

College of Agricultural Engineering & Technology


COLLEGE OF AGRICULTURAL ENGINEERING & TECHNOLOGY
51st Annual Convention of ISAE



College of Agricultural Engineering and Technology

B.Tech. (Agricultural Engineering)

Courses: Semester wise

Course No.	Course Title	Credits
Semester I		
CE 101	Surveying and Levelling	3(1+2)
CE 102	Engineering Mechanics	3(2+1)
CHEM 101	Engineering Chemistry	3(2+1)
MATH 104	Engineering Mathematics-I	3(2+1)
ME 101	Engineering Drawing	2(0+2)
ME 102	Heat and Mass Transfer	2(1+1)
PHY 101	Engineering Physics	3(2+1)
SOILS 103	Principles of Soil Science	3(2+1)
NCC/NSS	National Cadet Corps/National Service Scheme	2(0+2)
TUT	Tutorial	1(1+0)
	Total Credits	**25(13+12)**
Semester II		
ABM 102	Entrepreneurship Development and Business Management	3(2+1)
CE 103	Fluid Mechanics and Open Channel Hydraulics	3(2+1)
CE 104	Strength of Materials	2(1+1)
EE 101	Web Designing and Internet Applications	2(1+1)
FOR 201 AGM 201/ SOILS 201/ AG ECON 203/ CHEM 201	Environmental studies and disaster management (To be taught jointly by Forestry ; Agricultural Meteorology ; Soil Science; Agricultural Economics & Chemistry)	3(3+0)
MATH 105	Engineering Mathematics-II	3(2+1)
ME 103	Workshop Technology and Practices	3(1+2)
ME 104	Theory of Machines	2(1+1)
CCA	Co-curricular Activity	1(0+1)
TUT	Tutorial	1(1+0)
	Total Credits	**23(14+9)**
Semester III		
AGRON 203	Principles of Agronomy	3(2+1)
CE 201	Soil Mechanics	2(1+1)
CE 202	Design of Structures	2(1+1)
EE 201	Electrical Machines and Power Utilization	3(2+1)
ENG 201	Communication Skills and Personality Development	2(1+1)
HORT 203	Principles of Horticultural Crops and Plant Protection	2(1+1)
MATH 201	Engineering Mathematics-III	3(2+1)
ME 201	Machine Design	2(1+1)
ME 202	Thermodynamics; Refrigeration and Air Conditioning	3(2+1)
NCC/NSS	National Cadet Corps/National Service Scheme	2(0+2)
TUT	Tutorial	1(1+0)
	Total Credits	**25(14+11)**

Course No.	Course Title	Credits
Semester IV		
CE 203	Building Construction and Cost Estimation	2(2+0)
EE 202	Applied Electronics and Instrumentation	3(2+1)
FMPE 201	Tractor and Automotive Engines	3(2+1)
ME 203	Auto CAD Applications	2(0+2)
PFE 201	Engineering Properties of Agricultural Produce	2(1+1)
RBEE 201	Fundamentals of Renewable Energy Sources	3(2+1)
SWE 201	Watershed Hydrology	2(1+1)
SWE 202	Irrigation Engineering	3(2+1)
SWE 203	Sprinkler and Micro Irrigation Systems	2(1+1)
CCA	Co-curricular Activity	1(0+1)
TUT	Tutorial	1(1+0)
	Total Credits	**24(14+10)**
Skill Development Training-I (Student READY) during semester break after 4th Semester		
Semester V		
FMPE 301	Tractor Systems and Controls	3(2+1)
FMPE 302	Farm Machinery and Equipment-I	3(2+1)
PFE 301	Agricultural Structures and Environmental Control	3(2+1)
PFE 302	Post Harvest Engineering of Cereals; Pulses and Oil Seeds	3(2+1)
RBEE 301	Renewable Power Sources	3(2+1)
SWE 301	Soil and Water Conservation Engineering	3(2+1)
SWE 302	Watershed Planning and Management	2(1+1)
SWE 303	Drainage Engineering	2(1+1)
FMPE 390/ PFE 390/ RBEE 390/ SWE 390	Skill Development Training-I (Student READY)*	5(0+5)
CCA	Co-curricular Activity	1(0+1)
TUT	Tutorial	1(1+0)
	Total Credits	**29(15+14)**
Semester VI		
EE 301	Computer Programming and Data Structures	3(1+2)
FMPE 303	Farm Machinery and Equipment-II	3(2+1)
FMPE 304	Tractor and Farm Machinery Operation and Maintenance	2(0+2)
PFE 303	Post Harvest Engineering of Horticultural Crops	2(1+1)
PFE 304	Dairy and Food Engineering	3(2+1)
SWE 304	Water Harvesting and Soil Conservation Structures	3(2+1)
SWE 305	Groundwater; Wells and Pumps	3(2+1)
RBEE 302	Bio-energy Systems: Design and Applications	3(2+1)
FMPE 391/ PFE 391/ RBEE 391/ SWE 391	Undergraduate Seminar	1(0+1)
CCA$^{@}$	Co-curricular Activity	1(0+1)
TUT	Tutorial	1(1+0)
	Total Credits	**25(13+12)**

