a. Take marks of 5 subjects in integers, find the total in integer and average in float.

b. Generate the Roots of a Quadratic Equation.
c. Generate electricity bill.
d. Find the given year is a leap year or not.
e. Given num

5 : Arrays
a. Search an element in array (Linear Search)
b. Implement Bubble sort, selection sort
c. Find min and max elements in array
d. Insert an element into array
e. Find the Sum of two 2-D arrays
f. Multiplication of two 2-D arrays

6: Function
a. Swap two numbers using functions and without functions
b. Print factorial of given numbers using functions and withour function.
c. Print Fibonacci using functions and without functions.

7: Strings
a. Lowercase to Uppercase, Uppercase to Lowercase, Toggle case, Sentential case

8: linked list
Perform the creation, insertion, deletion and traversal operations on Singly linked list

9: Linked list
Perform the creation, insertion, deletion and traversal operations on doubly linked list

10: Linked list
Perform the creation, insertion, deletion and traversal operations on circular linked list

11: Stack
a. Implement stack (its operations) using arrays.
b. Implement stack (its operations) using pointers.

12: Queues
a. Implement Queue (its operations) using arrays.
b. Implements selection sort to sort given list of integers in ascending order.

Additional Practice:

1. Write a C program that implements selection sort to sort given list of integers in ascending order.
2. Write a C program that implements bubble sort to sort given list of integers in ascending order.
3. Pointers in C Objective: learn to implement the basic functionalities of pointers in C. https://www.hackerrank.com/challenges/pointer-in-c/problem?isFullScreen=true
4. Boxes through a Tunnel Objective: Using a structure for transporting some boxes thro

Text Books:

1. Byron S Gottfried, “Programming with C”, Schaum’s Outlines, Second Edition, Tata McGraw-Hill. ISBN: 978-0070240353
2. Ellis Horowitz, Sartaj Sahni, Susan anderson-Freed, ―Fundamentals of Data Structures in C, Second Edition, University Press. ISBN: 978- 0716782406.

Reference Books:

1. Fundamentals of data structures in C, Ellis Horowitz, Sartaj Sahni, Susan anderson-Freed, Silicon Press. ISBN: 0716782402.
2. Mark Allen Weiss, ―Data Structures and Algorithm Analysis in C, Second Edition, Pearson Education. ISBN: 978-8131714744.

Web Links:

1. https://nptel.ac.in/courses/106102064
2. https://archive.nptel.ac.in/courses/106/105/106105224/

Essential Cognitive Skills for Engineers

(Common to all branches)

Semester: I	**L**	**T**	**P**	**C**
Course Code: 241EN001	**0**	**0**	**1**	**1**

Course Outcomes: At the end of the course, student will be able to:

CO1: Recognize the different aspects of the English language proficiency with emphasis on LSRW skills.

CO2: Apply communication skills through various language learning activities.

CO3: Analyze the English speech sounds, stress, intonation and syllable division for better listening and speaking comprehension.

CO4: Enable them to learn and apply fundamentals of English grammar concepts for improved language.

CO5: Make use of various types of vocabulary in different academic and professional careers.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	-	-	-	-	-	-	-	3	-	-
CO2	-	-	-	-	-	-	-	-	3	-	-
CO3	-	-	-	-	-	-	-	-	3	-	-
CO4	-	-	-	-	-	-	-	-	3	-	-
CO5	-	-	-	-	-	-	-	-	3	-	-

Practice:

Unit – 1 **Outstanding people A/B/C/D**

Listening	Conversation about Jocelyn Bell- Burnell, Podcast: The 30-day challenge, Starting a new job, Conversation about technology
Speaking	Discussing inspiring people, Asking and answering questions about challenges, Explaining a process; Checking understanding, Discussing technology.
Reading	Articles: *Protector of the sea and The woman who reinvented children's TV,* Interviews*: 30-day challenge,* Article: *Tech free!*
Writing	Article Organizing an article
Grammar	Review of Tenses, Questions
Vocabulary	Character adjectives, trying and succeeding

Pronunciation	The letter e; Word stress, Rapid speech

Unit – 2 Survival A/B/C/D

Listening	Conversation about a survival situation, Interview: The Tiger, Cooking for a friend, Talking about getting lost
Speaking	Telling a survival story, Giving advice; Asking questions, Giving compliments and responding, Discussing the natural environment
Reading	Article: Lost at sea, Leaflet: *How to survive…an animal attack*, Leaflet: *Be wise and survive*
Writing	Guidelines, organizing guidelines in a leaflet
Grammar	Narrative tenses, Future time clauses and conditionals
Vocabulary	Expressions with *get,* Animals and the environment
Pronunciation	Sound and Spelling: g, Intonation in question tags

Unit – 3 Talent A/B/C/D

Listening	Conversation: learning experiences, Radio Programme: The sports gene, Making wedding plans, Interviews about sport
Speaking	Talking about something you have put a lot of effort into, Discussing sport and ways to improve performance, planning a party, Talking about popular sports
Reading	Text about learning; *Learning to learn*, Article: *Born to be the best*; Three articles about athletes, Article: *Fitness: Seattle snapshot*
Writing	Article describing data
Grammar	Multi-word verbs, Present perfect and present perfect continuous
Vocabulary	Ability and achievement, word connected with sport
Pronunciation	Word stress, sound and spelling consonant sounds

Unit – 4 Life Lessons A/B/C/D

Listening	Interview: Psychology of money; Two monologues: Life-changing events, Two monologues; training for a job, Presenting photos, Three monologues; living in different places
Speaking	Talking about how your life has changes, Discuss

	experiences of training and rules, Describing photos: Expressing careful disagreement, Discussing living in a different country
Reading	Two texts about life-changing events that helped people become rich, Article: *Training for the emergency frontline,* Advert for being an international student 'buddy'
Writing	Job application, Giving a positive impression
Grammar	*Used to* and *would*
Vocabulary	Cause and result, Talking about difficulty
Pronunciation	Sound and spelling: *u*

Unit – 5 Chance A/B/C/D

Listening	Monologue: What are your chances?, Conversation: Talking about work, Money problems, News reports: environmental problems
Speaking	Discussing possible future events, Role Play: job interview, Explaining and responding to an idea for a café, Giving opinions on environmental problems
Reading	Quiz: *Are you an optimist or a pessimist?; Article: Why we think we're going to have a long and happy life*, Quiz: *The unknown continent*; Article: *Cooking in Antarctica*, Essay about protecting the environment
Writing	For and against essay, Arguing for and against an idea
Grammar	Future probability, Future perfect and future continuous
Vocabulary	Adjectives describing attitude, The natural world
Pronunciation	Sound and spelling : *th,* Intonation groups

Text Book:

- Cambridge Empower – Second Edition B2 Level - Adrian Doff, Craig Thaine, Herbert Puchta, Jeff Stranks, Peter Lewis – Jones. ISBN: 978-1107468726.

Suggested Software:

- Cambridge Empower
- Soft X (K-Van Solutions)

Reference Books:

1. M Ashraf Rizvi: Effective Technical Communication. ISBN: 978-9352605781.
2. Raymond Murphy: English Grammar in Use, Cambridge University Press. Fifth Edition. ISBN 978-1-108-45771-2.
3. J. Sethi & P.V. Dhamija. A Course in Phonetics and Spoken English, (2nd Ed), Kindle, 2013. ISBN : 9788120314955.

Web links:

1. https://www.cambridgeone.org/login
2. https://www.britishcouncil.in/english/online
3. www.englishmedialab.com

Advanced Cognitive Skills For Engineers

(Common to all branches)

	L	T	P	C
Semester: II				
Course Code: 241EN002	**0**	**0**	**1**	**1**

Course Outcomes: At the end of the course, student will be able to:

CO1: Recognize the basics of communication and summarize formal and informal language expressions in all aspects.

CO2: Establish and maintain interpersonal relationships and transmit the message through different language activities.

CO3: Use language effectively to prepare and demonstrate proficiency in facing various types of interviews.

CO4: Demonstrate and exhibit professionalism in participating in various public speaking activities like debates, group discussions and presentation skills.

CO5: Identify the basic elements of writing and apply the fundamentals to compose e-mails catering to different professional needs.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	-	-	-	-	-	-	-	3	-	-
CO2	-	-	-	-	-	-	-	-	3	-	-
CO3	-	-	-	-	-	-	-	-	3	-	-
CO4	-	-	-	-	-	-	-	-	3	-	-
CO5	-	-	-	-	-	-	-	-	3	-	-

Practice

Unit – 1 Around the globe A/B/C/D

Listening	Two monologues about sightseeing tours, Interview: disappearing languages, Asking for a favour, conversation: a trip to the Grand Canyon
Speaking	Comparing different tourist destinations, Agreeing and disagreeing, Asking for a favour, Discussing local tourist destinations.
Reading	Website bout four tourist destinations; Website: *Where to go?*
Writing	Travel blog, Using descriptive language
Grammar	Infinitives and *–ing* forms

Vocabulary	Travel and tourism, Describing changes
Pronunciation	Consonant clusters, Consonant sounds

Unit – 2 City living A/B/C/D

Listening	Interview: 'Smart' cities: Two monologues talking about 'smart' cities, Two monologues: house renovations, Flat hunting, Interviews about a new shopping centre
Speaking	Discussing good and bad points about a city
Reading	Article: *Quick-slow down!*, Article: *Who puts the 'real' in reality* TV? Email: Complaining about an important issue.
Writing	Email of complaint, Using formal language
Grammar	*Too/enough; so/such*, Causative *have/get*
Vocabulary	Describing life in cities, Film and TV; Houses
Pronunciation	Sound and spelling: o, Stress in compound nouns

Unit – 3 Dilemmas A/B/C/D

Listening	Radio programme: person finance, Three monologues about honesty, Going to the bank, Conversation about a TV programme
Speaking	Giving opinions on financial matters, Discussing moral dilemmas, Talking about hopes and worries Discussing programmes about crime
Reading	Article: *Is it time to give up on cash?*, Newspaper article: *The honesty experiment*, Review: *Crime with a smile*
Writing	Review, Organising a review
Grammar	First and second conditionals, Third conditional; *should have+past participle*
Vocabulary	Money and finance, Crime
Pronunciation	Stressed and unstressed words; Sound and spelling: *l,* Word groups

Unit – 4 Discoveries A/B/C/D

Listening	Conversation about inventions, Conversation about an email hoax, Finding the perfect flat, Four monologues about alternative medicine
Speaking	Talking about inventions, Describing a hoax or a scam or a case of fraud, Giving and receiving surprises
Reading	Article: *Too good to be true?*, Article: *The rise and fall of Barry Minkow,* Essay: *The Value of alternative medicine*

Writing	Opinion essay, Presenting a series of arguments
Grammar	Relative clauses, Reported speech; Reporting verbs
Vocabulary	Health, Verbs describing thought and knowledge
Pronunciation	Sound and spelling : *ui*, Linking and intrusion

Unit – 5 Possibilities A/B/C/D

Listening	Interview about Dan Cooper, Two monologues: pursuing a dream, Celebrating good news, conversation about goals
Speaking	Telling stories about coincidences, Describing and comparing brave or amazing people, Telling an important piece of news, Talking about performing
Reading	Story: The man who disappeared; Blog: *The Wreck of the Titan*, Article: *Dream to help*, Story: Rosa's diary: *The ultimate goal*
Writing	Story, Making a story interesting
Grammar	Past modals of deduction, Wishes and regrets
Vocabulary	Adjectives with prefixes, Verbs of effort
Pronunciation	Word stress, Linking, Consonant clusters

Text Book:

- Cambridge Empower – Second Edition B2 Level - Adrian Doff, Craig Thaine, Herbert Puchta, Jeff Stranks, Peter Lewis – Jones. ISBN: 978-1107468726.

Suggested Software:

- Cambridge Empower
- Soft X (K-Van Solutions)

Reference Books:

1. Raman Meenakshi, Sangeeta-Sharma. Technical Communication. Oxford University Press.2018. ISBN: 9789354972246.
2. Michael Swan- Practical English Usage. ISBN:9780194421461.
3. Taylor Grant: English Conversation Practice, Tata McGraw-Hill Education India,2016. ISBN:978-0070996038.

Web links:

- **https://www.cambridgeone.org/login**
- https://www.coursera.org/
- https://www.skillshare.com/
- https://www.mindtools.com/cawh8bu/communication-tool

NSS/NCC-II

Semester : II	L	T	P	C
Course Code: 241PE003	0	0	1	1

1. Environmental Cleanup Campaign:
Organize a team to clean up local parks, beaches, or other public areas.
Educate the community about the importance of waste reduction and recycling.

2. Tree Planting Initiative:
Collaborate with local organizations to plant trees in deforested areas or urban spaces.
Raise awareness about the benefits of reforestation for the environment and local ecosystems.

3. Awareness about Food Insecurity
Raise awareness about food insecurity issues and encourage ongoing support for those in need.

4. Educational Workshops for Underprivileged Communities:
Conduct workshops on basic skills such as literacy, numeracy, or vocational training for underprivileged individuals or communities.
Empower participants with knowledge and resources to improve their quality of life.

5. Health and Hygiene Campaign:
Organize health and hygiene awareness campaigns in schools, communities, or public spaces.
Distribute hygiene kits containing essentials like soap, toothpaste, and sanitary products to those in need.

6. Environmental Education Programs:
Partner with schools or community centres to deliver educational programs on environmental conservation and sustainability.
Engage participants in hands on activities such as planting gardens, building compost bins, or creating recycling initiatives.

Physical Education, First Aid and Yoga Practice

Semester:III	L	T	P	C
Course Code: 241PE004	0	0	2	2

ACTIVITY-1 (Indoor)

Surya Namaskar

- **Pranamasana (Prayer Pose)**
- **Hasta Uttanasana (Raised Arms Pose)**
- **Hasta Padasana (Hand to Foot Pose)**
- **AshwaSanchalanasana (Equestrian Pose)**
- **Dandasana (Stick Pose)**
- **AshtangaNamaskara (Salute with Eight Parts or Points)**
- **Bhujangasana (Cobra Pose)**
- **Parvatasana (Mountain Pose)**
- **AshwaSanchalanasana (Equestrian Pose)**
- **Hasta Padasana (Hand to Foot Pose)**
- **Hasta Uttanasana (Raised Arms Pose)**
- **Pranamasana (Prayer Pose)**

ACTIVITY-2 (Outdoor)

Recreation Games:

- Shuttle Run relay
- Dodge Ball
- Tug of War

ACTIVITY-3 (Indoor)

Asanas

- Sitting Postures,
- Supine Postures,
- Abdominal Postures,
- Hand Postures,
- Knee Postures,
- Leg Postures,
- Head Postures

ACTIVITY-4 (Outdoor)

Major Games :

- Kabaddi
- Volleyball
- Basketball
- Cricket

ACTIVITY-5 (Indoor)

Kriyas&Bandas

- Dhouti,
- Basti
- Neti,
- Navali
- Kapalabati
- Trataka

ACTIVITY-6 (OutDoor)

Sports :(Athletics Throws)

- Shotput
- Discuss
- Javelin

ACTIVITY-7 (Indoor)

Pranayama

- **NadiShodhana (Alternate Nostril Breathing**
- **Ujjayi Pranayama (Victorious Breath)**
- **Kapalabhati (Skull Shining Breath)**
- **Bhastrika Pranayama (Bellows Breath)**
- **Sheetali Pranayama (Cooling Breath)**
- **Sheetkari Pranayama (Hissing Breath**
- **Bhramari Pranayama (Bee Breath)**
- **Sitali Pranayama (Cooling Breath)**
- **AnulomVilom (Alternate Nostril Breathing with Retention)**

ACTIVITY-8(Outdoor)

Sports Activities :(Athletics-Runs)

- 100Mts
- 200Mts
- 400Mts
- 800Mts
- 5000Mts

ACTIVITY-9 (Indoor)

Meditation

- Mantras
- Japas

ACTIVITY-10(Outdoor)

- Aerobic exercises
- Calisthenics
- weight training
- circuit training
- interval training
- Fartlek training

ACTIVITY-11(Indoor)

Yoga Mudras:

- Jana Mudra
- Chin Maya Mudra
- Vayu Mudra
- Agni Mudra
- Varun Mudra

ACTIVITY-12 (Outdoor)

Games:

- Foot ball
- Shuttle Badminton
- Table tennis
- Kho - Kho

ACTIVITY-13 (Outdoor)

Sports :(Athletics Jumps)

- Long jump
- Triple jump
- High jump

ACTIVITY-14 (Indoor)

First Aid:

- RICE
- Shock
- Drowning
- Snake Bite
- Poison
- Bone and Muscle(Injuries)

Personality Development

Semester: V	L	T	P	C
Course Code: 241UC012	1	0	1	2

Course Outcomes:
At the end of the Course, Student will be able to:

- **CO1:** Define personality, explain its nature, theories, and types.
- **CO2:** Interpret humanistic approaches, Maslow's theory, and determinants of personality.
- **CO3:** Analyze MBTI types, locus of control, and behavioral types and their impact on organizational behavior.
- **CO4:** Explain perception, attribution, learning theories, and their relevance to organizational behavior.
- **CO5:** Evaluate motivation, teamwork, intelligence, emotional intelligence, and their influence on organizational performance.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	-	-	1	-	-	-	2	-
CO2	3	2	-	-	-	2	-	-	-	2	-
CO3	3	3	-	-	-	2	-	2	3	3	1
CO4	3	2	-	2	-	1	-	2	2	2	-
CO5	3	2	-	2	-	2	-	2	3	3	2

UNIT – I
Personality
Personality Definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour.