Skill Development Training-II (Student READY) during semester break after VI Semester		
Course No.	**Course Title**	**Credits**
Semester VII		
Student READY (Rural and Entrepreneurship Awareness Development Yojana)		
FMPE 411/ PFE 411/ RBEE 411/ SWE 411	Industrial Attachment /Internship (Student READY)	10(0+10)
FMPE 412/ PFE 412/ RBEE 412/ SWE 412	Experiential Learning On campus (Student READY)	10(0+10)
FMPE 490/ PFE 490/ RBEE 490/ SWE 490	Skill Development Training-II (Student READY)*	5(0+5)
	Educational Tour* (optional)	
TUT	Tutorial	1(1+0)
	Total Credits	**26(1+25)**
	Educational tour during winter break /January	
Semester VIII		
Student READY (Rural and Entrepreneurship Awareness Development Yojana)		
	Elective course	3(2+1)
	Elective course	3(2+1)
	Elective course	3(2+1)
FMPE 491/ PFE 491/ RBEE 491/ SWE 491	Project Planning and Report Writing (Student READY)#	10(0+10)
	Total Credits	**19(6+13)**

*Registration only;

[@]NCC/NSS (0+2) for students admitted through lateral entry

Students required to register with same department as of elective package

Courses of B.Tech. (Agricultural Engineering) Programme
Department-wise

Core Courses:

Course No.	Course Title	Credit Hours	Semester
Agricultural Engineering and Technology			
FARM MACHINERY AND POWER ENGINEERING			
FMPE 201	Tractor and Automotive Engines	3(2+1)	IV
FMPE 301	Tractor Systems and Controls	3(2+1)	V
FMPE 302	Farm Machinery and Equipment-I	3(2+1)	V
FMPE 390	Skill Development Training-I (Student READY)	5(0+5)	V
FMPE 303	Farm Machinery and Equipment-II	3(2+1)	VI
FMPE 304	Tractor and Farm Machinery Operation and Maintenance	2(0+2)	VI
FMPE 391	Undergraduate Seminar	1(0+1)	VI
FMPE 411	Industrial Attachment/ Internship (Student READY)	10(0+10)	VII
FMPE 412	Experiential Learning On campus(Student READY)	10(0+10)	VII
FMPE 490	Skill Development Training-II (Student READY)	5(0+5)	VII
FMPE 491	Project Planning and Report Writing (Student READY)	10(0+10)	VIII
	Total Credits	**55(8+47)**	
PROCESSING AND FOOD ENGINEERING			
PFE 201	Engineering Properties of Agricultural Produce	2(1+1)	IV
PFE 301	Agricultural Structures and Environmental Control	3(2+1)	V
PFE 302	Post Harvest Engineering of Cereals; Pulses and Oil Seeds	3(2+1)	V
PFE 390	Skill Development Training-I (Student READY)	5(0+5)	V
PFE 303	Post Harvest Engineering of Horticultural Crops	2(1+1)	VI
PFE 304	Dairy and Food Engineering	3(2+1)	VI
PFE 391	Undergraduate Seminar	1(0+1)	VI
PFE 411	Industrial Attachment/ Internship (Student READY)	10(0+10)	VII
PFE 412	Experiential Learning On campus (Student READY)	10(0+10)	VII
PFE 490	Skill Development Training-II (Student READY)	5(0+5)	VII
PFE 491	Project Planning and Report Writing (Student READY)	10(0+10)	VIII
	Total Credits	**54(8+46)**	
RENEWABLE AND BIO ENERGY ENGINEERING			
RBEE 201	Fundamentals of Renewable Energy Sources	3(2+1)	IV
RBEE 301	Renewable Power Sources	3(2+1)	V
RBEE 390	Skill Development Training-I (Student READY)	5(0+5)	V
RBEE 302	Bio-energy Systems: Design and Applications	3(2+1)	VI
RBEE 391	Undergraduate Seminar	1(0+1)	VI
RBEE 411	Industrial Attachment/ Internship (Student READY)	10(0+10)	VII
RBEE 412	Experiential Learning On campus (Student READY)	10(0+10)	VII
RBEE 490	Skill Development Training-II (Student READY)	5(0+5)	VII
RBEE 491	Project Planning and Report Writing (Student READY)	10(0+10)	VIII
	Total Credits	**50(6+44)**	
SOIL AND WATER ENGINEERING			
SWE 201	Watershed Hydrology	2(1+1)	IV
SWE 202	Irrigation Engineering	3(2+1)	IV

SWE 203	Sprinkler and Micro Irrigation Systems	2(1+1)	IV
SWE 301	Soil and Water Conservation Engineering	3(2+1)	V
SWE 302	Watershed Planning and Management	2(1+1)	V
SWE 303	Drainage Engineering	2(1+1)	V
SWE 390	Skill Development Training-I (Student READY)	5(0+5)	V
SWE 304	Water Harvesting and Soil Conservation Structures	3(2+1)	VI
SWE 305	Groundwater; Wells and Pumps	3(2+1)	VI
SWE 391	Undergraduate Seminar	1(0+1)	VI
SWE 411	Industrial Attachment/ Internship (Student READY)	10(0+10)	VII
SWE 412	Experiential Learning On campus (Student READY)	10(0+10)	VII
SWE 490	Skill Development Training-II (Student READY)	5(0+5)	VII
SWE 491	Project Planning and Report Writing (Student READY)	10(0+10)	VIII
	Total Credits	**61(12+49)**	
BASIC ENGINEERING			
Civil Engineering			
CE 101	Surveying and Levelling	3(1+2)	I
CE 102	Engineering Mechanics	3(2+1)	I
CE 103	Fluid Mechanics and Open Channel Hydraulics	3(2+1)	II
CE 104	Strength of Materials	2(1+1)	II
CE 201	Soil Mechanics	2(1+1)	III
CE 202	Design of Structures	2(1+1)	III
CE 203	Building Construction and Cost Estimation	2(2+0)	IV
	Total Credits	**17(10+7)**	
Electrical and Electronics Engineering			
EE 101	Web Designing and Internet Applications	2(1+1)	II
EE 201	Electrical Machines and Power Utilization	3(2+1)	III
EE 202	Applied Electronics and Instrumentation	3(2+1)	IV
EE 301	Computer Programming and Data Structures	3(1+2)	VI
	Total Credits	**11(6+5)**	
Mechanical Engineering			
ME 101	Engineering Drawing	2(0+2)	I
ME 102	Heat and Mass Transfer	2(1+1)	I
ME 103	Workshop Technology and Practice	3(1+2)	II
ME 104	Theory of Machines	2(1+1)	II
ME 201	Machine Design	2(1+1)	III
ME 202	Thermodynamics; Refrigeration and Air Conditioning	3(2+1)	III
ME 203	Auto CAD Applications	2(0+2)	IV
	Total Credits	**16(6+10)**	
Agriculture			
AGRONOMY			
AGRON 203	Principles of Agronomy	3(2+1)	III
BUSINESS MANAGEMENT			
ABM 102	Entrepreneurship Development and Business Management	3(2+1)	II