Practice:
1. MBTI personality analysis.
2. Firo-B.
3. Leadership styles
4. Case studies on Personality and Organizational Behavior

UNIT – II
Individual Behaviour
Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution.

UNIT - III

Learning

Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback.

Practice:

1. Learning Styles and Strategies
2. Interpersonal Communication

UNIT - IV

Intelligence

Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence.

Practice:

1. Win-win game
2. Conflict Management

UNIT - V

Motivation

Motivation- theories and principles, Teamwork and group dynamics.

Practice:

1. Motivational needs
2. Teamwork and team building
3. Group Dynamics

Text Books:

1. Andrews, Sudhir, 1988, How to Succeed at Interviews. Tata McGraw-Hill.
2. Heller, Robert, 2002, Effective Leadership. Essential Manager series. Dk Publishing.

Reference Books:

1. Hindle, Tim, 2003, Reducing Stress. Essential Manager series. Dk Publishing.
2. Lucas, Stephen, 2001, Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.

Web Links:

1. https://www.udemy.com/courses/personal-development/?srsltid=AfmBOorazm-vv0VZlwF6Mv6AhA4qHJZSCzfroRmuUYD3LhehRwTxIpXV
2. https://www.bharathuniv.ac.in/colleges1/downloads/courseware_ece/notes/BSS201%20-%20PERSONALITY.pdf

Course Code	Skill Enhancement Courses (SEC)						Marks			Pre-requisite
241AE007	Course Name	Level	L	T	P	C	CIE	SEE	Total	
	2. Skill Enhancement (students can opt any two given modules)	FC	0	0	8	8	50	50	100	-
	n) Operation & maintenance of farm machinery.		0	0	4	4	50	50	100	-
	o) Repair and maintenance of tractors and power tillers.		0	0	4	4	50	50	100	-
	p) Management of agricultural machinery custom hiring and maintenance facilities.		0	0	4	4	50	50	100	-
	q) Valorization of agri-biomass and organic waste.		0	0	4	4	50	50	100	-
	r) Energy audit, energy conservation and energy efficiency.		0	0	4	4	50	50	100	-
	s) Installation and maintenance of micro-irrigation systems.		0	0	4	4	50	50	100	-
	t) Application of remote sensing and GIS for agricultural water management.		0	0	4	4	50	50	100	-
	u) Installation and maintenance of roof top rainwater harvesting systems.		0	0	4	4	50	50	100	-
	v) Agro processing methods, equipment operation and maintenance.		0	0	4	4	50	50	100	-
	w)Food grain goes down and warehouse management.		0	0	4	4	50	50	100	-

	x) Post-harvest value chain management including logistics.		0	0	4	4	50	50	100	-
	y) Operation and maintenance of drones used for agricultural applications		0	0	4	4	50	50	100	-
	z) Machine vision, sensors and sensors architecture		0	0	4	4	50	50	100	-
	n) Geophysical survey and investigations for groundwater exploration and installation of tube well/ bore well		0	0	4	4	50	50	100	-
	o) Construction, management and maintenance of protected cultivation structures		0	0	4	4	50	50	100	-
	p) Agro processing methods, equipment operation and maintenance		0	0	4	4	50	50	100	-
	Total		0	0	8	8				

SKILL ENHANCEMENT

Semester:II	L	T	P	C
Course Code: 241AE007	0	0	8	8

Course Schedule

1. After two to three days common orientation on different skill enhancement modules.
2. Each student can take two modules. The selection of the module(s) will be entirely on the student's choice.
3. The credit hours for each module have been kept as 0+4.

Indicative Modules

1. Operation & maintenance of farm machinery.
2. Repair and maintenance of tractors and power tillers.
3. Management of agricultural machinery custom hiring and maintenance facilities.
4. Valorisation of agri-biomass and organic waste.
5. Energy audit, energy conservation and energy efficiency.
6. Installation and maintenance of micro-irrigation systems.
7. Application of remote sensing and GIS for agricultural water management.
8. Installation and maintenance of roof top rainwater harvesting systems.
9. Agro processing methods, equipment operation and maintenance.
10. Food grain godown and warehouse management.
11. Post-harvest value chain management including logistics.
12. Operation and maintenance of drones used for agricultural applications.
13. Machine vision, sensors and sensors architecture.
14. Geophysical survey and investigations for groundwater exploration and installation of tube well/ bore well.
15. Construction, management and maintenance of protected cultivation structures.
16. Agro processing methods, equipment operation and maintenance.

Operation & Maintenance of Farm Machinery

Week 1: Introduction to Farm Machinery
Topics Covered:

Overview of common farm machinery.
Importance of proper operation and maintenance.
Safety measures and precautions.

Week 2: Tractor Basics and Maintenance
Topics Covered:

Types of tractors and their uses.
Engine components and functions.
Routine maintenance: oil changes, filter replacements.

Week 3: Tillage Equipment
Topics Covered:

Types of tillage equipment: plows, harrows, cultivators.
Operational techniques.
Maintenance: blade sharpening, component checks.

Week 4: Planting Equipment
Topics Covered:
Seed drills, planters, and transplanters.
Calibration and adjustment for different crops.
Routine maintenance: seed metering systems, lubrications.

Week 5: Irrigation Systems
Topics Covered:
Types of irrigation systems: drip, sprinkler, pivot.
Installation and operational techniques.
Maintenance: cleaning nozzles, checking pumps and filters.
Week 6: Crop Protection Equipment
Topics Covered:
Sprayers: types and applications.
Calibration of sprayers for pesticide and herbicide application.
Maintenance: nozzle checks, pump maintenance.

Week 7: Harvesting Equipment
Topics Covered:
Types of harvesters: combines, forage harvesters.
Operational settings for different crops.
Routine maintenance: checking belts, knives, and cleaning systems.

Week 8: Post-Harvest Equipment
Topics Covered:
Grain handling and storage systems.
Maintenance of silos, dryers, and elevators.
Ensuring quality and preventing spoilage.

Week 9: Hay and Forage Equipment
Topics Covered:
Mowers, balers, and rakes.
Operational techniques for different forage crops.
Routine maintenance: belt tension, blade sharpening.

Week 10: Precision Farming Technology
Topics Covered:
Introduction to GPS and GIS in farming.
Use of drones and sensors.
Maintenance of electronic equipment.

Week 11: Troubleshooting Common Issues
Topics Covered:
Identifying and diagnosing common problems in machinery.
Basic repair techniques.
Preventive maintenance strategies.

Week 12: Practical Session and Review
Topics Covered:
Hands-on practice with different machinery.
Review of key concepts.
Q&A and final discussion.

Repair and Maintenance of Tractors and Power Tillers

Week 1: Introduction to Tractors and Power Tillers
Topics Covered:
Overview of different types of tractors and power tillers.
Importance of proper maintenance and repair.
Safety precautions and guidelines.

Week 2: Engine Systems
Topics Covered:
Components of diesel and gasoline engines.
Basic engine operation principles.
Common engine issues and troubleshooting.

Week 3: Fuel Systems
Topics Covered:
Types of fuel systems: carbureted, fuel injection.
Maintenance of fuel filters, pumps, and injectors.
Diagnosing and resolving fuel system problems.

Week 4: Lubrication Systems
Topics Covered:
Importance of proper lubrication.
Types of lubricants and their applications.
Maintenance procedures for lubrication systems.

Week 5: Cooling Systems
Topics Covered:
Components of cooling systems: radiators, pumps, thermostats.
Maintenance of cooling systems.
Troubleshooting overheating and other cooling issues.

Week 6: Electrical Systems
Topics Covered:
Basic electrical components: battery, alternator, starter motor.
Diagnosing electrical problems.
Maintenance of wiring and connections.

Week 7: Transmission Systems
Topics Covered:
Types of transmissions: manual, automatic, hydrostatic.

Maintenance of clutch, gears, and drive belts.
Troubleshooting transmission issues.

Week 8: Hydraulic Systems
Topics Covered:
Principles of hydraulic systems.
Maintenance of hydraulic pumps, cylinders, and hoses.
Diagnosing hydraulic system problems.

Week 9: Steering and Brake Systems
Topics Covered:
Types of steering systems: manual, power.
Maintenance of steering components.
Brake system components and maintenance.

Week 10: Tires and Tracks
Topics Covered:
Types of tires and tracks used in tractors and power tillers.
Maintenance of tires: pressure, alignment, tread.
Track maintenance and adjustment.

Week 11: Preventive Maintenance
Topics Covered:
Developing a preventive maintenance schedule.
Regular checks and services.
Record-keeping and documentation.

Week 12: Practical Session and Review
Topics Covered:
Topics Covered:
Hands-on practice with repairing and maintaining tractors and power tillers.
Review of key concepts.
Q&A and final discussion.

Management of Agricultural Machinery Custom Hiring and Maintenance Facilities

Week 1: Introduction to Custom Hiring of Agricultural Machinery
Topics Covered:
Overview of custom hiring services in agriculture.
Benefits and challenges of custom hiring.
Key considerations for setting up a custom hiring center.

Week 2: Types of Agricultural Machinery for Custom Hiring
Topics Covered:
Commonly hired machinery: tractors, tillers, harvesters, sprayers.
Criteria for selecting machinery for custom hiring.
Understanding the demand for different types of machinery.

Week 3: Business Models and Planning
Topics Covered:
Different business models for custom hiring centers.
Financial planning and budgeting.
Developing a business plan.

Week 4: Facility Management
Topics Covered:
Setting up a custom hiring facility: location, infrastructure, layout.
Essential tools and equipment for a maintenance workshop.
Safety measures and facility management best practices.

Week 5: Machinery Procurement and Inventory Management
Topics Covered:
Strategies for procuring machinery: new vs. Used.
Inventory management techniques.
Tracking usage and maintenance schedules.

Week 6: Maintenance Planning and Scheduling
Topics Covered:
Developing a maintenance schedule for hired machinery.
Preventive vs. corrective maintenance.
Record-keeping and documentation.

Week 7: Operations Management
Topics Covered:
Daily operations of a custom hiring center.
Booking and scheduling machinery rentals.
Customer relationship management.

Week 8: Financial Management
Topics Covered:
Pricing strategies for custom hiring services.
Cost control and budgeting.
Financial record-keeping and reporting.

Week 9: Marketing and Outreach
Topics Covered:
Marketing strategies for promoting custom hiring services.
Building partnerships with farmers and agricultural organizations.
Utilizing digital platforms and social media.

Week 10: Legal and Regulatory Aspects
Topics Covered:
Understanding legal requirements and regulations.
Contracts and agreements for machinery rental.

Insurance and liability management.

Week 11: Staff Training and Management
Topics Covered:
Recruiting and training staff for the custom hiring center.
Roles and responsibilities of staff members.
Performance evaluation and management.

Week 12: Practical Session and Review
Topics Covered:
Hands-on practice with managing bookings, maintenance, and customer interactions.
Review of key concepts.
Q&A and final discussion.

Valorization of Agri-Biomass and Organic Waste

Week 1: Introduction to Agri-Biomass and Organic Waste
Topics Covered:
Overview of agri-biomass and organic waste.
Types and sources of biomass and organic waste.
Importance of waste valorization in agriculture.

Week 2: Principles of Biomass Conversion
Topics Covered:
Introduction to biomass conversion processes.
Physical, chemical, and biological conversion methods.
Overview of bioproducts and bioenergy.

Week 3: Composting
Topics Covered:
Principles and benefits of composting.
Composting techniques and methods.
Managing composting processes: temperature, moisture, aeration.
Week 4: Anaerobic Digestion
Topics Covered:
Fundamentals of anaerobic digestion.
Biogas production and utilization.
Designing and managing anaerobic digesters.

Week 5: Biochar Production
Topics Covered:
Introduction to biochar and its benefits.
Methods of biochar production: pyrolysis, gasification.
Applications of biochar in agriculture.

Week 6: Biomass to Biofuels
Topics Covered:
Types of biofuels: bioethanol, biodiesel, biogas.
Conversion technologies for biofuel production.
Sustainability and economic aspects of biofuels.

Week 7: Value-Added Products from Agri-Waste
Topics Covered:
Production of value-added products: organic fertilizers, soil amendments.
Extraction of high-value compounds: antioxidants, bioactive compounds.
Case studies and examples.

Week 8: Environmental and Economic Benefits
Topics Covered:
Environmental impact of biomass valorization.
Economic benefits and challenges.
Life cycle assessment and cost-benefit analysis.

Week 9: Policy and Regulatory Framework
Topics Covered:
National and international policies on biomass valorization.
Regulations and standards for biomass processing and bio-products.
Incentives and funding opportunities.

Week 10: Technology and Innovation
Topics Covered:
Emerging technologies in biomass valorization.
Innovations in waste processing and management.
Role of technology in enhancing efficiency and sustainability.

Week 11: Practical Applications and Case Studies
Topics Covered:
Case studies of successful biomass valorization projects.
Lessons learned and best practices.
Field visit or guest lecture from industry experts.

Week 12: Project Presentation and Review
Topics Covered:
Student presentations on valorization projects.
Review of key concepts.
Q&A and final discussion.

Energy Audit, Energy Conservation, and Energy Efficiency

Week 1: Introduction to Energy Audit
Topics Covered:
Definition and importance of energy audits.
Types of energy audits: preliminary and detailed.
Energy audit process and methodology.

Week 2: Energy Consumption Analysis
Topics Covered:
Understanding energy consumption patterns.
Data collection techniques.
Tools and instruments for energy auditing.

Week 3: Energy Conservation Principles
Topics Covered:
Fundamentals of energy conservation.
Key areas for energy conservation in industrial, commercial, and residential settings.
Energy conservation measures and strategies.

Week 4: Energy Efficiency Concepts
Topics Covered:
Definition and importance of energy efficiency.
Energy efficiency indicators and metrics.
Benefits of improving energy efficiency.

Week 5: Energy Management Systems
Topics Covered:
Components of an energy management system (EnMS).
ISO 50001 standard for energy management.
Implementing an energy management program.

Week 6: Energy Efficient Technologies
Topics Covered:
Overview of energy-efficient technologies in various sectors.
Lighting: LED, CFL, and smart lighting systems.
HVAC systems: energy-efficient heating, ventilation, and air conditioning.

Week 7: Industrial Energy Efficiency
Topics Covered:
Energy efficiency in industrial processes.
Efficient motor systems, boilers, and steam systems.
Waste heat recovery and cogeneration.

Week 8: Building Energy Efficiency
Topics Covered:
Building envelope: insulation, windows, and sealing.
Energy-efficient appliances and equipment.
Building automation and control systems.

Week 9: Renewable Energy Integration
Topics Covered:
Role of renewable energy in energy conservation.
Solar, wind, and biomass energy systems.
Integrating renewable energy into existing systems.

Week 10: Energy Policy and Regulations
Topics Covered:
National and international energy policies.
Energy conservation regulations and standards.
Incentives and programs for energy efficiency and conservation.

Week 11: Case Studies and Best Practices
Topics Covered:
Analysis of successful energy audit and conservation projects.
Lessons learned and best practices.
Guest lecture or field visit to an energy-efficient facility.

Week 12: Practical Session and Review
Topics Covered:
Hands-on practice with energy auditing tools and techniques.
Student presentations on energy audit projects.
Review of key concepts, Q&A, and final discussion.

Installation and Maintenance of Micro-Irrigation Systems

Week 1: Introduction to Micro-Irrigation Systems
Topics Covered:
Overview and importance of micro-irrigation.
Types and benefits of micro-irrigation systems.
Basic components and terminology.

Week 2: Design of Micro-Irrigation Systems
Topics Covered:
Principles of system design.

Week 3: Planning of Micro-Irrigation Systems
Topics Covered:
Calculating water requirements.
Layout planning and system mapping.

Week 4: Components of Micro-Irrigation Systems
Topics Covered:
Detailed study of system components.
Functionality of filters, pumps, pipes, and valves.
Selection criteria for different components.

Week 5: Installation Techniques
Topics Covered:
Step-by-step installation process.
Safety protocols and best practices.
Field setup and initial testing.

Week 6: Filtration and Water Treatment

Topics Covered:

Importance of filtration in micro-irrigation
Types of filters: screen, disk, sand
Maintenance of filtration systems

Week 7: Maintenance Practices
Topics Covered:

Regular maintenance routines.
Troubleshooting common issues.
Systematic record-keeping and scheduling.

Week 8: Water Management and Efficiency
Topics Covered:

Strategies for efficient water use.
Monitoring and controlling water distribution.
Impact of water management on crop yield.

Week 9: Troubleshooting
Topics Covered:

Identifying common system problems.
Troubleshooting techniques.

Week 10: Problem Solving
Topics Covered:

Preventative measures
Finding solutions to the problems

Week 11: Advanced Topics
Topics Covered:

Advanced technologies (automation, IoT integration).

Week 12: Future Trends
Topics Covered:

Future trends in micro-irrigation.
Sustainable agricultural practices.

Application of Remote Sensing and GIS for Agricultural Water Management

Week 1: Introduction to Remote Sensing and GIS

Overview of remote sensing and GIS technologies
Importance in agricultural water management
History and evolution of remote sensing and GIS in agriculture

Week 2: Fundamentals of Remote Sensing

Principles of remote sensing
Types of remote sensing (optical, thermal, radar)
Key remote sensing satellites and sensors

Week 3: Basics of Geographic Information Systems (GIS)

Introduction to GIS concepts and components

Spatial data types and formats
GIS software and tools (e.g., ArcGIS, QGIS)

Week 4: Data Acquisition and Processing
Sources of remote sensing data
Data acquisition techniques
Preprocessing steps (georeferencing, atmospheric correction, etc.)

Week 5: Remote Sensing for Soil Moisture Monitoring
Techniques for measuring soil moisture using remote sensing
Key indices (e.g., NDVI, NDWI)
Case studies and applications

Week 6: Crop Water Requirement Estimation
Remote sensing methods for estimating crop water requirements
Evapotranspiration (ET) models
Application of remote sensing data in ET estimation

Week 7: GIS for Agricultural Water Management
Mapping and analyzing spatial variability in fields
GIS-based decision support systems
Integrating GIS with other data sources for water management

Week 8: Irrigation Scheduling and Management
Using remote sensing and GIS for precision irrigation
Creating irrigation schedules based on spatial data
Case studies on effective irrigation management

Week 9: Drought Monitoring and Assessment
Remote sensing techniques for drought monitoring
Drought indices and their applications
GIS for drought impact assessment and management

Week 10: Flood Monitoring and Management
Remote sensing for flood detection and mapping
Integrating GIS for flood risk assessment
Case studies on flood management in agriculture

Week 11: Climate Change and Water Resources
Impact of climate change on agricultural water resources
Using remote sensing and GIS to study climate change effects
Adaptive strategies for water management under changing climates

Week 12: Advanced Topics and Future Trends
Emerging technologies in remote sensing and GIS
Machine learning and AI applications in agricultural water management
Future trends and research directions in the field.

Installation and Maintenance of Roof Top Rainwater Harvesting Systems

Week 1: Introduction to Rainwater Harvesting
Topics Covered:

Basics and importance of rainwater harvesting.
Historical context and modern applications.
Overview of roof top rainwater harvesting systems.

Week 2: Components of Rainwater Harvesting
Topics Covered:

Key components of a roof top rainwater harvesting system (catchment area, conveyance, filtration, storage).
Types of storage tanks.

Week 3: Design Principles of Rainwater Harvesting System
Topics Covered:

Design principles and considerations.
Placement of Storage Tanks

Week 4: Calculating Water Demand and Supply
Topics Covered:

Estimating water demand for various purposes.
Calculating potential water supply from rainfall data.
Balancing supply and demand.

Week 5: Installation Techniques
Topics Covered:

Step-by-step installation process.
Tools and materials required.
Safety protocols and best practices.

Week 6: Filtration
Topics Covered:

Importance of water quality in rainwater harvesting.
Types of filtration systems and their maintenance.

Week 7: Water Quality Maintenance
Topics Covered:

Water quality testing and treatment options.

Week 8: Maintenance Practices
Topics Covered:

Routine maintenance tasks and schedules.
Troubleshooting common issues.
Long-term system care and upgrades.

Week 9: Legal Considerations of Rainwater Harvesting System
Topics Covered:
Local regulations and codes for rainwater harvesting.

Week 10: Environmental Considerations of Rainwater Harvesting System
Topics Covered:
Environmental impacts and benefits.
Sustainable practices and certifications.

Week 11: Advanced Topics
Topics Covered:
Innovations in rainwater harvesting technology.
Integrating rainwater harvesting with other sustainable practices.

Week 12: Future Trends
Topics Covered:
Future trends and research directions.

Agro Processing Methods, Equipment Operation And Maintenance

Week 1: Introduction to Agro Processing
Topics Covered:
Overview of agro processing and its importance
Role of agro processing in food preservation and value addition
Discussion on various agro processing methods

Week 2: Basics of Equipment Operation
Topics Covered:
Introduction to different types of processing equipment
Safety measures in equipment operation
Hands-on demonstration of equipment operation

Week 3: Cleaning and Sorting Techniques
Topics Covered:
Importance of cleaning and sorting in agro processing
Different cleaning and sorting techniques
Equipment used for cleaning and sorting

Week 4: Drying Methods and Equipment
Topics Covered:
Importance of drying in agro processing
Various drying methods (sun drying, mechanical drying, etc.)
Equipment used for drying and their operation

Week 5: Milling and Grinding Processes
Topics Covered:
Introduction to milling and grinding
Types of mills and grinders used in agro processing
Demonstration of milling and grinding equipment

Week 6: Crushing and Pressing Techniques
Topics Covered:
- Overview of crushing and pressing in agro processing
- Types of crushers and presses
- Operation and maintenance of crushing and pressing equipment

Week 7: Extraction Processes
Topics Covered:
- Different extraction methods (solvent extraction, cold pressing, etc.)
- Equipment used for extraction
- Hands-on demonstration of extraction equipment (if feasible)

Week 8: Fermentation and Preservation
Topics Covered:
- Role of fermentation in agro processing
- Preservation techniques (canning, freezing, etc.)
- Equipment for fermentation and preservation

Week 9: Packaging and Storage
Topics Covered:
- Importance of proper packaging and storage
- Types of packaging materials
- Equipment used for packaging and storage

Week 10: Quality Control in Agro Processing
- Importance of quality control in agro processing
- Methods for quality assessment
- Equipment used for quality control

Week 11: Maintenance of Processing Equipment
Topics Covered:
- Importance of equipment maintenance
- Regular maintenance procedures
- Troubleshooting common issues

Week 12: Future Trends in Agro Processing
Topics Covered:
- Emerging technologies in agro processing
- Sustainable practices in agro processing
- Discussion on future challenges and opportunities

Food Grain Godown and Warehouse Management

Week 1: Introduction to Food Grain Warehousing
Topics Covered:
- Importance of food grain storage
- Overview of the food grain supply chain
- Types of food grain godowns and warehouses

Week 2: Principles of Food Grain Storage
Topics Covered:
- Factors influencing food grain storage
- Techniques for maintaining food grain quality
- Methods to minimize losses during storage

Week 3: Warehouse Layout and Design
Topics Covered:
- Principles of warehouse layout design
- Optimization of storage space
- Considerations for efficient material handling

Week 4: Inventory Management
Topics Covered:
- Importance of inventory management in food grain warehouses
- Inventory control techniques
- Best practices for managing inventory accuracy

Week 5: Handling Equipment and Machinery
Topics Covered:
- Types of handling equipment used in food grain warehouses
- Safety considerations in equipment operation
- Maintenance of handling machinery

Week 6: Quality Assurance and Control
Topics Covered:
- Importance of quality assurance in food grain storage
- Quality control measures and standards
- Monitoring and evaluation of grain quality

Week 7: Pest Management
Topics Covered:
- Common pests affecting food grains
- Integrated pest management techniques
- Prevention and control measures

Week 8: Environmental Factors and Safety Regulations
Topics Covered:
- Impact of environmental factors on food grain storage
- Compliance with safety regulations and standards
- Measures to mitigate environmental risks

Week 9: Technology in Warehouse Management
Topics Covered:
- Role of technology in modern warehouse management
- Automated systems for inventory tracking and management
- Integration of technology for efficiency improvement

Week 10: Risk Management and Insurance
Topics Covered:
- Understanding risks associated with food grain storage
- Importance of insurance coverage for warehouses
- Strategies for risk mitigation and loss prevention

Week 11: Case Studies and Best Practices
Topics Covered:
- Analysis of successful food grain warehouse management practices
- Case studies highlighting challenges and solutions
- Learning from industry best practices

Week 12: Future Trends and Innovations
Topics Covered:
- Emerging trends in food grain warehousing
- Anticipated challenges and opportunities
- Strategies for adapting to future changes and advancements

Post-Harvest Value Chain Management Including Logistics

Week 1: Introduction to Post-Harvest Value Chain Management
Topics Covered:
- Overview of post-harvest processes
- Importance of post-harvest management in enhancing food security
- Key components of the post-harvest value chain

Week 2: Post-Harvest Losses and Their Causes
Topics Covered:
- Understanding post-harvest losses
- Identification of causes of post-harvest losses
- Quantification and assessment methods for losses

Week 3: Post-Harvest Technologies and Innovations
Topics Covered:
- Overview of post-harvest technologies
- Innovations in harvesting, handling, and storage
- Role of technology in reducing post-harvest losses

Week 4: Quality Management in Post-Harvest Handling
Topics Covered:
- Importance of maintaining quality in post-harvest handling
- Factors affecting post-harvest quality
- Techniques for quality assessment and assurance

Week 5: Packaging and Storage Techniques
Topics Covered:
- Importance of proper packaging in post-harvest management
- Types of packaging materials and methods
- Storage techniques to preserve quality and reduce losses

Week 6: Post-Harvest Handling Practices for Specific Crops
Topics Covered:
- Crop-specific post-harvest handling practices
- Challenges and best practices for handling different types of crops
- Case studies on successful crop-specific handling techniques

Week 7: Transportation and Logistics in the Post-Harvest Value Chain
Topics Covered:
- Importance of transportation and logistics in the post-harvest value chain
- Challenges and considerations in post-harvest transportation
- Strategies for efficient and cost-effective logistics management

Week 8: Cold Chain Management
Topics Covered:
- Overview of the cold chain and its importance in post-harvest management
- Components of the cold chain
- Best practices and technologies for cold chain management

Week 9: Market Access and Distribution
Topics Covered:
- Importance of market access in post-harvest management
- Distribution channels and market linkages
- Strategies for enhancing market access for smallholder farmers

Week 10: Value Addition and Processing
Topics Covered:
- Role of value addition in post-harvest management
- Techniques for value addition and processing
- Value-added products and their market potential

Week 11: Sustainability and Environmental Considerations
Topics Covered:
- Environmental impacts of post-harvest activities
- Sustainable practices in post-harvest management
- Strategies for reducing environmental footprint

Week 12: Future Trends and Challenges
Topics Covered:
- Emerging trends in post-harvest value chain management
- Anticipated challenges and opportunities
- Strategies for advancing post-harvest management practices

Operation and Maintenance of Drones used for Agricultural Applications

Week 1: Introduction to Drones in Agriculture
Topics Covered:
Overview of drone technology and its evolution in agriculture.
Types of drones used in agriculture (fixed-wing, rotary-wing, hybrids).
Applications of drones in crop monitoring, spraying, and mapping.

Week 2: Drone Regulations and Safety
Topics Covered:
Understanding drone regulations (global and local laws).
Licensing and certification requirements for agricultural drone operators.
Safety protocols and risk management in drone operations.

Week 3: Drone Components and System Architecture
Topics Covered:
Detailed overview of drone components (frames, motors, propellers, etc.).
Sensors and cameras used in agricultural drones.
Power systems and batteries: types, maintenance, and best practices.

Week 4: Basic Drone Operation and Flight Mechanics
Topics Covered:
Principles of flight and drone control.
Hands-on training: Basic flight maneuvers.
Introduction to flight planning and GPS-based navigation.

Week 5: Advanced Drone Operation Techniques
Topics Covered:
Autonomous flight modes and programming.
Waypoint navigation and mission planning.
Hands-on training: Advanced flight techniques and troubleshooting.

Week 6: Payloads and Data Collection
Topics Covered:
Understanding different types of payloads (cameras, sprayers, sensors).
Data collection methods for agricultural applications (NDVI, multispectral imaging).
Hands-on training: Installing and using payloads.

Week 7: Image Processing and Data Analysis
Topics Covered:
Introduction to image processing software for agricultural drones.
Techniques for analyzing drone-captured data.
Hands-on training: Basic image processing and analysis.

Week 8: Maintenance of Drones
Topics Covered:
Routine maintenance: Pre-flight and post-flight checks.

Troubleshooting common issues (motor failures, GPS errors).
Hands-on training: Performing basic repairs and maintenance.

Week 9: Battery Management and Power Systems
Topics Covered:
Understanding battery types and specifications for drones.
Best practices for battery charging, storage, and disposal.
Hands-on training: Battery maintenance and replacement.

Week 10: Calibration and Sensor Maintenance
Topics Covered:
Importance of calibration for accurate data collection.
Steps for calibrating sensors and cameras.
Hands-on training: Sensor maintenance and calibration.

Week 11: Drone Software and Firmware Updates
Topics Covered:
Overview of drone control software and firmware.
Importance of keeping software and firmware up to date.
Hands-on training: Performing software and firmware updates.

Week 12: Final Project and Review
Topics Covered:
Review of key concepts and skills learned.
Student presentations of their final projects.
Course wrap-up and discussion on future trends in drone technology for agriculture.

Machine Vision, Sensors, and Sensors Architecture
Week 1: Introduction to Machine Vision and Sensor Systems
Topics Covered:
Overview of machine vision systems
Importance and applications of sensors in machine vision
Introduction to sensor architecture
Week 2: Image Acquisition and Sensor Types
Topics Covered:
Principles of image formation
Types of image sensors: CCD vs. CMOS
Introduction to non-optical sensors: LIDAR, RADAR, Ultrasonic
Week 3: Sensor Characteristics and Performance
Topics Covered:
Key sensor characteristics: resolution, sensitivity, dynamic range, SNR
Calibration and error analysis in sensors
Noise and its impact on sensor performance
Week 4: Image Processing Fundamentals
Topics Covered:
Introduction to image processing techniques: filtering, edge detection, thresholding
Image preprocessing for machine vision
Role of sensors in enhancing image quality

Week 5: 3D Vision and Depth Sensing
Topics Covered:
Basics of stereo vision and depth estimation
Structured light and time-of-flight (ToF) sensors
Applications of 3D sensing in machine vision
Week 6: Sensor Fusion and Multi-Sensor Systems
Topics Covered:
Concepts of sensor fusion
Combining data from multiple sensors for improved accuracy
Algorithms for sensor fusion: Kalman Filter, Bayesian Networks
Week 7: Embedded Systems and Real-Time Processing
Topics Covered:
Architecture of embedded systems in machine vision
Real-time processing constraints
Hardware acceleration techniques (FPGA, GPUs)
Week 8: Machine Learning in Machine Vision
Topics Covered:
Role of machine learning in sensor-based vision systems
Introduction to convolutional neural networks (CNNs)
Training models with sensor data
Week 9: Advanced Vision Sensors
Topics Covered:
Hyperspectral and multispectral imaging sensors
Thermal imaging and its applications
Emerging sensor technologies: quantum sensors, neuromorphic sensors
Week 10: Sensor Network Architecture
Topics Covered:
Architecture of distributed sensor networks
Communication protocols for sensor networks
Power management and optimization in sensor networks
Week 11: Case Studies and Applications
Topics Covered:
Case studies on machine vision in industrial automation, robotics, automotive (e.g., autonomous vehicles)
Discussion on challenges and future trends in sensor technology and machine vision
Week 12: Project Presentations and Course Review
Topics Covered:
Review of key concepts learned throughout the course
Discussion on potential future developments in the field

Geophysical Survey and Investigations for Groundwater Exploration and Installation of Tube Well/Bore Well

Week 1: Introduction to Groundwater Systems
Topics Covered:
Overview of groundwater systems and their importance.

Key features and characteristics of groundwater systems.
Introduction to groundwater exploration techniques.

Week 2: Geophysical Survey Methods
Topics Covered:
Study of different types of geophysical surveys for groundwater exploration.
Overview of resistivity meter components.
Introduction to Wenner-Schlumberger arrangement.
Comparison of various geophysical survey techniques.

Week 3: Geophysical Survey Process
Topics Covered:
Conducting geophysical surveys in the field.
Data collection techniques during geophysical surveys.
Analysis and interpretation of surveyed data.

Week 4: Well Logging Techniques
Topics Covered:
Introduction to well logging and its importance in groundwater exploration.
Different types of well logs and their applications.
Preparation and analysis of commonly used well logs.

Week 5: Types of Wells
Topics Covered:
Study of different types of wells, including tube wells and bore wells.
Understanding the components and structure of tube wells/bore wells.

Week 6: Drilling Methods and Equipment
Topics Covered:
Overview of different drilling methods used for well installation.
Study of various drilling equipment and their applications.
Selection criteria for drilling methods based on geological conditions.

Week 7: Installation of Well Assembly
Topics Covered:
Process of installing well assemblies, including casing and screens.
Types of casing and screen materials used in tube wells/bore wells.
Introduction to gravel packing and its significance in well installation.

Week 8: Well Development Process
Topics Covered:
Study of the well development process to enhance well efficiency.
Techniques used in well development.
Importance of well development in ensuring long-term groundwater supply.

Week 9: Sanitary Protection of Wells
Topics Covered:
Understanding the need for sanitary protection of tube wells/bore wells.
Methods and best practices for ensuring sanitary protection.

Legal and environmental considerations in well installation.

Week 10: Case Studies and Field Applications
Topics Covered:
Analysis of successful groundwater exploration and well installation projects.
Lessons learned from real-world case studies.
Guest lectures or field visits to observe geophysical surveys and well installations.

Week 11: Practical Session on Geophysical Surveys
Topics Covered:
Hands-on practice with resistivity meters and other geophysical survey tools.
Conducting a geophysical survey in the field.
Data analysis and interpretation exercises.