FORESTRY			
FOR 201 AGM 201/ SOILS 201/ AG ECON 203/ CHEM 201	Environmental studies and disaster management (To be taught jointly by Forestry; Agricultural Meteorology; Soil Science; Agricultural Economics & Chemistry)	3 (3+0)	II
HORTICULTURE			
HORT 203	Principles of Horticultural Crops and Plant Protection	2(1+1)	III
SOIL SCIENCE			
SOILS 103	Principles of Soil Science	3(2+1)	I
	Total Credits (Agriculture)	**14(10+4)**	
Basic Sciences and Humanities			
CHEMISTRY (CHEMISTRY & BIOCHEMISTRY)			
CHEM 101	Engineering Chemistry	3(2+1)	I
ENGLISH (LANGUAGES AND HARYANVI CULTURE)			
ENG 201	Communication Skills and Personality Development	2(1+1)	III
MATHEMATICS & PHYSICS (MATHEMATICS ; STATISTICS & PHYSICS)			
PHY 101	Engineering Physics	3(2+1)	I
MATH 104	Engineering Mathematics-I	3(2+1)	I
MATH 105	Engineering Mathematics-II	3(2+1)	II
MATH 201	Engineering Mathematics-III	3(2+1)	III
	Total Credits (Basic Sciences and Humanities)	**17(11+6)**	

ELECTIVE COURSES: PACKAGE-WISE (PACKAGE I TO IV)
(A student is required to elect any one package out of Packages I to IV and take three courses from the selected package)

Course No.	Course Title	Credit Hours	Semester
Package I: Farm Machinery and Power Engineering			
FMPE 401	Human Engineering and Safety	3(2+1)	VIII
FMPE 402	Hydraulic Drives and Controls	3(2+1)	VIII
FMPE 403	Tractor Design and Testing	3(2+1)	VIII
FMPE 404	Mechanics of Tillage and Traction	3(2+1)	VIII
FMPE 405	Farm Machinery Design and Production	3(2+1)	VIII
FMPE 406	Precision Agriculture and System Management	3(2+1)	VIII
FMPE 407	Artificial Intelligence	3(2+1)	VIII
FMPE 408	Mechatronics	3(2+1)	VIII
	Total Credits	**24(16+8)**	
Package II: Processing and Food Engineering			
PFE 401	Food Quality and Control	3(2+1)	VIII
PFE 402	Food Plant Design and Management	3(2+1)	VIII
PFE 403	Food Packaging Technology	3(2+1)	VIII
PFE 404	Development of Processed Products	3(2+1)	VIII
PFE 405	Process Equipment Design	3(2+1)	VIII
	Total Credits	**15(10+5)**	

Package III: Renewable and Bio Energy Engineering			
RBEE 401	Photovoltaic Technology and Systems	3(2+1)	VIII
RBEE 402	Waste and By-products Utilization	3(2+1)	VIII
RBEE 403	Biogas Technology and Mechanism	3(2+1)	VIII
RBEE 404	Solar Energy Utilization	3(2+1)	VIII
RBEE 405	Energy Auditing and Management	3(2+1)	VIII
	Total Credits	**15(10+5)**	
Package IV: Soil and Water Engineering			
SWE 401	Management of Canal Irrigation System	3(2+1)	VIII
SWE 402	Remote Sensing and GIS Applications	3(2+1)	VIII
SWE 403	Precision Farming Techniques for Protected Cultivation	3(2+1)	VIII
SWE 404	Landscape Irrigation Design and Management	3(2+1)	VIII
SWE 405	Water Quality and Management Measures	3(2+1)	VIII
SWE 406	Plastic Applications in Agriculture	3(2+1)	VIII
SWE 407	Information Technology for Land and Water Management	3(2+1)	VIII
SWE 408	Minor Irrigation and Command Area Development	3(2+1)	VIII
SWE 409	Wasteland Development	3(2+1)	VIII
SWE 410	Floods and Control Measures	3(2+1)	VIII
	Total Credits	**30(20+10)**	

FARM MACHINERY AND POWER ENGINEERING

Core Courses:

Course No.	Course Title	Credit Hours	Semester
FMPE 201	Tractor and Automotive Engines	3(2+1)	IV
FMPE 202	Farm Machinery and Power **(For B.Sc. (Hons.) Agriculture)**	2(1+1)	III/VII
FMPE 301	Tractor Systems and Controls	3(2+1)	V
FMPE 302	Farm Machinery and Equipment-I	3(2+1)	V
FMPE 390	Skill Development Training-I (Student READY)	5(0+5)	V
FMPE 303	Farm Machinery and Equipment-II	3(2+1)	VI
FMPE 304	Tractor and Farm Machinery Operation and Maintenance	2(0+2)	VI
FMPE 391	Undergraduate Seminar	1(0+1)	VI
FMPE 411	Industrial Attachment/ Internship (Student READY)	10(0+10)	VII
FMPE 412	Experiential Learning On campus (Student READY)	10(0+10)	VII
FMPE 490	Skill Development Training-II (Student READY)	5(0+5)	VII
FMPE 491	Project Planning and Report Writing (Student READY)	10(0+10)	VIII
	Total Credits	**57(9+48)**	