Week 12: Practical Session on Well Installation
Topics Covered:
Hands-on practice with well installation techniques.
Student presentations on groundwater exploration and well installation projects.
Review of key concepts, Q&A, and final discussion.

Construction, Management and Maintenance of Protected Cultivation Structures

Week 1: Introduction to Protected Cultivation
Topics Covered:
Enlist advantages of protected cultivation.
Enlist factors affecting protected cultivation.
Enlist and identify different crops suitable for protected cultivation.

Week 2: Types of Protected Structure and its Components
Topics Covered:
Differentiate greenhouse shade house and low tunnels.
Demonstration of utility of mist house.
Identify the cladding material used for greenhouse erection.

Week 3: Types of Protected Structure and its Components
Topics Covered:
Enlist factors affecting selection of greenhouse design.
Draw a typical greenhouse and label the parts.
Collect figures of different components of greenhouse.

Week 4: Preparation of Media and Container for Commercial Cultivation in Greenhouse
Topics Covered:
Identification of various types of media.
Differentiate soil and soil less cultivation in green house.
Differentiation of chemical and physical methods of soil sterilization.

Week 5: Preparation of Media and Container for Commercial Cultivation in Greenhouse

Topics Covered:

Demonstration of raised beds preparation.
Demonstration of filling of pots/ containers.
Identification of containers.
Enlist different constituents of growing media.

Week 6: Crop Management in Protected Cultivation

Topics Covered:

Demonstration of measuring pH, TDS and EC in water for irrigation.
Identification of components of drip irrigation.

Week 7: Irrigation and Fertigation Systems

Topics Covered:

Enlist merits and demerits of micro-irrigation.
Identification of important water-soluble fertilizers used in protected cultivation.

Week 8: Irrigation and Fertigation Systems

Topics Covered:

Enlist advantages of foliar application.
Demonstration of fertigation procedure.
Identification of equipment used in fertigation.

Week 9: Greenhouse Operations

Topics Covered:

Enlist different greenhouse operations.
Enlist equipment used.
Demonstration of the regulation of temperature.
Enlist optimum temperature for important flower and vegetable crops.
Demonstration of the regulation process of light.

Week 10: Greenhouse Operations

Demonstration of how to regulate the humidity.
Enlist effect of high and low humidity.
Demonstration of the use of CO_2 enrichment Procedure.
Demonstration of the use of ventilation in green house.

Week 11: Maintenance of Protected Cultivation Structures

Topics Covered:

Routine Maintenance:

- Cleaning and upkeep of structures
- Maintenance of environmental control systems

Pest and Disease Management:

- Common pests and diseases in protected cultivation
- Integrated Pest Management (IPM) strategies

Structural Repairs:

- Identifying wear and tear

- Repairing damages to the structure

Week 12: Economic Aspects of Protected Cultivation
Topics Covered:

Cost Analysis:
- Initial investment and operational costs
- ROI (Return on Investment)

Marketing and Sales:
- Market demand and pricing strategies
- Supply chain and distribution

Financial Planning:
- Budgeting and financial management
- Subsidies and government schemes

Agro Processing Methods, Equipment Operation and Maintenance

Week 1: Introduction to Agro Processing
Topics Covered:

Overview of agro processing and its importance
Role of agro processing in food preservation and value addition
Discussion on various agro processing methods

Week 2: Basics of Equipment Operation
Topics Covered:

Introduction to different types of processing equipment
Safety measures in equipment operation
Hands-on demonstration of equipment operation

Week 3: Cleaning and Sorting Techniques
Topics Covered:

Importance of cleaning and sorting in agro processing
Different cleaning and sorting techniques
Equipment used for cleaning and sorting

Week 4: Drying Methods and Equipment
Topics Covered:

Importance of drying in agro processing
Various drying methods (sun drying, mechanical drying, etc.)
Equipment used for drying and their operation

Week 5: Milling and Grinding Processes
Topics Covered:

Introduction to milling and grinding
Types of mills and grinders used in agro processing
Demonstration of milling and grinding equipment

Week 6: Crushing and Pressing Techniques

Topics Covered:

Overview of crushing and pressing in agro processing
Types of crushers and presses
Operation and maintenance of crushing and pressing equipment

Week 7: Extraction Processes

Topics Covered:

Different extraction methods (solvent extraction, cold pressing, etc.)
Equipment used for extraction
Hands-on demonstration of extraction equipment (if feasible)

Week 8: Fermentation and Preservation

Topics Covered:

Role of fermentation in agro processing
Preservation techniques (canning, freezing, etc.)
Equipment for fermentation and preservation

Week 9: Packaging and Storage

Topics Covered:

Importance of proper packaging and storage
Types of packaging materials
Equipment used for packaging and storage

Week 10: Quality Control in Agro Processing

Importance of quality control in agro processing
Methods for quality assessment
Equipment used for quality control

Week 11: Maintenance of Processing Equipment

Topics Covered:

Importance of equipment maintenance
Regular maintenance procedures
Troubleshooting common issues

Week 12: Future Trends in Agro Processing

Topics Covered:

Emerging technologies in agro processing
Sustainable practices in agro processing
Discussion on future challenges and opportunities

Course Code	Value Added Courses (VAC)						Marks			Pre-requisite
	Course Name	Level	L	T	P	C	CIE	SEE	Total	
241AE006	Agricultural Informatics	FC	2	0	1	3	50	50	100	-
241AE010	Environmental Studies and Disaster Management	FC	2	0	1	3	50	50	100	-
	Total		4	0	2	6				

Agricultural Informatics

Semester: I	L	T	P	C
Course Code: 241AE006	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Utilize MS office in agriculture.
CO2: Apply DBMS in agriculture.
CO3: Comprehend programming languages.
CO4: Retrieve and generate information using geospatial technology.
CO5: Compute, create, operate and translate data using operating systems and IT tools.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	2			3						1
CO2	2	3			3						1
CO3	1	2			3						1
CO4	2	1	2	2	2						2
CO5	1	2		2	3						2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	1	2	1
CO2	2	2	2
CO3	2	2	2
CO4	1	1	2
CO5	2	2	2

UNIT – I
Introduction to computer
Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types. Applications of MS-Office for document creation and Editing. Data presentation, interpretation and graph creation.
Practice:
1. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific document.
2. MS-EXCEL: Creating a spreadsheet; use of statistical tools; writing expressions; creating graphs and analysis of scientific data.

UNIT – II
DBMS in Agriculture
Statistical analysis, mathematical expressions, database, concepts and types. Uses of DBMS in Agriculture.
Practice:
1. MS-ACCESS: Creating database; preparing queries and reports.

2. Demonstration of Agri-information systems.

UNIT – III

Computer Languages

World Wide Web (WWW): Concepts and components.

Introduction to computer programming languages: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations

Practice:

1. Basic concept of HTML for creating a Web page.
2. Introduction to Programming Language : C

UNIT – IV

Concepts and applications of e-agriculture and use of ICT in Agriculture

Concepts and applications of e-agriculture and use of ICT in Agriculture. Computer Models for understanding plant processes. IT application for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for agri-input management, smartphone Apps in Agriculture for farm advises market price and postharvest management.

Practice:

1. Hands on Decision Support System and Crop Simulation Model: DSSAT (Decision Support System for Agrotechnology Transfer)
2. Smartphone mobile apps in agriculture.

UNIT – V

Geospatial technology

Geospatial technology for generating valuable agri-information. Decision support systems, concepts, components and applications in agriculture. Agriculture Expert System, Soil Information Systems for supporting farm decisions. Preparation of contingent crop-planning using IT tools.

Practice:

1. Introduction of geospatial technology for generating valuable information for agriculture.

Text Books:

1. Mamta Rana D. Prasad. Agro-informatics. Bioscientific Publisher, India. ISBN: 9789383284146.
2. Vanitha, G and Kalpana, M. Agro-informatics. New India Publishing Agency, India. ISBN: 978-8196089368.

Reference Books:

1. Raju, K. V.,V. R. Hegde and Satish A. Hegde. 2018. Geospatial Technologies for Agriculture: Case Studies from India. Springer International Publishing, Switzerland. ISBN: 9783319966458.
2. Chandan Kumar Panda, Anil Paswan and Siya Ram Singh. 2018. Advances in ICT in Agriculture. New Delhi Publisher, India. ISBN: 978-9386453341.

Web Links:

1. https://www.fao.org/agroinformatics/training-and-resources/agroinformatics-tutorials/en
2. https://github.com/ag-informatics/ag-informatics-course

Environmental Studies and Disaster Management

Semester: II	L	T	P	C
Course Code: 241AE010	2	0	1	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Outline the natural resources and their importance for the sustenance of the life
- **CO2:** Explain about the biodiversity of India, threats and its conservation methods
- **CO3:** Illustrate various attributes of the pollution, impacts and measures to control the pollution along with waste management practices
- **CO4:** Describe social issues of both rural and urban environment to combat the challenges and the legislation's of India in environmental protection
- **CO5:** Explain the causes, effects, and mitigation strategies for various natural disasters

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1					1	2				
CO2	1						3				
CO3						2	3				1
CO4						1	3	1			1
CO5							3				

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1	-	-	1
CO2	-	-	1
CO3	-	-	2
CO4	-	-	2
CO5	-	-	1

UNIT – I

Introduction to Environment

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.

Practice:

1. Visit to a local area to document environmental assets river/forest/grassland/hill/mountain.

UNIT – II

Natural Resources

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 ecosystem. Biodiversity and its conservation: Introduction, definition, types. Bio geographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity

Practice:
1. Visit to wind mill / hydro power / solar power generation units.
2. Biodiversity assessment in farming system.
3. Floral and faunal diversity assessment in polluted and un polluted system.
4. Study of simple ecosystem – Visit to pond/river/hills.

UNIT – III
Pollution and its Classification
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 h. 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.

Practice:
1. Energy: Biogas production from organic wastes.
2. Water quality analysis: pH, EC and TDS.
3. Estimation of Acidity, Alkalinity. Estimation of water hardness.
4. Assessment of Suspended Particulate Matter (SPM)

UNIT – IV
Social Issues in Rural and Urban Environment
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.

Practice:
1. Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds.
2.Environmental sampling and preservation.
3.Estimation of DO, COD and BOD in water samples.

UNIT – V
Disaster Management
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.

Practice:
1. Enumeration of E. coli in water sample.
2. Visit to areas affected by natural disaster

Text Books:

1. De. A.K.. Environmental chemistry. Published by New Age International Publishers, New Delhi. 384 pp. ISBN:978- 81224 26175.
2. DharChakrabarti. P.G. Disaster management - India's risk management policy frameworks and key challenges. Published by Centre for Social Markets (India), Bangalore. 36 pp.

Reference Books:

1. Parthiban, K.T. Vennila, S. Prasanthrajan, M. UmeshKanna, S. 2023. Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi.
2. Prasanthrajan M, P.P. Mahendran., A text book on Ecology and Environmental Science. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur.

Web Links:
1. www.nptel.ac.in/courses/122102006/
2. www.nptel.ac.in/courses/120108002/
3. www.nptelvideos.in/2012/12/fundamentals-of-environmental-pollution.html
4. www.nptel.ac.in/courses/120108004/

Course Code	Audit Courses (AUC)						Marks			Pre-requisite
	Course Name	Level	L	T	P	C	CIE	SEE	Total	
241AE001	Deeksharambh	FC	0	0	2	0	100	-	100	-
241UC011	Employability Skills-I	FC	0	0	2	0	100	-	100	-
241UC013	Employability Skills-II	FC	0	0	3	0	100	-	100	ES-I
241UC014	Employability Skills-III	FC	0	0	3	0	100	-	100	ES-II
241UC015	Employability Skills-IV	FC	0	0	3	0	100	-	100	ES-III
241UC017	Employability Skills-V	FC	0	0	3	0	100	-	100	ES-IV
241AC001	Student Activity Based Learning	AC	0	0	2	0				
	*On-line courses (24 weeks or 80 hours)	FC	0	0	6	0	100	-	100	-
	Total		0	0	22	0				

DEEKSHARAMBH (NG)

Semester: I	**L**	**T**	**P**	**C**
Course Code: 241AE001	**0**	**0**	**2**	0

1: University Orientation & Academic Framework
Activity: Welcome Session.
Description: Introduction by university officials and brief campus tour.
Objective: Familiarize students with the university environment and key personnel.
Activity: Workshop on Academic Framework.
Description: Overview of university's academic processes, credit system, grading, etc.
Objective: Understand the operational framework of the academic process.

2: Cultural Integration & Subject Awareness
Activity: Cultural Exchange Session.
Description: Students present their cultural backgrounds and traditions.
Objective: Promote cultural integration and appreciation of diversity.
Activity: Introductory Lecture on Subjects of Study.
Description: Faculty provide an overview of various disciplines offered.
Objective: Provide a broad view of the subjects and their application areas.

3: Life Skills & Ethical Values
Activity: Seminar on Personality Development & Ethical Values.
Description: Discussions on communication, teamwork, leadership skills, ethical behavior and societal values.
Objective: Foster a sense of ethics and values among students.

4: Interaction with Alumni & Leaders
Activity: Alumni Meet and Inspirational Talks.
Description: Interaction with successful alumni, business leaders, and achievers.
Objective: Inspire students through real-life success stories and experiences.

5: Workshop on design thinking
Activity: Workshop on design thinking.
Description: Activities and projects to encourage creativity and innovative thinking.
Objective: Develop creative skills and innovative approaches.

6: Field Exposure
Activity: Field Visit.
Description: Tour of industries, research labs or cultural sites.
Objective: Provide practical exposure and understanding of various fields.

7: Reflection & Feedback
Activity: Reflective Session.
Description: Students share their experiences and reflections on the program.
Objective: Reflect on learning outcomes and personal growth.
Activity: Feedback Collection.
Description: Collect feedback from students and suggest improvements for future programs.
Objective: Improve future iterations of the program based on student feedback.

Additional Activities:
Mentorship Program: Continuous guidance through pairing students with mentors.
Cultural Clubs: Encouraging participation in various cultural clubs and societies.

Evaluation:
Feedback Forms: Collect feedback from students at the end of each session.
Peer Reviews: Group reviews to assess the impact of activities.
Final Assessment: Evaluation based on participation and improvement in identified areas.

Employability Skills- I

(CE,EEE,ME,ECE,CSE,IT,AIML,CSE(DS),PT,Min.E & Agri.E)

Semester: II	**L**	**T**	**P**	**C**
Course Code: 241UC011	**0**	**0**	**2**	**0**

Aptitude:

Number System, LCM & HCF, Ratio and Proportion, Averages

Reasoning:

Number Series, Letter Series, Number Analogy, Letter Analogy, Odd Man Out, Logical Sequence of Words.

Verbal:

Introduction to soft skills, how to improve communication? Parts of Speech, Mind your language towards better English, Vocabulary Expansion

Text Books:

1. Quantitative Aptitude –Dr. R. S. Aggarwal, S CHAND, **ISBN** · 9789355012326.
2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal, **ISBN**-13. 978-9352832163.
3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND, **ISBN**-13. 978-8121922111.

Reference Books:

1. Quantitative Aptitude – Abhijit Guha Mc Graw Hill Publications, **ISBN-13** 9789389957426.
2. How To Crack Test of Reasoning Verbal , Non-Verbal & Analytical – Jaikishan and Premkishan,Arihant Publications, NEW EDITION 2024, **ASIN : B0CRQ9BVBC**.
3. A New Approach to Objective English – R. S. Dhillon DGP Publications, ISBN-13: **978-8186651032**.

Web Links:

1. www.indiabix.com
2. www.bankersadda.com

Employability Skills- II

(CE,EEE,ME,ECE,CSE,IT,AIML,CSE(DS),PT,Min.E & Agri.E)

	L	T	P	C
Semester: III				
Course Code: 241UC013	**0**	**0**	**3**	**0**

Aptitude:

Problems on Ages, Partnership, Percentages, Profit and Loss

Reasoning:

Coding and Decoding, Ranking Test, Alphabet Test, Direction Test

Verbal:

Written communication skill practice, Grammatical use, Concept of 4 step method for presentation, Present Tense

Text Books:

1. Quantitative Aptitude –Dr. R. S. Aggarwal, S CHAND, **ISBN** · 9789355012326.

2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal, **ISBN**-13. 978-9352832163.

3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND, **ISBN**-13. 978-8121922111.

Reference Books:

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2. www.bankersadda.com

Employability Skills- III

(CE,EEE,ME,ECE,CSE,IT,AIML,CSE(DS),PT,Min.E & Agri.E)

	L	T	P	C
Semester: IV				
Course Code: 241UC014	**0**	**0**	**3**	**0**

Aptitude:

Simple Interest, Compound Interest, Time and Work, Pipes and Cisterns

Reasoning:

Blood Relations, Calendar, Clocks, Cubes and Dice, Coded Inequalities

Verbal:

Grammar in use, Group discussion, Reading Comprehension, Past Tense, Future Tense

Text Books:

1. Quantitative Aptitude –Dr. R. S. Aggarwal, S CHAND, **ISBN** · 9789355012326.

2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal, **ISBN**-13. 978-9352832163.

3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND, **ISBN**-13. 978-8121922111.

Reference Books:

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3. A New Approach to Objective English – R. S. Dhillon DGP Publications, ISBN-13: **978-8186651032**.