Elective Courses (any three):

Course No.	Course Title	Credit Hours	Semester
FMPE 401	Human Engineering and Safety	3(2+1)	VIII
FMPE 402	Hydraulic Drives and Controls	3(2+1)	VIII
FMPE 403	Tractor Design and Testing	3(2+1)	VIII
FMPE 404	Mechanics of Tillage and Traction	3(2+1)	VIII
FMPE 405	Farm Machinery Design and Production	3(2+1)	VIII
FMPE 406	Precision Agriculture and System Management	3(2+1)	VIII
FMPE 407	Artificial Intelligence	3(2+1)	VIII
FMPE 408	Mechatronics	3(2+1)	VIII
	Total Credits	**24(16+8)**	

FMPE 201	TRACTOR AND AUTOMOTIVE ENGINES	3 (2 + 1)	SEM IV

Theory

Study of sources of farm power –conventional & non-conventional energy sources; classification of tractors and IC engines; review of thermodynamic principles of IC (CI & SI) engines and deviation from ideal cycle; general energy equation and heat balance sheet; study of mechanical, thermal and volumetric efficiencies; study of engine components their construction; operating principles and functions; study of engine strokes and comparison of 2-stroke and 4-stroke engine cycles and CI and SI engines; study of engine valve systems, valve mechanism, valve timing diagram and valve clearance adjustment; study of cam profile; valve lift and valve opening area; study of importance of air cleaning system; study of types of air cleaners and performance characteristics of various air cleaners; study of fuel supply system; study of fuels; properties of fuels; calculation of air-fuel ratio; study of tests on fuel for SI and CI engines; study of detonation and knocking in IC engines; study of carburetion system; carburetors and their main functional components; study of fuel injection system – Injection pump, their types, working principles, fuel injector nozzles – their types and working principle; engine governing – need of governors, governor types and governor characteristics; study of lubrication system – need, types, functional components; study of lubricants – physical properties,

additives and their application; engine cooling system – need, cooling methods and main functional components; study of need and type of thermostat valves; additives in the coolant; study of radiator efficiency; study of ignition system of SI engines; study of electrical system including battery, starting motor, battery charging, cut-out etc; comparison of dynamo and alternator; familiarization with the basics of engine testing.

Practical

Introduction to different systems of CI engines; engine parts and functions; working principles etc.; valve system – study, construction and adjustments; oil & fuel – determination of physical properties; air cleaning system; fuel supply system of SI engine; diesel injection system & timing; cooling system and fan performance; thermostat and radiator performance evaluation; part load efficiencies & governing; lubricating system & adjustments; starting and electrical system; ignition system; tractor engine heat balance and engine performance curves; visit to engine manufacturer/ assembler/ spare parts agency.

Reference Books

1. Jain, S.C. and Rai, C.R. (2012). Farm Tractor Maintenance and Repair. Standard Publishers Distributors, New Delhi.
2. Lal, Radhey. (2005). Agricultural Engineering Through Worked Examples. Saroj Prakashan, Allahabad.
3. Michal, A. M. and Ojha, T. P. (2016). Principle of Agricultural Engineering, Vol. 1. Jain Brothers, New Delhi.
4. Kumar, Sanjay. (2008). Textbook of Tractor at a Glance: A Unique Book of Farm Power International Book Distributing Company, Lucknow.
5. Sahay, Jagdishwar. (2015). Elements of Agricultural Engineering. Standard Publishers Distributors, New Delhi.

FMPE 202	FARM MACHINERY AND POWER	2 (1 + 1)	SEM III/VII
For B.Sc. (Hons.) Agriculture			

Theory

Status of farm power in India; sources of farm power; IC engines: working principles of IC engines; comparison of two stroke and four stroke cycle engines; study of different components of IC engine; IC engine terminology and solved problems; familiarization with different systems of IC engines: air cleaning, cooling, lubrication, fuel supply and hydraulic control system of a tractor; familiarization with power transmission system : clutch, gear box, differential and final drive of a tractor; tractor types; cost analysis of tractor power and attached implement; familiarization with primary and secondary tillage implement; implement for hill agriculture; implement for intercultural operations; familiarization with sowing and planting equipment; calibration of a seed drill and solved examples; familiarization with plant protection equipment; familiarization with harvesting and threshing equipment.

Practical

Study of different components of IC engine; to study air cleaning and cooling system of engine; familiarization with clutch, transmission; differential and final drive of a tractor; familiarization with lubrication and fuel supply system of engine; familiarization with brake, steering, hydraulic control system of engine; learning of tractor driving; familiarization with operation of power tiller, implements for hill agriculture; familiarization with different types of primary and secondary tillage

implements: mould plough, disc plough and disc harrow; familiarization with seed-cum-fertilizer drills their seed metering mechanism and calibration; planters and transplanter; familiarization with different types of sprayers and dusters; familiarization with different inter-cultivation equipment; familiarization with harvesting and threshing machinery.

Reference Books

1. Sahay, Jagdishwar. (2015). Elements of Agricultural Engineering. Standard Publishers Distributors, New Delhi.
2. Lal, Radhey. (2005). Agricultural Engineering through Worked Examples. Saroj Prakashan, Allahabad.
3. Jain, S.C. and Rai, C.R. (2012). Farm Tractor Maintenance and Repair. Standard Publishers Distributors, New Delhi.
4. Kumar, Sanjay. (2008). Textbook of Tractor at a Glance: A Unique Book of Farm Power International Book Distributing Company, Lucknow.
5. Nakra, C. P. (2016). Farm Machines and Equipments. Dhanpat Rai Publishing Company, New Delhi.

FMPE 301	TRACTOR SYSTEMS AND CONTROLS	3 (2+1)	SEM V

Theory

Study of need for transmission system in a tractor; transmission system – types, major functional systems; study of clutch – need, types, functional requirements, construction and principle of operation; familiarization with single plate, multi-plate, centrifugal and dual clutch systems; study of gear box – gearing theory, principle of operation, gear box types, functional requirements and calculation for speed ratio; study of differential system – need, functional components, construction, calculation for speed reduction; study of need for a final drive; study of brake system – types, principle of operation, construction, calculation for braking torque; study of steering system – requirements, steering geometry characteristics, functional components, calculation for turning radius; familiarization with ackerman steering, steering systems in track type tractors; study of hydraulic system in a tractor – principle of operation, types, main functional components, functional requirements; familiarization with the hydraulic system adjustments and ADDC; study of tractor power outlets –PTO standards, types and functional requirements; introduction to traction, traction terminology, theoretical calculation of shear force and rolling resistance on traction device; study of wheels and tyres – solid tyres and pneumatic tyres; tyre construction and tyre specifications; study of traction aids; study of tractor mechanics – forces acting on the tractor; determination of CG of a tractor; determination and importance of moment of inertia of a tractor; study of tractor static equilibrium; tractor stability especially at turns; determination of maximum drawbar pull; familiarization with tractor as a spring-mass system; ergonomic considerations and operational safety; introduction to tractor testing; deciphering the engine test codes.

Practical

Introduction to transmission systems and components; study of clutch functioning, parts and design problem on clutch system; study of different types of gear box; calculation of speed ratios; design problems on gear box; study on differential and final drive and planetary gears; study of brake systems and some design problems; steering geometry and adjustments; study of hydraulic systems in a tractor; hydraulic trainer and some design problems; appraisal of various controls in different makes tractors in relation to anthropometric measurements; determination of location of CG of a tractor, moment of inertia of a tractor; traction performance of a traction wheel.

Reference Books

1. Kumar, Sanjay. (2008). Textbook of Tractor at a Glance. A unique book of farm Power. International Book Distributing Company, Lucknow.
2. Nakra, C. P. (2016). Farm Machines and Equipments. Dhanpat Rai Publishing Company, New Delhi.
3. Jain, S.C. and Rai, C.R. (2012). Farm Tractor Maintenance and Repair. Standard Publishers Distributors, New Delhi.
4. Lal, Radhey. (2005). Agricultural Engineering through Worked Examples. Saroj Prakashan, Allahabad.
5. Liljedahl, John B., Turnquist, Paul K., Smith, David W., Makoto, Hoki. (2004). Tractors and their Power Units. Van Nostrand Reinhold, New York.

FMPE 302	FARM MACHINERY AND EQUIPMENT-I	3 (2+1)	SEM V

Theory

Introduction to farm mechanization; classification of farm machines; unit operations in crop production; identification and selection of machines for various operations on the farm; hitching systems and controls of farm machinery; calculation of field capacities and field efficiency; calculations for economics of machinery usage; comparison of ownership with hiring of machines; introduction to seed-bed preparation and its classification; familiarization with land reclamation and earth moving equipment; introduction to machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage; measurement of draft of tillage tools and calculations for power requirement for the tillage machines; introduction to tillage machines like mould-board plough, disc plough, chisel plough, sub-soiler, harrows, cultivators; identification of major functional components; attachments with tillage machinery; introduction to sowing, planting & transplanting equipment; introduction to seed drills, no-till drills and strip-till drills; introduction to planters, bed-planters and other planting equipment; study of types of furrow openers and metering systems in drills and planters; calibration of seed-drills/ planters; adjustments during operation; introduction to materials used in construction of farm machines; heat treatment processes and their requirement in farm machines; properties of materials used for critical and functional components of agricultural machines; introduction to steels and alloys for agricultural application; identification of heat treatment processes specially for the agricultural machinery components.

Practical

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

Reference Books

1. Lal, Radhey. (2005). Agricultural Engineering through Worked Examples. Saroj Prakashan, Allahabad.
2. Nakra, C. P. (2016). Farm Machines and Equipments. Dhanpat Rai Publishing Company, New Delhi.

3. Kepner, R.A., Bainer, Roy and Barger, E.L. (2005). Principles of Farm Machinery. John Wiley & Sons, New York.
4. Singh, T.P. (2017). Farm Machinery. PHI Learning Privet Limited, New Delhi
5. Handbook of Agricultural Engineering (2013). ICAR, Bio-Green Books, New Delhi.

FMPE 303	FARM MACHINERY AND EQUIPMENT-II	3 (2+1)	SEM VI

Theory

Introduction to plant protection equipment – sprayers and dusters; classification of sprayers and sprays; types of nozzles; calculations for calibration of sprayers and chemical application rates; introduction to interculture equipment; use of weeders – manual and powered; study of functional requirements of weeders and main components; familiarization of fertilizer application equipment; study of harvesting operation–harvesting methods; harvesting terminology; study of mowers – types, constructional details, working and adjustments; study of shear type harvesting devices – cutter bar, inertial forces, counter balancing, terminology and cutting pattern; study of reapers, binders and windrowers – principle of operation and constructional details; importance of hay conditioning; methods of hay conditioning and calculation of moisture content of hay; introduction to threshing systems – manual and mechanical systems; types of threshing drums and their applications; types of threshers-tangential and axial, their constructional details and cleaning systems; study of factors affecting thresher performance; study of grain combines, combine terminology, classification of grain combines; study of material flow in combines; computation of combine losses; study of combine troubles and troubleshooting; study of chaff cutters and capacity calculations; study of straw combines–working principle and constructional details; study of root crop diggers–principle of operation, blade adjustment and approach angle and calculation of material handled; study of potato and groundnut diggers; study of cotton harvesting – cotton harvesting mechanisms; study of cotton pickers and strippers; functional components; study of maize harvesting combines; introduction to vegetables and fruit harvesting equipment and tools.