Web Links:

1. www.indiabix.com

2. www.bankersadda.com

Employability Skills- IV

(CE,EEE,ME,ECE,CSE,IT,AIML,CSE(DS),PT,Min.E & Agri.E)

	L	T	P	C
Semester: V				
Course Code: 241UC015	**0**	**0**	**3**	**0**

Aptitude:

Time, Speed and Distance, Problems on Trains, Boats and Streams, Mensuration - I, Mensuration - II

Reasoning:

Venn Diagrams, Syllogisms, Non - Verbal Reasoning, Seating Arrangement

Verbal:

Grammatical use, Self-introduction, Letters, E-Mail & Report writing, Error correction, Effective Communication

Text Books:

1. Quantitative Aptitude –Dr. R. S. Aggarwal, S CHAND, **ISBN** · 9789355012326.

2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal, **ISBN**-13. 978-9352832163.

3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND, **ISBN**-13. 978-8121922111.

Reference Books:

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2. How To Crack Test of Reasoning Verbal , Non-Verbal & Analytical – Jaikishan and Premkishan,Arihant Publications, NEW EDITION 2024, **ASIN : B0CRQ9BVBC**.

3. A New Approach to Objective English – R. S. Dhillon DGP Publications, ISBN-13: **978-8186651032**.

Web Links:

1. www.indiabix.com

2. www.bankersadda.com

Employability Skills- V

Semester: VIII	L	T	P	C
Course Code: 241UC017	0	0	3	0

Aptitude:

Permutations and Combinations, Probability, Data Interpretation, Logarithms, Statistics

Reasoning:

Puzzle Tests, Eligibility Test, Data Sufficiency, Statements – Arguments, Statements – Assumptions, Statements - Course of Action, Statements - Conclusions

Verbal:

Interview skills, Grammar in use, Interpersonal Skills, Negotiation Skills, Social Skills, Problem-Solving Skills, Time Management Skills

Text Books:

1. Quantitative Aptitude –Dr. R. S. Aggarwal, S CHAND, **ISBN** · 9789355012326.

2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal, **ISBN**-13. 978-9352832163.

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Reference Books:

1. Quantitative Aptitude – Abhijit Guha Mc Graw Hill Publications, **ISBN-13** 9789389957426.

2. How To Crack Test of Reasoning Verbal , Non-Verbal & Analytical – Jaikishan and Premkishan,Arihant Publications, NEW EDITION 2024, **ASIN : B0CRQ9BVBC**.

3. A New Approach to Objective English – R. S. Dhillon DGP Publications, ISBN-13: **978-8186651032**.

Web Links:

1. www.indiabix.com

2. www.bankersadda.com

Course Code	Summer Internship (SI)						Marks			Pre-requisite
	Course Name	Level	L	T	P	C	CIE	SEE	Total	
241AE031	Summer Internship-1 (Study tour)	FC	0	0	0	0	100	-	100	-
241AE049	In-plant Training/ Research Internship	AC	0	0	8	8	100	-	100	-
	Total		0	0	8	8				

Course Code	Research Project / Dissertation (PROJ)						Marks			Pre-requisite
	Course Name	Level	L	T	P	C	CIE	SEE	Total	
241AE040	Project- I	AC	0	0	3	3	50	50	100	-
241AE048	Project –II	AC	0	0	4	4	50	50	100	-
	Total		0	0	7	7				

Minor Degree in Agricultural Engineering (offered to other branches students):

Agricultural Engineering							Marks			Pre-requisite
Course Code	**Course Name**	**Level**	**L**	**T**	**P**	**C**	**CIE**	**SEE**	**Total**	
241AE082	Fundamentals of Renewable Energy Sources	FC	3	0	0	3	50	50	100	-
241AE083	Post-harvest Engineering of Cereal Crops	FC	3	0	0	3	50	50	100	-
241AE084	Ground Water Hydrology	FC	3	0	0	3	50	50	100	-
241AE085	Micro Irrigation Systems	IC	2	0	0	2	50	50	100	-
241AE086 241AE087	Surface Water Hydrology (OR) Land & Water Management Engineering	IC	3	0	0	3	50	50	100	GWH
241AE088 241AE089	Agricultural Process Engineering & Food Quality (OR) Post-harvest Engineering for Horticultural Produce	AC	3	0	0	3	50	50	100	PHECC
241AE090 241AE091	Agricultural Machinery & Equipment (OR) Design of Bio-energy systems	AC	3	0	0	3	50	50	100	FRES
	Total		20			20				

Fundamentals of Renewable Energy Sources

	L	T	P	C
Course Code: 241AE082	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the course, student will be able to:

CO1: Understand and explain the fundamental concepts of renewable energy.
CO2: Analyze the principles of solar energy and explore its various applications.
CO3: Describe wind energy conversion systems, including wind generators, and evaluate their power generation capabilities.
CO4: Analyze the processes involved in biogas production from biomass.
CO5: Explain the basic principles and operations of tidal energy, fuel cells, and geothermal energy systems.Explain the basic principles and operations of tidal energy, fuel cells, and geothermal energy

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	3	2							
CO2	3	2	2	2							
CO3	3		3		2						1
CO4	3		3	2		1					
CO5	3		3	2		1					

UNIT – I

Renewable energy sources

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

UNIT – II

Solar energy

Solar energy- energy available from sun, solar radiation data, solar energy conversion into heat through flat plate and concentrating collectors, different solar thermal devices, principle of natural and forced convection solar drying system. Solar photo voltaics- basics and applications, p-n junctions. Solar cells, PV systems, stand alone, grid connected solar power station. Calculation of energy through photovoltaic power generation and cost economics.

UNIT – III

Wind Energy

Wind energy- energy availability, general formula, lift and drag. Basics of wind energy conversion, effect of density, frequency variances, angle of attack, wind speed, types of windmill rotors, determination of torque coefficient, induction type generators. Working principle of wind power plant. Wind farms, aero-generators, wind power generation system.

UNIT – IV

Energy from Biomass

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

UNIT – V

Other source of energy

Power generation from urban, municipal and industrial waste. Ocean thermal and electric power generation, wave and tidal power. Power generation from biomass (gasification & Dendro- thermal). Mini and micro hydel plants. Fuel cells and its associated parameters

Text Books:

1. Rai G D. Non-Conventional Energy Sources. Khanna Publishers, New Delhi. (ISBN:978-81-7409-073-8)
2. Basu P. Biomass Gasification and Pyrolysis Practical Design and Theory. Academic Press. (ISBN: 10-0123749883)

Reference Books:

1. Patel M R. Wind and Solar Power Systems. CRC Press, Bota Racon. (ISBN: 978-0849315701)
2. DeubleinD and SteinhauserA. Biogas from Waste and Renewable Resources. WILEY- VCH Verlag GmbH & Co. KGaA, Weinheim. (ISBN:9783527621705)

Web Links:

1. https://onlinecourses.nptel.ac.in/noc22_ch27/preview
2. https://www.vssut.ac.in/lecture_notes/lecture1428910296.pdf

Post-harvest Engineering of Cereal Crops

	L	T	P	C
Course Code: 241AE083	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the course, student will be able to:

- **CO1:** Explain the importance of different unit operations and working of size reduction equipments.
- **CO2:** Identify various methods for determining moisture content, EMC and drying.
- **CO3:** Compare separator equipments based on physical characteristics of grains and Explain material handling devices.
- **CO4:** Explain the importance, design and working of milling equipments for cereals.
- **CO5:** Explain the importance, design and working of milling equipments for rice.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	3	2		1	1					
CO2	3	2	2	2							
CO3	3	2	2	2	2						
CO4	3	2	2	2							
CO5	3	2	2	1							

UNIT – I

Unit operations in grain processing

General unit operations in agricultural process engineering and importance of these unit operations in grain processing; Structure and composition of cereals. Cleaning and grading: Principles of cleaning, scalping, sorting and grading; Size reduction: Principle; Bond's law, Kick's law, Rittinger's law; Sieve analysis; Different classifications of size reduction machines; description of jaw crusher, hammer mill, attrition mill, and ball mill.

UNIT – II

Drying

Moisture content and water activity, free moisture, bound moisture and equilibrium moisture content, isotherm, hysteresis effect, EMC determination; Psychrometric chart and its use in drying; Drying principles and theory, thin layer and deep bed drying analysis, falling rate and constant rate drying periods, maximum and decreasing drying rate periods, drying equations, mass and energy balance, Shedd's equation; Drying methods (conduction, convection, radiation, batch, continuous); Different types of cereal grain dryers (bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray), tempering during drying; dryer performance.

UNIT – III

Separation and Material Handling

Screens, different types of screen separators, fixed and variable aperture screens, capacity and effectiveness of screens, sieve analysis; various types of separators as specific gravity, magnetic, disc, spiral, pneumatic, inclined belt draper, velvet roll separator, colour sorter, cyclone separator.

Basic parts of different types of conveyors and elevators, viz. belt, roller, chain, screw, and bucket elevator, cranes & hoists, pneumatic conveying, power requirement for conveying and elevating.

UNIT – IV

Milling of wheat, corn, pulses and oil seeds

Milling of wheat: unit operations and equipment; Milling of corn: unit operations and equipment in dry and wet milling methods; Milling of pulses: pre-conditioning, dry milling and wet milling methods, CFTRI and Pantnagar methods.

UNIT – V

Milling of Rice

Merits and demerits, changes during parboiling of rice, parboiling methods, viz. traditional methods, CFTRI method, Jadavpur method, pressure parboiling; different unit operations and equipment involved in traditional and modern rice milling methods; Preparation of rice products as rice flakes and puffed rice.

Text Books:

1. Unit Operations of Agricultural Processing, Sahay KM and Singh KK, Vikas Publishing House Pvt. Ltd., New Delhi. (ISBN-13. 978-8124911424)
2. Post-Harvest Technology of Cereals, Pulses and oil seeds, Chakraverty A, Oxford and IBH Publishing. Ltd., Calcutta.(ISBN-10. 9788120409699)

Reference Books:

1. Transport Processes and separation Process Principle, Geankoplis C J Prentice-HallInc., New Jersey.(ISBN-13. 9788120409699)
2. Unit Operations of Chemical Engineering, McCabe WL, Smith JC and Harriott P McGraw-Hill Book Co., Boston.(ISBN-13. 978-8184959635)

Web Links:

1. http://www.cigr.org/documents/CIGRHandbookVol4.pdf
2. http://ecoursesonline.iasri.res.in/course/view.php?id=22

Ground Water Hydrology

	L	T	P	C
Course Code: 241AE084	**3**	**0**	**0**	**3**

Course Outcomes:

At the end of the course, student will be able to:

CO1: Understand properties of various water bearing formations and movement of ground water.

CO2: Determine the aquifer properties under unsteady state and steady state subsurface flow conditions.

CO3: Explain design, development and construction of wells.

CO4: Analyze various water quality parameters and explain the occurrence of saline water intrusion.

CO5: Select appropriate method for exploration and replenishment of ground water.

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO9	PO 10	PO11
CO 1	1										
CO 2		2			3		1				
CO 3			3	2							
CO 4	1		2								
CO 5	1	1									

UNIT-I

Occurrence and Movement of Ground water: Introduction- Global water scenario; Water resources status in India; Origin and age of ground water; groundwater column, zones of aeration and saturation, Aquifer and its types; Aquifer characteristics.

Ground water movement: Darcy's law; Determination of Hydraulic conductivity; Ground water flow rates and directions; Ground water tracers, General flow equations through porous media.

UNIT-II

Well Hydraulics: Determination of aquifer parameters under steady/ unsteady, uniform/ radial flow to a well in a confined/ unconfined /leaky aquifer by different methods- Dupit Theim, Theis, Jacob and Chow's; Characteristic well losses; Specific capacity.

UNIT-III

Water Wells: Classification of wells; Methods of drilling of wells; Design and assembly of gravel packing; Installation of well screens; Common well drilling difficulties; Completion and development of well; Well Rehabilitation.

UNIT-IV

Ground water quality: Sources of salinity; Measures of water quality; Chemical, Physical and Biological analysis of ground water; Ground water samples; Water quality criteria; Occurrence of saline water intrusion- Ghyben-Herzberg relation between fresh and saline waters.

UNIT-V

Ground Water Investigations: Geological /geophysical exploration/ remote sensing / electric resistivity /seismic refraction-based methods for surface investigation of ground water, sub-surface ground water investigation through geophysical / resistivity; Methods of artificial recharge of ground water.

Text Books:

1. Groundwater, H.M. Raghunath, New Age International,3rd Edition. (ISBN: 978-8122419047)
2. Groundwater Hydrology, D.K. Todd, John Wiley and Son, New York, 2nd Edition. (ISBN: 9788126508365)

Reference Books:

1. Land and Water Management Engineering, V.V.N Murty and M.K Jha, Kalyani Publishers, 6th Edition. (ISBN: 978-9327214659)
2. Groundwater and tube wells, Garg S.P, Oxford and IBH publishing company limited, New Delhi.(ISBN: 8120408268)

Web Links:

1. http://nptel.ac.in/courses/105105042/
2. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=124667/

Micro Irrigation Systems

	L	T	P	C
Course Code: 241AE085	**2**	**0**	**0**	**2**

Course Outcomes:

At the end of the course, student will be able to:

- **CO1:** Assess the adaptability, problems, and prospects of different types of sprinkler irrigation systems.
- **CO2:** Plan and design the layout of sprinkler irrigation systems, including the hydraulic design of lateral, sub-main, and main pipelines, and select appropriate pumps and power units.
- **CO3:** Evaluate the performance of sprinkler irrigation systems by analyzing water distribution patterns, overlapping of sprinklers and laterals, uniformity coefficient, and pattern efficiency.
- **CO4:** Understand the types, components, and advantages and disadvantages of micro irrigation systems (drip, spray, and bubbler), and design effective drip irrigation systems considering wetting patterns and irrigation requirements.
- **CO5:** Perform proper operation and maintenance of micro irrigation systems, addressing issues like clogging, filter cleaning, flushing, and chemical treatment, and apply fertigation techniques, understanding their benefits, limitations, and best practices.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1:					1						
CO2:	2		1		2						
CO3:					1						
CO4:	2		1		2						
CO5:		2			1	1					1

UNIT – I

Introduction to Sprinkler Irrigation Systems

Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems.

UNIT – II

Design and Components of Sprinkler Irrigation Systems

Design of sprinkler irrigation system: layout selection, hydraulic design of lateral, sub-main and main pipe line, design steps; Selection of pump and power unit for sprinkler irrigation system.

UNIT – III

Performance Evaluation and Micro Irrigation Systems

Performance evaluation of sprinkler irrigation system: water distribution pattern and overlapping of sprinklers and laterals, uniformity coefficient and pattern efficiency; Micro Irrigation systems: types- drip, spray, & bubbler systems, merits and demerits, different components.

UNIT – IV

Design and Operation of Drip Irrigation Systems

Design of drip irrigation system: general considerations, wetting patterns, irrigation requirement, emitter selection; Hydraulics of drip irrigation system, design steps; Necessary steps for proper operation of a drip irrigation system, maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment.

UNIT – V

Fertigation in Micro Irrigation Systems

Fertigation: advantages and limitations of fertigation, fertigation frequency, duration and injection rate, methods of fertigation.

Text Books:

1. Principles of Sprinkler Irrigation system, Mane M S and Ayare B L.Jain Brothers, New Delhi.(ISBN : 9788183601504)
2. Irrigation: Theory and Practice, Michael A M. ,Vikas Publishing, New Delhi. (ISBN:978-8124918677)

Reference Books:

1. Micro Irrigation - Theory and Practices, Suresh R, Standard Publishers Distributors, Delhi. (ISBN:9788180141508)
2. Sprinkler Irrigation, Sivanappan R K.,Oxford & IBH Publishing House, New Delhi. (ISBN:978-8120402324)

Web Links:

1. http://agritech.tnau.ac.in/agricultural_engineering/agriengg_swc_microirri_ferti.html
2. Course: Micro Irrigation Systems Design 3(2+1) (iasri.res.in)

Surface Water Hydrology

	L	T	P	C
Course Code: 241AE086	**3**	**0**	**0**	**3**

Course Outcomes:

At the end of the course, student will be able to:

CO1: Calculate the mean areal precipitation using various methods.
CO2: Explain rainfall characteristics and measuring devices in India.
CO3: Explain runoff and stream flow measurement methods.
CO4: Estimate the discharge volume of runoff using hydrographs and unit hydrographs.
CO5: Plan a reservoir using flood routing techniques for management of natural resources.

Mapping of course outcomes with program outcomes:

CO/PO	PO1	PO2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2										
CO2	2	1			2						
CO3	2	1			2						
CO4	2			2	3						
CO5	1	2			3						

UNIT-I

Precipitation: Hydrology-definition, hydrological cycle and its components. Forms of Precipitation, Characteristics of rainfall in India (types of monsoon). Measurement of Rainfall – Recording and Non-Recording Rain gauges- Rain gauge network density for different topographic conditions – Point rainfall analysis - Presentation of Rainfall data – Mass Curve and hyetograph, Mean Precipitation over an area –

Arithmetic Mean, Thiessen Polygon, Isohyetal methods, DAD Relationships and curves. Probability Analysis of Rainfall – Return Period, Plotting position by Weibull's method – Rainfall events at different probability levels (20%, 40%, 60%, and 80 %).

UNIT-II

Runoff: definition-components of runoff-direct runoff and base flow, overload flow and interflows, pictorial representation of different routes of runoff. Runoff characteristics of streams – perennial, intermittent and ephemeral streams. Definition and Estimation of peak runoff using rational method.

Stream flow measurement: Measurement of stream flows. Measurement of stage and velocities, staff gauge, wire gauge, automatic stage recorders, current meters (horizontal and vertical axis meters), calibration (V= a Ns + b). Rainfall-Runoff relations (R=a P + b), curve fitting and determination of 'a' and 'b' and (correlation coefficient). Intensity-Duration-Frequency-Relationship (i= ((KTx) / (D+A) n).

Determination of net effective rainfall-infiltration indices- Phi index.

UNIT-III

Hydrographs: definition and components, factors affecting flood hydrographs, hydrograph separation for simple and complex storms – Method I, II and III. Unit Hydrograph-concept and the three implications of the definitions and the two basic assumptions. Effects of the characteristics of storms (duration of rain, time-intensity pattern, areal distribution of runoff and amount of runoff) on the shape of the resulting hydrographs. Derivation of Unit hydrographs for simple and complex storms. Derivation of an average unit hydrographs from several storms of the same duration (proper procedure of computing average peak flow and time to peak).

UNIT-IV

Unit Hydrographs: The methods for conversion of unit hydrograph of different durations, (1) method of superposition and (2) S-curve. Concept of S-curve method, explanation application and determination of lower duration graph from the given higher duration graph and vice-versa. Concepts of Synthetic unit hydrograph, Snyder' synthetic unit hydrograph and formulas relating to hydrograph features (basin lag, Peak flow and time base of the unit hydrograph). Concept and application of Instantaneous unit hydrograph and SCS Triangular Hydrograph.

UNIT-V

Flood Routing: Flood Routing-introduction, two broad categories of flood routing and channel routing, hydrologic routing and hydraulic routing, basic equations. Hydrologic storage routing, Schematic representation of storage routing, modified Pul's method (semi-graphical method). Explanation of the features of the modified Pul's method. Flood routing through a reservoir by modified Pul's method.
Applications of Hydrology in land and water management, watershed management, Flood mitigation, Floodplain mapping, Retards, Flood control and Regulation.

Text Books:

1. Engineering Hydrology, Raghunath H.M., Willey Eastern Limited, New Delhi, 3rd Edition. (ISBN: 978-9393159045)
2. Watershed Hydrology, Suresh R., Standard Publisher and Distributors, New Delhi. (ISBN: 978-8186308233)

Reference Books:

1. Engineering Hydrology, Subramanyam K., Tata Mc. Graw – Hill PublishingCo., Limited, New Delhi.(ISBN: 978-1249029974)
2. Hydrology for Engineers, Linsley R.K. Kholer A. & Paul Hus J.L.H., Mc-Graw Hill Book Co. New Delhi. (ISBN-13. 978-0070379565)
3. Watershed Management, Dhruvanarayana, VV., ICAR Publication, New Delhi. (ISBN: 978-8120346765)

Web Links:

1. http://www.nptelvideos.in/2012/11/advanced-hydrology.html
2. https://www.slideshare.net/MohammedSalahat1/chapter-3-surface-water-hydrolo
3. https://theconstructor.org/water-resources/types-of-rain-gauges/12801/
4. http://nptel.ac.in/downloads/105101002/

Land & Water Management Engineering

	L	T	P	C
Course Code: 241AE087	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the course, student will be able to:

- **CO1:** Apply methods for assessing and mitigating soil erosion to enhance soil conservation and sustainable land management.
- **CO2:** Design, implement, and evaluate various water erosion control measures, incorporating both agronomical and engineering approaches to enhance soil conservation and land sustainability.
- **CO3:** Apply energy and momentum principles in open channels, design soil erosion control structures, and implementing permanent gully control structures, ensuring hydrologic, hydraulic, and structural integrity.
- **CO4:** Demonstrate wind erosion control measures, land use capability classification and sedimentation of reservoirs.
- **CO5:** Classify water harvesting techniques, design and construct various structures such as farm ponds and percolation ponds, and apply design considerations for nala bunds.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2			2	3		2	1	2
CO2	2	3	3			2	3		2	1	2
CO3	2	3	3			2	3		2	1	2
CO4	2	2					2				
CO5	2	2	2				2			1	

UNIT – I

Soil Erosion: Causes, Types, Mechanisms, and Measurement

Soil erosion: introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion; Water erosion: mechanics and forms- splash, sheet, rill, gully, ravine and stream bank erosion; Gullies: classification, stages of development; Soil loss estimation– Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity- estimation by KE>24 and EI30 methods; Soil erodibility- topography, crop management and conservation practice factors; Measurement of soil erosion- Runoff plots, soil samples.

UNIT – II

Water Erosion Control Measures and Techniques

Water erosion control measures- agronomical measures, contour farming, strip cropping, conservation tillage and mulching; Engineering measures- bunds and terraces, bunds: contour and graded bunds- design and surplussing arrangements; terraces: level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stone

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

UNIT – III

Hydraulic Principles and Soil Erosion Control Structures

Energy and momentum principles in open channels; specific energy and specific force, hydraulic jump and its application, types of hydraulic jump, energy dissipation due to the jump; Soil erosion control structures- introduction, classification and functional requirements. Permanent structures for soil conservation and gully control- check dams, drop, chute and drop inlet spillways- design requirements, planning for design, design procedures- hydrologic, hydraulic and structural design and stability analysis.

UNIT – IV

Wind Erosion and Sedimentation Control in Agriculture

Wind erosion- factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes; Land capability classification, dryland farming; Rate of sedimentation, silt monitoring and storage loss in tanks, control of sedimentation in reservoirs.

UNIT – V

Water Harvesting Techniques and Structures for Agricultural Use

Water harvesting techniques- classification based on source, storage and use, runoff harvesting- short- term and long-term techniques; Structures- farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes; Farm pond- components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction; Percolation pond - site selection, design and construction details. Design considerations of nala bunds.

Text Books:

1. Open-Channel Hydraulics, Chow V T, McGraw- Hill Book Company, Inc.**(**ISBN: 9780070107762)
2. Manual of Soil and Water Conservation Practices, Singh. G., Venkataraman C, Sastry G and Joshi B P., Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.(ISBN: 978-8120405523)

Reference Books:

1. Land and Water Management Engineering, Murthy V V N., Kalyani Publishers, New Delhi,4th Edition, (ISBN: 978-9327214659)
2. Principles of Agricultural Engineering, Michael A M and Ojha T.P, Volume II. Jain Brothers, New Delhi, 4th Edition. (ISBN: 978-8183601849)

Web Links:

1. Course: Soil & Water Conservation Engg. 3(2+1) (iasri.res.in)
2. Soil-and-Water-Conservation-Engineering.pdf (agrimoon.com)

Agricultural Process Engineering & Food Quality

	L	T	P	C
Course Code: 241AE088	**3**	**0**	**0**	**3**

Course Outcomes:

At the end of the course, student will be able to:

CO1: Explain the functions of various unit operations and working of size reduction equipments for processing of fibrous and dry size reduction in processing of agriculture produce.

CO2: Explain the design and working of mixing equipments for powder, high and low viscosity liquids.

CO3: Classify separator equipment based on physical characteristics of grains.

CO4: Identify various methods for determining moisture content, EMC and drying process.

CO5: Explain the importance, design and working of milling and material handling devices, food quality control, food laws, food standards and HACCP.

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	1	1	-	-	-	-	-	-	-
CO2	3	1	2	2	-	-	-	-	-	-	-
CO3	3	2	1	2	-	-	-	-	-	-	-
CO4	3	1	1	1	-	-	-	-	-	-	-
CO5	3	2	2	2	-	-	-	-	-	-	-

UNIT-I

Unit operation in agricultural Processing:

Scope and importance crop processing – principles and methods of food processing, cleaning, grading, screening, scalping, sorting, size reduction, mixing, separation, drying, storage, milling, material handling, packaging, baking.

Size reduction:

Size reduction –principle of comminution/size reduction, particle shape, average particle size, crushing efficiency. Determination and designation of the fineness of ground material, screen analysis, Empirical relationships (Rittinger's, Kick's and Bond's equations) and related problems. Size reduction equipment – Crushers (Jaw crusher, Gyratory crusher, Crushing rolls), Grinders (Attrition mill, Hammer mill, Ball mill), Fine grinders (Rietz mill or disintegrator, Dispersion and colloid mills) and Cutting machines (Rotary knife cutter).

UNIT-II

Mixing:

Mixing –Introduction, theory of solids mixing, Mixing of low and moderate viscosity liquids (paddle mixer, turbine mixer, propeller mixer) its applications. Mixing of high viscosity liquids, pastes and plastic solids (pan mixer, kneaders) its applications. Mixers for dry powders and particulate solids (Horizontal screw and ribbon mixer, Vertical screw mixer, Tumbling mixer) and its applications, mixing index,

Separator units:

Theory of separation, types of separators, separator based on length, width, shape of the grains, specific gravity, density, cyclone separators, Pneumatic separator. Air-screen grain cleaner principle and types, Design considerations of air-screen grain cleaners, Sieve analysis- particle size determination, Ideal screen and actual screen– effectiveness of separation and related problems.

UNIT-III

Drying:

Moisture content and its representation (wet basis, dry basis), methods for determination moisture content (direct and indirect methods) and related problems, Importance of EMC and methods of determination (static-dynamic methods), EMC models, hysteresis effect, bound, unbound and free moisture. Principles of drying, theory of diffusion, mechanism of drying, falling rate, constant rate period, thin layer, deep bed dying methods, Effect of different factors on the drying process, types of dryers.

UNIT-IV

Milling and Material handling devices:

Rice milling, principles and equipments, paddy parboiling methods and milling equipment, milling of pulses and oilseeds. Scope and importance of material handling devices, Belt Conveyor– idlers, idler spacing, belt tension, Bucket elevator– classification, operation, capacity, drive mechanism, advantages and disadvantages. Screw conveyor – Principle of operation, capacity, and power requirement. Pneumatic conveying system- types, limitations of pneumatic conveying system.

UNIT-V

Food Quality: Concept, objectives and importance. Sensory evaluation or organoleptic evaluation of food quality, Food laws and regulations in India. Food gradeand standards – BIS, AGMARK, PFA, FPO. Hazard analysis and critical control point (HACCP) – objectives, principles, Steps involved in implementation of HACCP.

Text Books:

1. Unit Operations of Agricultural Processing, Sahay KM and Singh KK, Vikas Publishing House Pvt. Ltd., New Delhi. (ISBN: 978-8124911424)
2. Post-Harvest Technology of Cereals, Pulses and oil seeds, Chakraverty A, Oxford and IBH Publishing. Ltd., Calcutta. (ISBN: 978-8120409699)
3. Unit operations in Food processing, Earle R L, Pergamon Press, New York. (ISBN: 978-0080245361)

Reference Books:

1. Transport Processes and separation Process Principle, Geankoplis C J Prentice-HallInc., New Jersey. (ISBN:978-0134181028)
2. Unit Operations of Chemical Engineering, McCabe WL, Smith JC andHarriott PMcGraw-Hill Book Co., Boston.(ISBN: 978-0072848236)

Web Links:

1. http://www.cigr.org/documents/CIGRHandbookVol4.pdf
2. http://www.rpaulsingh.com/Learning and teaching resources
3. http://ecoursesonline.iasri.res.in/course/view.php?id=22
4. https://moodle.ufsc.br/pluginfile.php/772348/mod_resource/content/0/UnitOperations_in_Food_Engineering_-_A._Ibarz_G._BarbosaCanovas_CRC_2003_WW.pdf
5. http://www.nzifst.org.nz/unitoperations/matlenerg2.htm

Post-harvest Engineering for Horticultural Produce

	L	T	P	C
Course Code: 241AE089	**3**	**0**	**0**	**3**

Course Outcomes:
At the end of the course, student will be able to:

CO1: Explain about various properties and factors affecting quality of fruits and vegetables.
CO2: Classify various post harvest operations involved in horticulture processing.
CO3: Identify various preservation techniques for processed foods.
CO4: Apply the advanced packaging technology in food preservation.
CO5: Categorize different beverages based on method of preparation and explain the procedure for extraction of oleoresins and essential oils.

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11
CO1	3	2	2	2							
CO2	3	1	1	1							
CO3	3	2	2	2							
CO4	3	2	2	2							
CO5	3	1	1	1							

UNIT-I

Properties of Fruits and Vegetables: Engineering properties of fruits and vegetables - physical, aerodynamic, rheological and thermal properties. Electrical properties- Near Infrared reflectance (NIR), radiation, dielectric properties and optical properties: Light transmittance, Light reflectance, machine vision. Quality parameters of fruits and vegetable for processing: sensory, biochemical and nutritional characteristics.

Factors affecting fruits and vegetables quality: Pre-harvest factors, environmental factors, cultural factors and post-harvest factors. Harvesting indices of different horticultural produce, modern techniques for determination of harvesting indices. Handling and transportation of fruits and vegetables. Determination of quality parameters for fruits and vegetables: aroma, fruit ripening, leaf changes, firmness, juice content, sugar content, skin color, total soluble solids, pH and acidity.

UNIT-II

Post-Harvest Operations: Cleaning of fruits & vegetables: soaking, rinsing, sanitizing, washing methods: agitating, spraying water, wet and dry brushing, chemical washing. Peeling of fruits and vegetables: hand peeling, mechanical peeling, peeling by heat treatment and lye peeling. Grading of fruits & vegetables, factors affecting grading, types of graders: screen grader, roller grader, rope and cable type grader and weight grader. Canning of fruits & vegetables: grading, washing, peeling, cutting, blanching, cooling,

filling, syruping/brining, exhausting, sealing, retorting, cooling, storage, labeling. Cans making, causes of spoilage of canned foods.

UNIT-III

Principles of Preservation of Fruits & Vegetables: Asepsis, preservation by high temperature: pasteurization, flash pasteurization, sterilization. Chemical preservation with sulphur dioxide and benzoic acid, advantages, disadvantages. Drying and dehydration of fruits & vegetables (flow chart), types of dryers: cabinet dryer, tray dryers, tunnel dryer, freeze drying. Rehydration, ratio of rehydration coefficient. Freezing: Definition and methods - slow freezing, quick freezing and IQF, advantagesand disadvantages. Types of freezing - direct immersion, indirect contact with refrigerant, air blast, cryogenic and de-hydro freezing. Cooling methods - pre-cooling, room cooling, hydro cooling, refrigerated trucks.

UNIT-IV

Packaging of Horticultural crops: Controlled atmospheric storage (CAS), factors effecting on CAS, additional benefits, limitations, maintaining CAS, modified atmosphere storage/packaging (MAS/MAP), maintenance of MAP, active modification, passive modification, requirements of fresh fruits package under CAS orMAS. Packaging of fruits and vegetables, advantages and disadvantages. Packaging materials: cellophane, poly vinyl chloride, polyethylene, ethyl vinyl alcohol. Packaging of horticultural crops.

UNIT-V

Preparation and Preservation of Beverages: Preservation of unfermented fruit beverages: apple juice, grape juice, pineapple juice, citrus juice, mango juice with all flow sheets. Fermented beverages: wine, grape wine with all flow charts. Preparation of vinegar - alcoholic fermentation and acetic acid fermentation.

Oleoresin and Essential Oil Extraction: Turmeric oleoresin and chilli oleoresin. Solvents used for oleoresin extraction, advantages and disadvantages. Extraction of essential oil from spices by steam distillation.

Text Books:

1. Food Science by Potter N. and Hotchkiss J. H, An Aspen Publication, 5th Edition. (ISBN:978-8123904726)
2. Fruits and Vegetable Preservation: Principles and Practices, Srivastava, R.P. & Kumar, S. CBS Publishing, 3rd Edition. (ISBN: 978-8123924373)
3. The Complete Technology Book on Processing, Dehydration, Canning, Preservation of Fruits & Vegetables by NIIR Project Consultancy Services, 3rd Edition. (ISBN: 978-9381039694)

Reference Books:

1. Fruits: Tropical and subtropical, Bose T. K & Mitre, S. K. Naya Prakash, 3rd Edition. (ISBN: 978-8185971810)
2. Fruits and Vegetable processing, Bhatti, S. and Varma U., CBSPublishers, 1st Edition. (ISBN: 978-8123904047)
3. Food Processing and Preservation, Sivasenkar, B., CBS Publications. (ISBN: 978-8120320864)

Web Links:

1. http://www.rpaulsingh.com/animations/animaitons_master3.html
2. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=1098
3. https://onlinecourses.nptel.ac.in/noc18_ar08/preview

Agricultural Machinery & Equipment

	L	T	P	C
Course Code: 241AE090	**3**	**0**	**0**	**3**

Course Outcomes:

At the end of the course, student will be able to:

CO1: Explain the process of selection, cost estimation and methods of ploughing of farm mechanization.

CO2: Calculate the forces acting on tillage implements.

CO3: Explain inter-culture equipments and understand the sowing, planting and transplanting operation with various implements used for these operations.

CO4: Explain the harvesting and threshing operation with various implements used for these operations.