Practical

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

Reference Books

1. Nakra, C. P. (2016). Farm Machines and Equipments. Dhanpat Rai Publishing Company, New Delhi.
2. Kepner, R.A., Bainer, Roy and Barger, E.L. (2005). Principles of Farm Machinery. John Wiley & Sons, New York.
3. Singh, T.P. (2017). Farm Machinery. PHI Learning Privet Limited, New Delhi.
4. Smith, D. W., Sims, B. G. and O'Neill, D. H. (1994). Testing and Evaluation of Agricultural Machinery and Equipment. Food & Agriculture Organization, Rome.
5. Mehta, M.L., Verma, S.R., Misra S.K. and Sharma, V.K. (2005). Testing and Evaluation of Agricultural Machinery. Daya Publishing House, New Delhi.

FMPE 304	TRACTOR AND FARM MACHINERY OPERATION AND MAINTENANCE	2 (0+2)	SEM VI

Practical

Familiarization with different makes and models of agricultural tractors; identification of functional systems including fuels system, cooling system, transmission system, steering and hydraulic systems; study of maintenance points to be checked before starting a tractor; familiarization with controls on a tractor; safety rules and precautions to be observed while driving a tractor; driving practice of tractor; practice of operating a tillage tool (mould-board plough/ disc plough) and their adjustment in the field; study of field patterns while operating a tillage implement; hitching & de-hitching of mounted and trail type implement to the tractor; driving practice with a trail type trolley – forward and in reverse direction; introduction to tractor maintenance – precautionary and break-down maintenance; tractor starting with low battery charge; introduction to trouble shooting in tractors; familiarization with tools for general and special maintenance; introduction to scheduled maintenance after 10, 100, 300, 60, 900 and 1200 hours of operation; safety hints; top end overhauling; fuel saving tips; preparing the tractor for storage; care and maintenance procedure of agricultural machinery during operation and off-season; repair and maintenance of implements – adjustment of functional parameters in tillage implements; replacement of broken components in tillage implements; replacement of furrow openers and change of blades of rotavators; maintenance of cutter bar in a reaper; adjustments in a thresher for different crops; replacement of v-belts on implements; setting of agricultural machinery workshop.

Reference Books

1. Jain, S.C. and Rai, C.R. (2012). Farm Tractor Maintenance and Repair. Standard Publishers Distributors, New Delhi.
2. Liljedahl, J. B., Casleton, W. M., Turnquist, P. K. and Smith, D.W. (2004). Tractors and their Power Units. Van Nostrand Reinhold, New York.
3. Mehta, M. L., Verma, S. R., Misra S. K. and Sharma, V. K. (2005). Testing and Evaluation of Agricultural Machinery. Daya Publishing House, New Delhi.
4. Hunt, D. and Wilson, D. (2015). Farm Power and Machinery Management. Waveland Press Inc Long Grove, Illinois, USA.
5. Gupta, R. B. and Gupta, B. K. (1987). Tractor Mechanic, Theory, Maintenance and Repair. Sathya Prakashan and Tech India Publication, New Delhi.

FMPE 390/ PFE 390/ RBEE 390/ SWE 390	SKILL DEVELOPMENT TRAINING-I (Student READY)	5 (0+5)	SEM V

Exposure to industrial and institutional applications in selected fields of interest (Farm Machinery and Power Engineering; Processing & Food Engineering; Renewable & Bio-energy Engineering; Soil & Water Engineering; Information Technology etc.); training report preparation and presentation (students will be required to undergo training of about 4 weeks during semester break after IVth semester).

FMPE 391/ PFE 391/ RBEE 391/ SWE 391	UNDERGRADUATE SEMINAR	1 (0+1)	SEM VI

Topic selection; material collection; slide preparation; presentation and interaction.

FMPE 411/ PFE 411/ RBEE 411/ SWE 411	**INDUSTRIAL ATTACHMENT/ INTERNSHIP (Student READY)**	**10 (0+10)**	**SEM VII**

Attachment with selected industries/organizations dealing with tractors, agril machinery, precision agriculture, irrigation systems, pumps, soil conservation, watershed management, processing, value addition, renewable and bio-energy and other aspects related to agricultural engineering; to enrich desired skills and practical knowledge of the students.

FMPE 412/ PFE 412/ RBEE 412/ SWE 412	**EXPERIENTIAL LEARNING ON CAMPUS (Student READY)**	**10 (0+10)**	**SEM VII**

FMPE: Exposure to production technology; testing and evaluation of agricultural machinery as per standards; interpretation and preparation of test reports.

PFE: Agro-processing; food product development; setting up of model plants for food processing and value addition; processing and packaging of selected grains; fruits and vegetables.

RBEE: Design; development; installation and maintenance of renewable energy appliances/ equipments and use of related softwares.

SWE: Farm planning and development of irrigation and drainage projects; watershed project formulation; design of water harvesting and recycling systems; maintenance and operation of wells and pumps; irrigation and drainage systems; installation of weirs and flumes for water measurement.