CO5: Explain the operation of grain combines harvesting mechanism.

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3			2	2						1
CO2		1			3						2
CO3	3										
CO4	3				1						
CO5	3	1									

UNIT-I

Introduction to farm mechanization: Classification of farm machines. Introduction to materials used in construction of farm machines. Heat treatment processes and their requirement in farm machines. Selection of farm machinery and cost estimation. Hitching systems and controls of farm machinery. Introduction to seed-bed preparation. Familiarization with land reclamation and earth moving equipment. Methods of Ploughing.

UNIT-II

Tillage Practices: Definition, primary tillage, secondary tillage, rotary tillage, deep tillage, minimum tillage and conservation tillage. Draft measurement of tillage equipment, Identification and major functional components of mould-board plough, disc plough, chisel plough, sub-soiler, harrows, cultivators, levelling, Forces acting on tillage implements. Cost of operation of farm machinery.

UNIT-III

Introduction to inter-culture equipments: Weeder – manual and powered, main components and their functional requirement.

Introduction to sowing, planting & transplanting equipment: Study of working of seed drills, no-till drills, happy seeder and strip-till drills. Brief description and working of planters. Study of types of furrow openers and metering systems in drills and planters. Calibration of seed-drills/ planters. Adjustments during operation. Introduction to plant protection equipment – sprayers and dusters.

Classification of sprayers. Types of nozzles. Calculations for calibration of sprayers and chemical application rates.

UNIT-IV

Study of harvesting operation – methods and terminology. Study of Reapers, Mowers and windrowers – types, working and adjustments. Introduction to threshing systems – manual and mechanical systems. Types of threshing drums and their applications. Types of threshers- tangential and axial, factors affecting thresher performance. Chaff cutters and capacity calculations.

UNIT-V

Study of grain combines (Wheat and Paddy) - Combine terminology, Computation of combine losses, study of combine troubleshooting. Study of Root crop diggers –potato and groundnut. Cotton harvesting mechanisms, study of cotton pickers and strippers. Introduction to vegetables and fruit harvesting equipment and tools.

Text Books:

1. Principles of Agricultural Engineering (Vol. II). A. M. Michael and T.P. Ojha, Jain brothers, New Delhi. (ISBN: 8183601849)
2. Principals of Farm Machinery, R.A. Kepner, Bainer Roy, and E.C. Barges, Publishers and Distributors, Delhi-17. (ISBN: 8123909772)
3. Theory, Construction and Calculation of Agricultural Machines (Vol. 1 and 2), Bosoi, E.S., Oxonion Press Pvt. Ltd., New Delhi. (ISBN: 9383692378)

Reference Books:

1. Agricultural Machines, Theory and Construction (Vol. 1 & 2). Kanafoshi, C.Z. and Karwawshi T. (ISBN: 9388399838)
2. Agricultural Machines, Kelnin, N.I.,Popov, I.F., and Sakun, V.A Amerind Publishers, New Delhi. (ISBN: 978-9061914488)

Web Links:

1. https://nptel.ac.in/courses/126/105/126105009/
2. http://www.hillagric.ac.in/edu/coa/agengg/lecture/243/agriengg-243.htm

Design of Bio-energy Systems

	L	T	P	C
Course Code: 241AE091	**3**	**0**	**0**	**3**

Course Outcomes:

At the end of the course, student will be able to:

- **CO1:** Comprehend Biomass Sources and Fermentation Processes
- **CO2:** Explore Biomass Production and Preparation
- **CO3:** Analyze Biomass Conversion Technologies
- **CO4:** Evaluate Biofuel Production Processes and Applications
- **CO5:** Assess Environmental and Economic Aspects of Bio-Energy

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2					2	3				
CO2	3	2		1		2					
CO3	2	1				2	3				
CO4	2	1				3	1				
CO5	2	1				3	1				

UNIT – I

Biomass sources and characteristics. Fermentation processes and its general requirements. Aerobic and anaerobic fermentation processes and their industrial applications. Heat transfer processes in anaerobic digestion systems.

UNIT – II

Biomass production- wastelands, classification and their use through energy plantation. Selection of species, methods of field preparation and transplanting. Harvesting of biomass and coppicing characteristics. Biomass preparation techniques for harnessing (size reduction, densification and drying).

UNIT – III

Bio-energy

Properties of biomass and conversion technologies, pyrolysis of biomass to produce solid, liquid and gaseous fuels. Biomass gasification, types of gasifiers, various types of biomass cook stoves for rural energy needs.

UNIT – IV

Thermo-chemical degradation. History of small gas producer engine system. Chemistry of gasification. Producer gas- type, operating principle. Gasifier fuels, properties, preparation, conditioning of producer gas. Applications, shaft power generation, thermal application and economics.

UNIT – V

Trans-esterification for biodiesel production and application in CI engines. production process, properties and application of ethanol. Bio-hydrogen production routes. Environmental aspect of bio-energy. Assessment of greenhouse gas mitigation potential. Cost economics of bio-energy systems.

Text Books:

1. Biomass Gasification, Pyrolysis and Torrefaction, Basu P, Academic Press, 2018. (ISBN: 10-10128129921)
2. Renewable Energy Academy Training wood energy professionals,Butler S. (ISBN: 13-978-0128129920)

Reference Books:

1. The Biodiesel Handbook, Knothe G, Gerpen J V, Krahl J. (Eds.), AOCS Press. (ISBN: 9781893997622)
2. Non-Conventional Energy Sources, Rai G D,Khanna Publishers, New Delhi. (ISBN: 978-8174090737)

Web links:

1. https://elearning.icar.gov.in/
2. https://saveetha.ac.in/images/sec/2021/Syllubus/Agriculture/19AG423-_BIO-ENERGY_SYSTEM_DESIGN_AND_APPLICATIONS.pdf

Minor Degree in Quantum Technologies

S.No.	Course Code	Course Name	L	T	P	C	Semester
Mandatory Courses							
1	241EC097	Survey of Quantum technologies and Application	3	0	0	3	IV
2	241EC098	Foundations of Quantum Technologies	3	0	0	3	V
3	241EC099	Basic Programming Lab (or)	1	0	2	3	V
	241EC100	Basic Laboratory Course for Quantum Technologies					
4	241EC101	Quantum Algorithms and Cryptography	12 week 3 Credit - NPTEL MOOC			3	VII/VIII
Any One course from the below							
5	241EC102	Introduction to Quantum Computation	3	0	0	3	VI
6	241EC103	Introduction to Quantum Communication	3	0	0	3	VI
7	241EC104	Introduction to Quantum Sensing	3	0	0	3	VI
8	241EC105	Introduction to Quantum Materials	3	0	0	3	VI
Any One course from the below							
9	241EC106	Engineering Foundations of Quantum Technologies	3	0	0	3	VII
10	241EC107	Solid State Physics for Quantum Technologies	3	0	0	3	VII
11	241EC108	Quantum Optics	3	0	0	3	VII
12	241EC109	Quantum Cybersecurity	3	0	0	3	VII
13	241EC110	Quantum Machine Learning	3	0	0	3	VII
Total			**18**	**0**	**0**	**18**	

Survey of Quantum Technologies and Applications

	L	T	P	C
Course Code: 241EC097	3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- **CO1** Explain the core quantum mechanical principles relevant to qubits and quantum technologies.
- **CO2** Analyze and compare major qubit hardware platforms used in quantum computation.
- **CO3** Describe the principles and operating mechanisms of quantum sensing techniques.
- **CO4** Evaluate practical applications of quantum sensing in measurement and metrology.
- **CO5** Explain and assess quantum communication protocols over fibre-based and free-space channels.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3		2	2						2
CO3	2	2		2	2						2
CO4	2	2		3	2	2					2
CO5	3	3		2	3	2	1				2

UNIT – 1: Quantum Technologies – four verticals: Motivation for Quantum Technologies A qualitative overview of salient aspects of quantum physics: Quantum States, Wavefunctions, Probabilistic interpretation, Physical observables, Hermitian operators, expectation values, Heisenberg uncertainty principle, Schrodinger equation, Time evolution; distinction from classical physics; Heuristic description of Superposition, Tunnelling and entanglement; No cloning theorem; Simulating classical systems – Feynman's idea of a quantum simulator and the birth of the field.

UNIT-II: Quantum Computation: Basics of qubits -- what is a qubit?, How is it different from a classical bit? – Review of classical logic gates; Di Vincenzo criteria for realising qubits; Basics of qubit gates and quantum circuits; Physical implementation of qubits (very qualitative description); Solid State Qubits: Semiconducting Qubits – quantum dots, spins, Superconducting Qubits – charge, flux and phase, Topological Qubits – proposals and advantages; Atoms and Ions: Trapped ions, Rydberg atoms, Neutral atoms; Photonic Qubits: Conventional linear optical setups, Integrated Photonics; NMR qubits: Conventional NMR qubits, NV centres Overview of applications and recent achievements: RSA and Shor's algorithm, Quantum Advantage; Long term goals and strategies being followed : Error correction

UNIT-III: Quantum Sensing: Basics of quantum sensing, Basics of Photon (single and entangled) generation and detection, Gravimetry, Atomic clock, Magnetometry, State of the art in Quantum Sensing

UNIT-IV: Quantum Communications: Basics of digital communication, Quantifying classical information – Shannon entropy, Basic ideas of quantum communication, security, eavesdropping, Overview of quantum communication achievements : Terrestrial – fibre-based, Free space, Satellite-based

UNIT-V: Introduction to Quantum Materials: What are quantum materials, Why are they important, Applications (quantum computing, spintronics, etc.)

Overview of Key Classes of Quantum Materials: Topological Insulators, Superconductors, Mott Insulators, 2D Materials and Quantum Spin Liquids.

Course References:

1. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)
2. Quantum computation and quantum information – Nielsen M. A., and Chuang I. L., 10th Anniversary edition, Cambridge University Press (2010)
3. Elements of Quantum Computation and Quantum Communication, A. Pathak, Boca Raton, CRC Press (2015)
4. An Introduction to Quantum Computing, Phillip Kaye, Raymond Laflamme, and Michele Mosca, Oxford University Press (2006)
5. Quantum computing explained, David McMahon, Wiley (2008)

Foundations of Quantum Technologies

	L	T	P	C
Course Code: 241EC098	3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- **CO1** Apply mathematical tools to model and analyze classical and quantum physical systems.
- **CO2** Explain and apply the postulates of quantum mechanics to solve elementary quantum system problems.
- **CO3** Analyze statistical physics concepts and differentiate classical and quantum statistical distributions.
- **CO4** Explain and interpret information-theoretic concepts in classical and quantum information systems.
- **CO5** Analyze and compare classical and quantum computational complexity classes with reference to post-quantum cryptography.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2			1						2
CO2	3	3		2	1						2
CO3	3	2		2							2
CO4	2	2			2						2
CO5	2	3			1	1	1				2

UNIT-I: Brief overview of classical physics (This segment is meant for the student to understand what a Hamiltonian is, which will feature later in quantum mechanics) : Hamiltonian function and Hamilton's equations, Phase-space description of a system, Connection and Equivalence with Newton's laws for simple systems – free particle, particle moving in a conservative potential, examples of Harmonic oscillator, hydrogen atom. Historical evolution of quantum mechanics: Planck's quantum hypothesis, Photo electric effect, Atomic spectra, Bohr's quantisation principle, De Broglie's Wave particle duality

UNIT-II Postulates of Quantum Mechanics: State vectors and Hilbert Space, Dirac Bra-Ket notation, Measurables and Hermitian Operators, Unitary Transformations, Schrodinger. Equation and Time evolution of quantum states, Measurement Postulate, Schrodinger, Heisenberg and Interaction pictures, Eigen values, Expectation values and Matrix elements, Heisenberg's Uncertainty principle

UNIT-III:

Density operator formalism of quantum mechanics – pure and mixed states; Superposition and Entanglement in quantum mechanics; No cloning theorem; Applications of postulates – Particle in a box, Hydrogen atom, Harmonic Oscillator. Number states, ladder operators and Coherent states of a harmonic oscillator; Spin and Angular momentum – spin half particles; Rabi problem of a spin-half particle in a rotating magnetic field; Bosons and Fermions

UNIT-IV:

Statistical Physics: Quick review of first and second laws of thermodynamics, Thermal Equilibrium and Gibbs principle, Applying Gibbs principle to Classical and Quantum harmonic oscillators, Bosons and Fermions and Quantum statistics – Fermi-Dirac and Bose-Einstein distributions

UNIT - V: Information Science: Digital communication and information: Quantifying information in terms of Shannon entropy; Basic ideas of quantum information; Decoherence and noise; Introductory ideas of Kraus operators Brief overview of Computational Complexity: Qualitative ideas of a Turing machine: Types of Turing machines; Time and Space complexity – P vs NP, PSPACE; Quantum complexity classes – Q, EQP, BQP, BPP, QMA; Post Quantum Cryptography (PQC)

Course References:

1. Introduction to Quantum Mechanics, Griffiths D. J., 3rd Edition, Cambridge University Press (2024)
2. Introduction to Electrodynamics, Griffiths D. J., 4th edition, Cambridge University Press (2020)
3. Principles of Quantum Mechanics, Shankar, R., 2nd edition, Springer (2014)
4. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)
5. Quantum computation and quantum information – Nielsen M. A., and Chuang I. L., 10th Anniversary edition, Cambridge University Press (2010)
6. A Pathak, Elements of Quantum Computation and Quantum Communication, Boca Raton, CRC Press (2015)
7. Information Theory, Robert B. Ash, Dover Publications (2003)
8. Introduction to the Theory of Computation, Michael Sipser, 3rd edition, Cengage India Pvt. Ltd. (2014) Statistical Mechanics, Pathria R. K., Paul D. Beale, 4th edition, Academic Press, (2021)

Basic Programming Lab

L	T	P	C
1	0	2	3

Course Code: 241EC099

Course Outcomes: At the end of the course, student will be able to:

CO1 Apply basic programming concepts and object-oriented principles to develop scientific programs.

CO2 Implement and analyze simple algorithms and evaluate their computational performance.

CO3 Apply numerical methods to solve differential equations and linear algebra problems.

CO4 Analyze probabilistic and statistical data using numerical and simulation techniques.

CO5 Develop computational models for quantum mechanics and electromagnetism applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2			2						2
CO2	3	3			2						2
CO3	3	2		2	2						2
CO4	2	3		2	2						2
CO5	3	3	2	3	2	1		1			2

Course Content and syllabus:

- Basics of programming
  - Data structures, classes, Object-oriented programming
  - Data storage and retrieval, Memory allocation
  - Scientific plotting, documentation of codes
- Simple algorithms and benchmarking run time
  - Sorting
  - Searching
  - Arithmetic algorithms like GCD, Prime factorisation
- Numerical Integration and differential equations
  - Linear 2nd Order ODEs with constant coefficients
  - Linear 2nd order ODEs with variable coefficients
  - Boundary value problems
    - Poisson equation
    - Laplace equation
    - Wave equation
    - Diffusion Equation
- Numerical techniques in linear algebra
  - Matrix inverse
  - Eigenvalue problem

- Diagonalisation of matrices
- Singular value decomposition

- Numerical techniques in Probability and Statistics
  - (Pseudo) Random number generation
  - Computing statistical moments for data samples
  - Least Squares fitting
  - Error Analysis
  - Hypothesis Testing
  - Monte Carlo sampling
- Applications to Quantum Mechanics (can be done using openly available modules in languages like Python, Julia etc.)
  - Eigen energies of coupled two level systems
  - Eigen energies of two-level system coupled to oscillator (Jaynes-Cummings Model)
  - Driven two-level system – Rabi Problem
  - Driven damped oscillator — coherent states
- Applications to EM theory (e.g. magnetic field simulation)
  - Electrostatic charge distributions
  - Magnetostatic current distributions
  - Finite Element techniques for electromagnetic simulations

Course References:

Computational Physics, Nicholas Giordano, Hisao Nakanishi, 2nd edition, Pearson-Addison Wesley (2005)

Basic Laboratory Course for Quantum Technologies

	L	T	P	C
Course Code: 241EC100	1	0	2	3

Course Outcomes: At the end of the course, student will be able to:

CO1 Apply optical experimental techniques to measure wavelength, diffraction, polarization, and imaging parameters.

CO2 Analyze and characterize RLC circuits and resonators to determine quality factor and losses.

CO3 Implement and verify basic digital circuits using standard ICs and laboratory instruments.

CO4 Operate RF and microwave instruments to measure transmission, reflection, noise, and network parameters.

CO5 Acquire, process, and interpret experimental data using computer interfacing and quantum simulation tools.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2		2	2						2
CO2	3	3		2	2						2
CO3	3	2	2		2		1				2
CO4	3	3		2	2	1					2
CO5	3	3	2	2	2	1	1				2

Course Content and syllabus:

- Optics
  - Interferometry – wavelength measurements, intensity measurements
  - Diffraction – single slit, grating
  - Microscopy – magnification, aberration
  - Polarization optics – PBS, HWP, QWP
- RLC circuits
  - Series and parallel RLC circuits – Verifying the quality factor formulae
  - Extracting intrinsic losses
- Digital circuits
  - Adder, Multiplier
  - Encoder, Decoder
  - D flipflop, shift registers
  - How to use common Integrated Circuit chips
- Radio Frequency Technology:
  - Using Oscilloscope

- Ring-up and ring-down time measurements of RLC circuits
- Measurements of different pulse-shapes generated by a function generator
    - Using Vector Network Analyser
- Transmission and reflection measurements of coaxial cable in open, short and matched termination
- Voltage standing wave ratio measurement
- Amplitude and Phase quadrature, In-phase and Out-of-phase quadrature plots and Quality factor measurement of RLC circuits
- Characterising S-parameters, ABCD and Z matrices of common 2 port networks – coaxial cable, attenuator, low pass high pass bandpass filters etc.
- Characterising 3 port networks – directional couplers, circulators, isolators
    - Using a spectrum analyser
- Noise from a resistor at different temperatures

- Interfacing instruments with a computer
- Data acquisition
    - Signal demodulation – heterodyne vs Homodyne, Mixing of signals
    - Sampling, digitisation using ADCs – under-sampling and aliasing, oversampling and noise
    - Averaging and interpolation techniques
- Quantum Simulators
    - Running quantum protocols in a quantum simulator
    - Implementing simple quantum algorithms on cloud-based quantum computers (depending on availability of time on such machines)
- Running simple algorithms on cloud-based quantum processors (optional)

Course References:

1. Optics, Eugene Hecht, A. R. Ganesan, 5th edition, Pearson (2019)
2. Art of Electronics, Paul Horowitz and Winfield Hill, 3rd edition, Cambridge University Press (2015)
3. Digital Design, Morris Mano, Michael D. Cilletti, 6th edition, Pearson Education (2018)
4. Microwave Engineering, David Pozar, 4th edition, Wiley (2013)
5. Discrete-time signal processing, Alan V. Oppenheim and Ronald W. Shaffer, 4th edition, Pearson (2009)
6. Optical quantum information and quantum communication, A. Pathak and A. Banerjee, SPIE Spotlight Series, SPIE Press (2016)

Introduction to Quantum Computation

	L	T	P	C
Course Code: 241EC102	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the course, student will be able to:

CO1 Explain the principles of qubits and compare their physical realizations with classical bits.

CO2 Analyze quantum correlations, entanglement, and Bell-type inequalities in quantum systems.

CO3 Apply universal quantum gates and circuits to construct basic quantum computational models.

CO4 Analyze and explain the working of fundamental quantum algorithms such as Grover's and Shor's algorithms.

CO5 Explain quantum computational complexity, error correction techniques, and the limitations of NISQ-era processors.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3		2							2
CO3	3	2			2						2
CO4	3	3		2	2						2
CO5	2	3		2	2	2	1		1		2

Course Content and syllabus:

- Qubits versus classical bits
  - Spin-half systems and photon polarizations
  - Trapped atoms and ions
  - Artificial atoms using circuits
  - Semiconducting quantum dots
  - Single and Two qubit gates – Solovay - Kitaev Theorem
- Quantum correlations
  - Entanglement and Bell's theorems
- Review of Turing machines and classical computational complexity
  - Time and space complexity (P, NP, PSPACE)
- Reversible computation
- Universal quantum logic gates and circuits
- Quantum algorithms
  - Deutsch algorithm
  - Deutsch Josza algorithm
  - Bernstein - Vazirani algorithm
  - Simon's algorithm

- Database search
    - Grover's algorithm
- Quantum Fourier Transform and prime factorization
    - Shor's Algorithm.
- Quantum complexity classes – Q, EQP, BQP, BPP, QMA
- Additional Topics in Quantum Algorithms
    - Variational Quantum Eigensolver (VQE)
    - HHL
    - QAOA
- Introduction to Error correction
- Fault-tolerance
- Simple error correcting codes
- Survey of current status
    - NISQ era processors
    - Quantum advantage claims
    - Roadmap for future

Course References:

1. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)
2. Quantum computation and quantum information – Nielsen M. A., and Chuang I. L., 10th Anniversary edition, Cambridge University Press (2010)
3. A Pathak, Elements of Quantum Computation and Quantum Communication, Boca Raton, CRC Press (2015)
4. Quantum error correction and Fault tolerant computing, Frank Gaitan, 1st edition, CRC Press (2008)
5. Quantum computing explained, David McMahon, Wiley (2008)
6. Introduction to Quantum Computing: From a lay person to a programmer in 30 steps, Hui Yung Wong, 1st edition, Springer-Nature Switzerland AG (2022)

Introduction to Quantum Communication

	L	T	P	C
Course Code: 241EC103	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the course, student will be able to:

- **CO1** Explain the principles of polarization optics and photodetection relevant to quantum communication systems.
- **CO2** Analyze classical and quantum information concepts including entropy, noise, and channel capacity.
- **CO3** Explain and analyze quantum correlations, Bell measurements, and fundamental quantum communication protocols.
- **CO4** Analyze the working of quantum communication protocols such as teleportation, dense coding, and quantum key distribution.
- **CO5** Evaluate quantum communication architectures, hardware implementations, and the concept of quantum networks and internet.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3			2						2
CO3	3	3		2							2
CO4	3	3		2	2		1		2		2
CO5	2	2		2	3	2	1		2		2

Course Content and syllabus:

- Basics of Polarization optics
  - Quarter and half-wave plates
  - Polarizing beam splitters
- Basics of linear and square-law detectors
  - Quadrature amplitude modulation
  - Heterodyne and Homodyne demodulation and linear detectors
  - Intensity measurements and square law detectors
  - Photomultipliers, Avalanche Photo diodes
- Digital communication – information theory (basics)
  - Information entropy
  - Noiseless channel encoding
  - Noisy channel encoding
- No cloning theorem
- Quantum Memories
- Quantum repeaters
- Entanglement and Bell Theorems
- Bell Measurements and Tests
- Quantum Teleportation protocol

- Quantum Dense coding
- Quantum Key Distribution protocols
  - BB84
  - E91
  - BBM92.
  - B92
  - COW
  - DPS
- Quantum Networks and Quantum Internet
- Survey of Hardware implementations
  - Free space communications
  - Satellite based communications
  - Fibre optics-based communications

Course References:

1. Quantum computation and quantum information – Nielsen and Chuang Cambridge University Press, Cambridge (2010)
2. A Pathak, Elements of Quantum Computation and Quantum Communication, Boca Raton, CRC Press (2015)

Introduction to Quantum Sensing

	L	T	P	C
Course Code: 241EC104	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the course, student will be able to:

- **CO1** Explain the principles of classical sensing, noise mechanisms, and measurement sensitivity limits.
- **CO2** Analyze quantum measurement processes including projective, weak, and non-demolition measurements.
- **CO3** Apply information-theoretic bounds to quantify and optimize quantum sensing performance.
- **CO4** Analyze quantum states of light and photodetection techniques used in precision measurements.
- **CO5** Evaluate photon-, entanglement-, atomic-, and spin-based quantum sensing applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3		2							2
CO3	3	3		2	2						2
CO4	3	3		2	2				2		2
CO5	2	3		3	2	2			2		2

Course Content and syllabus:

- Classical sensing
  - photo detection
- Classical Noise
  - Johnson Noise, Telegraph noise, flicker or 1/f noise
- Sensitivity of classical measurements
  - Classical Fisher information
  - Cramer - Rao bounds (information theory basics may be required here).
- Quantum measurements
  - projective/orthogonal measurements
  - Approximate/non-orthogonal measurements
  - Weak continuous measurements
  - Error-disturbance relations
  - Standard quantum limits
  - Quantum non-demolition measurements
- States of light
  - fock states
  - Coherent states

- Squeezed states
- Tomography
- Wigner quasi-probability distribution
- P-distribution
- Husimi Q function

- Quantum photo detection
  - Square-law detectors, Intensity measurements and Photo-detection
  - Linear Detectors and Quadrature Measurements
- Quantum Cramer-Rao bounds
- Single photon-based sensing applications
- Entanglement based sensing applications
- Atomic state-based sensing, solid-state spin-based sensing applications (gravimetry, magnetometry)

Course References:

1. Quantum Measurement and Control , Howard Wiseman and David Milburn, Cambridge University Press (2014)
2. Quantum Measurement , Vladimir Braginsky and Farid Ya Khalili, Cambridge University Press (1995)
3. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)

Introduction to Quantum Materials

	L	T	P	C
Course Code: 241EC105	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the course, student will be able to:

CO1 Explain the fundamental concepts of band theory and electronic structure in solids.
CO2 Analyze correlated systems and magnetic phenomena using basic experimental and theoretical principles.
CO3 Explain the principles of superconductivity and the operation of superconducting devices.
CO4 Analyze the electronic and optical properties of two-dimensional materials such as graphene and TMDCs.
CO5 Explain topological phases of matter and assess material growth techniques relevant to quantum technologies.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3		2							2
CO3	3	2		2							2
CO4	3	3		2	2				2		2
CO5	2	2		2	2	2			2		2

Course Content and syllabus:

- Band theory basics
  - Metals, Semiconductors and Insulators
  - Band structure of solids
  - Survey of semiconducting devices for quantum technologies (electronic, quantum optical devices and principle of operation)
- Correlated systems
- Magnetism
  - Para, ferro magnetism basics
  - Magnetic measurements, hall effect, magnetoresistance
  - Faraday and Kerr effects
- Superconductivity
  - BCS theory
  - Ginzburg Landau
  - Josephson Effect – AC and DC Josephson effects
  - Survey of superconducting devices for quantum technologies

- 2D materials
    - Graphene and its properties – single and few layers
    - Transition Metal Dichalcogenides – Electronic and Optical Properties
- Topological Phases of matter
    - Basics of Topology
    - Geometric phases - Berry Phase
    - Aharonov Bohm effect
    - Topological phases of matter
- Survey of material growth techniques
    - Molecular beam epitaxy
    - Chemical vapor deposition, MOVPE
    - Pulsed laser deposition, etc.
    - Crystal growth techniques

Course References:

1. Condensed Matter Physics , M P Marder, 2nd Edition, John Wiley and Sons, 2010
2. Introduction to Superconductivity, Michael Tinkham, standard ed., Medtech (2017)

Engineering Foundations of Quantum Technologies

Semester:	**L**	**T**	**P**	**C**
Course Code: 241EC106	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the course, student will be able to:

CO1 Apply principles of electrical networks and transmission lines to analyze resonant circuits and signal propagation.

CO2 Explain abstract models of computation and analyze algorithmic complexity using classical computation theory.

CO3 Analyze analog and digital communication techniques with respect to modulation, noise, and information capacity.

CO4 Apply noise analysis and signal conditioning principles to evaluate system performance and quantum noise limits.

CO5 Explain cryptographic principles and analyze classical and post-quantum cryptographic protocols.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2		2						2
CO2	3	3									2
CO3	3	3		2	2			2			2
CO4	3	3		2	2						2
CO5	2	3			2	2		2			2

Course Content and syllabus:

- Electrical Networks (4 hours)
    - Analog RLC circuits – resonances, impedances, quality factors
    - Transmission line basics (2 hours)
        - Telegrapher equations, wave impedance, impedance matching, transmission line resonators
- Computer Science (15 hours)
    - Basics of computer architecture (1 hour)
- Arithmetic Logic Unit
- Memory
    - Abstract models of computation (12 hours)
        - Finite State Machine
        - Turing Machines
        - Overview of Hierarchy of languages – Regular, Context-Free, Turing Decidable and Turing Recognisable
    - Complexity Theory (2 hours)
        - Time and Space complexity

        - P vs NP, NP-completeness
- Electrical Communications (1 hour)
    - Analog Communications (1 hour)
        - Quadrature amplitude modulation
        - Heterodyne and Homodyne demodulation
- Noise and Signals (6 hours)
    - Characterising Noise
    - Types of Noise
        - Shot Noise
        - Johnson-Nyquist Noise
        - Telegraphic noise or flicker or 1/f noise
- Signal conditioning and noise mitigation
- Amplification and Added Noise
        - Linear Amplifier theory
        - Signal-Noise Ratio, Added Noise, Noise Figure of amplification
        - Dynamic Range
        - Noise temperature
        - Quantum limits on noise in linear amplifiers
- Digital Communications (4 hours)
- Information entropy
- Noiseless channel encoding
- Noisy channel encoding
- Basics of cryptography (6 hours)
    - Basics of Number Theory
    - Random Number Generation
    - One time pad, Private key, public key, symmetric and asymmetric cryptography protocols
    - RSA and DH
    - Post Quantum Cryptography (PQC)

Course References:

1. Art of Electronics, Paul Horowitz and Winfield Hill, 3rd edition, Cambridge University Press (2015)
2. Digital Design, Morris Mano, Michael D. Cilletti, 6th edition, Pearson Education (2018)
3. Microwave Engineering, David Pozar, 4th edition, Wiley (2013)
4. Information Theory, Robert B. Ash, Dover Publications (2003)
5. Introduction to the Theory of Computation, Michael Sipser, 3rd edition, Cengage India Pvt. Ltd. (2014)
6. Protecting Information – From Classical error correction to quantum cryptography, Susan Loepp and William K. Wootters, Cambridge University Press (2006)

Solid State Physics for Quantum Technologies

	L	T	P	C
Course Code: 241EC107	3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

CO1 Explain crystal structures, symmetry, diffraction principles, and bonding mechanisms in solids.

CO2 Analyze electronic properties of solids using free-electron, band theory, and tight-binding models.

CO3 Analyze lattice vibrations and phonon dynamics to explain vibrational and thermal properties of solids.

CO4 Explain and analyze magnetic phenomena in solids using classical and quantum models.

CO5 Explain superconducting phenomena and analyze superconducting materials and devices relevant to quantum technologies.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3		2							2
CO3	3	3		2							2
CO4	3	2		2							2
CO5	3	3		2	2	2					2

Course Content and syllabus:

- Structure of solids –
  - Symmetry, Bravais lattices
  - Laue equations and Bragg's law,
  - Brillouin Zones
  - Atomic scattering and structure factors.
- Characterisation of crystal structures – XRD etc.
- Bonding in solids –
  - van der Waals and Repulsive interactions,
  - Lennard Jones potential,
  - Madelung constant
- The Drude theory of metals –
  - DC & AC electrical conductivity of a metal;
  - Hall effect & magnetoresistance,
  - Density of states, Fermi-Dirac distribution, Specific heat of degenerate electron gases
  - Free electron model

- Beyond the Free electron model
  - Kronig-Penney Model
  - Periodic potential – Bloch Theorem
  - Band theory
  - Tight binding model
- Phonons in Solids
  - One dimensional monoatomic and diatomic chains
  - Normal modes and Phonons
  - Phonon spectrum
  - Long wavelength acoustic phonons and elastic constants
  - Vibrational Properties- normal modes, acoustic and optical phonons.
- Magnetism
  - Dia-, Para-, and Ferromagnetism
  - Langevin's theory of paramagnetism
  - Weiss Molecular theory
- Superconductivity:
  - Phenomenological description – Zero resistance, Meissner effect
  - London Theory
  - BCS theory
  - Ginzburg-Landau Theory
  - Type-I and type-II superconductors
  - Flux quantization
  - Josephson effect.
  - High Tc superconductivity

Course References:

1. Introduction to Solid State Physics, Charles Kittel, Wiley India Edition (2019)
2. Condensed Matter Physics, M P Marder, 2nd Edition, John Wiley and Sons (2010)
3. Introduction to Superconductivity, Michael Tinkham, standard edition, Medtech (2017)

Quantum Optics

	L	T	P	C
Course Code: 241EC108	3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- **CO1** Explain the quantization of the electromagnetic field and the properties of non-classical states of light.
- **CO2** Analyze optical coherence phenomena and interferometric techniques using quantum optical principles.
- **CO3** Analyze phase-space representations of quantum states of light to identify non-classical features.
- **CO4** Analyze classical, semi-classical, and quantum models of light–matter interaction in atomic systems.
- **CO5** Apply open quantum system models to describe decoherence and dissipation in quantum optical systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3		2					1		2
CO3	3	3		2					1		2
CO4	3	3		2	2				1		2
CO5	3	3		2	2				1		2

Course Content and syllabus:

- Quantization of the electromagnetic field
  - Number states, coherent states, squeezed states
  - Hanbury-Brown and Twiss experiments – Photon bunching, Photon anti bunching
  - Hong-Ou-Mandel interference
- Theory of Optical coherence
  - Young's double slit experiment and first order coherence
  - Coherence functions of arbitrary order
  - Normal ordering, symmetric ordering and ani-normal ordering of operators
  - Interferometry
- Phase-space representations of states of light
  - Wigner distribution
  - P-function and the notion of non-classicality with some examples of nonclassical states like squeezed states and their applications
  - Husimi Q function
- Light-matter interaction
  - Classical model of light-matter interaction

- Semi-classical model of light-matter interaction-
- Quantum light-matter interaction
- Rabi Model
- Jayne's-cummings model
- Open quantum systems
  - Fermi golden rule
  - Born-Markov Lindblad Master Equation

Course References:

1. Introductory Quantum Optics, Christopher Gerry and Peter Knight, Cambridge University Press (2004)
2. Quantum Optics, D. F. Walls, Gerard J. Milburn, 2nd Edition, Springer (2008)
3. Quantum Optics: An introduction, Mark Fox, Oxford University Publishers (2006)
4. Quantum Optics for Beginners, Z. Ficek and M. R. Wahiddin, 1st edition, Jenny Stanford Publishing (2014)