FMPE 490/ PFE 490/ RBEE 490/ SWE 490	**SKILL DEVELOPMENT TRAINING-II (Student READY)**	**5 (0+5)**	**SEM VII**

Exposure to an environment in which students are expected to be associated in their future career; preparation of training report technical aspects of the training and presentation (students will be required to undergo training of about 4 weeks during semester break after VIth semester).

FMPE 491/ PFE 491/ RBEE 491/ SWE 491	**PROJECT PLANNING AND REPORT WRITING (Student READY)**	**10 (0+10)**	**SEM VIII**

Field/lab studies; project report writing and presentation.

Elective Courses

(A student can opt need based elective courses equivalent to 9 Credit Hours)

FMPE 401	**HUMAN ENGINEERING AND SAFETY**	**3 (2+1)**	**SEM VIII**

Theory

Human factors in system development – concept of systems, basic processes in system development, performance reliability, human performance, information input process, visual displays, major types and use of displays; auditory and factual displays; speech communications; biomechanics of motion; types of movements; range of movements; strength and endurance; speed and accuracy; human control of systems; human motor activities, controls, tools and related devices; anthropometry: arrangement and utilization of work space, atmospheric conditions, heat exchange process and performance; air pollution; dangerous machine (regulation) act; rehabilitation and compensation to

accident victims; safety gadgets for spraying; threshing; chaff cutting and tractor & trailer operation etc.

Practical

Calibration of the subject in the laboratory using bi-cycle ergo-meter; study and calibration of the subject in the laboratory using mechanical treadmill; use of respiration gas meter from human energy point of view; use of heart rate monitor; study of general fatigue of the subject using blink ratio method; familiarization with electro-myograph equipment; anthropometric measurements of a selected subjects; optimum work space layout and locations of controls for different tractors; familiarization with the noise and vibration equipment; familiarization with safety gadgets for various farm machines.

Reference Books

1. Bridger, Robert. (2008). Introduction to Ergonomics (3rd Edition), CRC Press.
2. Singh, Pal Lakhwinder. (2016). Work Study and Ergonomics. Cambridge University Press.
3. Chauhan, Kaur Manjit. (2016). Ergonomics-Practical Manual for Beginners. Authors press.
4. Khan, M. I. (2010). Industrial Ergonomics. Prentice Hall India Learning Pvt. Ltd.
5. Stephanidis, Constantine. (2009). The Universal Access Handbook (Human Factors and Ergonomics). CRC Press.

FMPE 402	HYDRAULIC DRIVES AND CONTROLS	3 (2+1)	SEM VIII

Theory

Hydraulic basics: Pascal's law, flow, energy, work and power; hydraulic systems: color coding, reservoirs, strainers and filters; filtering material and elements; accumulators, pressure gauges and volume meters; hydraulic circuit; fittings and connectors: pumps, pump classifications, operation, performance, displacement, design of gear pumps, vane pumps, piston pumps, hydraulic actuators, cylinders, construction and applications; maintenance: hydraulic motors, valves, pressure-control valves, directional-control valves, flow-control valves; valve: installation; valve failures and remedies; valve assembly; troubleshooting of valves hydraulic circuit diagrams and troubleshooting; United States of American Standards Institute USASI graphical symbols tractor hydraulics; nudging system; ADDC; pneumatics; air services; logic units; fail safe and safety systems robotics: application of hydraulics and pneumatics drives in agricultural systems; Programmable Logic Controls (PLCs).

Practical

Introduction to hydraulic systems; study of hydraulic pumps; hydraulic actuators; study of hydraulic motors; hydraulic valves; colour codes and circuits; building simple hydraulic circuits; hydraulics in tractors; introduction to pneumatics; pneumatics devices; pneumatics in agriculture; use of hydraulics and pneumatics for robotics.

Reference Books

1. Liljedahl, J. B., Casleton, W. M., Turnquist, P. K. and Smith, D. W. (2004). Tractors and Their Power Units. Van Nostrand Reinhold, New York.
2. Hunt, D. and Wilson, D. (2015). Farm Power and Machinery Management. Waveland Press Inc Long Grove, Illinois, USA.
3. Walters, R.B. (1991). Hydraulic and Electro-Hydraulic Control Systems. Elsevier Science Publishers LTD, New York, USA.
4. Majumdar, S. R. (2002). Oil hydraulic Systems: Principles and Maintenance. London, UK.
5. Parr, Andrew. (2011). Hydraulics and Pneumatics: Technicians and Engineer's Guide. Elsevier Ltd., Kidlington, UK.

FMPE 403	TRACTOR DESIGN AND TESTING	3 (2+1)	SEM VIII

Theory

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

Practical

Design problem of tractor clutch – (single/ multiple disc clutch); design of gear box (synchromesh/ constant mesh); variable speed constant mesh drive; selection of tractor tires – problem solving; problem on design of governor; design and selection of hydraulic pump; engine testing as per BIS code; drawbar performance in the lab; PTO test and measure the tractor power in the lab/field; determining the turning space; turning radius and brake test; hydraulic pump performance test and air cleaner and noise measurement test; visit to tractor testing centre/industry.

Reference Books

1. Sharma, D. N. and Mukesh, S. (2016). Design of Agricultural Tractor (3rd Edition). Publisher: Jain Brothers, New Delhi.
2. Londhe, Dattatraya, Atkari, Vinod and Kamble, Yatiraj (2013). Testing of Tractor. LAP Lambert Academic Publishers.
3. Londhe, Dattatraya, Atkari, vinod and Kamble, Yatiraj. (2013). Testing of Tractor: Based on IS Codes. LAP Lambert Academic Publishers.
4. Alcock, Ralph. (2012). Tractor - Implement Systems. Springer
5. Butterworth, Bill (1984). Farm tractors: The Case Guide to Tractor Selection, Operation, Economics and Servicing. Publisher: Springer.

FMPE 404	MECHANICS OF TILLAGE AND TRACTION	3 (2+1)	SEM VIII

Theory

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

Practical

Measurement of static and dynamic soil parameters related to tillage; soil parameters related to puddling and floatation; draft for passive rotary and oscillating tools; slip and sinkage under dry and wet soil conditions and load and fuel consumption for different farm operations; weight transfer and tractor loading including placement and traction aids; studies on tyres; tracks and treads under different conditions and soil compaction and number of operations.

Reference Books

1. Gill, William R. and Berg, Glen E. Vanden (1967). Soil Dynamics in Tillage and Traction. Agricultural Research Service, U.S. Department of Agriculture, Washington, D.C.

2. Punmia, B. C. and Jain, Ashok Kumar. (2005). Soil Mechanics and Foundations. Laxmi Publications (P) Ltd, New Delhi.
3. Sineokov, G. N. Design of soil tilling machines.
4. Terzaghi, Karl Peck, Ralph, B., Mesri, Gholamreza. Soil Mechanics in Engineering Practice.
5. Punmia, B.C. and Jain, A. K. Soil Mechanics and Foundations.

FMPE 405	FARM MACHINERY DESIGN AND PRODUCTION	3 (2+1)	SEM VIII

Theory

Introduction to design parameters of agricultural machines & design procedure; characteristics of farm machinery design; research and development aspects of farm machinery; design of standard power transmission components used in agricultural machines: mechanical & hydraulic units; introduction to safety in power transmission; application of design principles to the systems of selected farm machines; critical appraisal in production of agricultural machinery; advances in material used for agricultural machinery; cutting tools including CNC tools and finishing tools; advanced manufacturing techniques including powder metallurgy; EDM (Electro-Discharge Machining); heat treatment of steels including pack carburizing; shot pining process etc.; limits; fits & tolerances; jigs & fixtures; industrial lay-out planning; quality production management; reliability; economics of process selection; familiarization with project report.

Practical

Familiarization with different design aspects of farm machinery and selected components; solving design problems on farm machines & equipment visit to agricultural machinery manufacturing industry; tractor manufacturing industry jigs and fixtures – study in relation to agricultural machinery; fits; tolerances and limits; layout planning of a small scale industry; problems on economics of process selection; preparation of a project report; case study for manufacturing of simple agricultural machinery.

Reference Books

1. Sharma, D. N. and Mukesh, S. (2013). Farm Machinery Design (3rd Edition). Jain Brothers, New Delhi.
2. Krutz, Gary Thompson, Lester and Claar, Paul. (1984). Design of Agricultural Machinery. Publisher: New York: Wiley.
3. Bosoi, E. S. and Verniaev, O. V. (1990). Theory, Construction and Calculations of Agricultural Machines. Oxonian Press, New Delhi.
4. Varshney, A. C. (2004). Data Book for Agricultural Machinery Design. Central Institute of Agricultural Engineering, Bhopal.
5. Rajput, R. K. (2016). A Textbook of Manufacturing Technology (Manufacturing Processes). Laxmi Publications, New Delhi.

FMPE 406	PRECISION AGRICULTURE AND SYSTEM MANAGEMENT	3 (2+1)	SEM VIII

Theory

Precision agriculture – need and functional requirements; familiarization with issues relating to natural resources; familiarization with equipment for precision agriculture including sowing and planting machines; power sprayers; land clearing machines; laser guided land levellers; straw-chopper; straw-balers; grain combines; etc.; introduction to GIS based precision agriculture and its applications; introduction to sensors and application of sensors for data generation; database management; system concept; system approach in farm machinery management; problems on

machinery selection; maintenance and scheduling of operations; application to PERT and CPM for machinery system management.

Practical

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

Reference Books

1. Handbook of Agricultural Engineering (2013). ICAR, Bio-Green Books, New Delhi.
2. Srinivasan, Ancha. (2006). Handbook of Precision Agriculture: Principles and Applications. Food Products Press, New York.
3. Heege, Hermann J. (2013). Precision in Crop Farming: Site Specific Concepts and Sensing Methods: Applications and Results. New York, USA.
4. Shenoy, G. V., Srivastava, U. K. and Sharma, S. C. (1991). Operations Research for Management. New Age international (P) limited, New Delhi.
5. Hunt, D. and Wilson, D. (2015). Farm Power and Machinery Management. Waveland Press Inc Long Grove, Illinois, USA.

FMPE 407	ARTIFICIAL INTELLIGENCE	3 (2+1)	SEM VIII

Theory

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

Practical:

Developing AI applications using LISP and PROLOG; development of prototype expert system of agricultural systems with LISP/POLOG.

Reference Books

1. Panigrahi, S. and Ting, K. C. (2012).Artificial Intelligence for Biology and Agriculture. Springer Science & Business Media, Berlin, Germany.
2. Bakti, Z. A. K. (1993). The Role of Information Technology and Artificial Intelligence in Mechanized Agriculture Malaysian Agricultural Research and Development Institute. Institute of Agriculture, Malaysia.
3. Más, Francisco Rovira, Zhang, Qin, and Hansen, Alan C. (2010). Mechatronics and Intelligent Systems for off-road Vehicles. Springer London Dordrecht Heidelberg, New York.

4. Li, D. and Chen, Y. (2012). Computer and Computing Technologies in Agriculture. Springer Heidelberg Dordrecht, London, UK.

5. Kubota, N., Kiguichi, K., Liu, H. and Obo, T. (2016). Intelligent Robotics and Applications. Springer International Publishing Switzerland.

FMPE 408	MECHATRONICS	3 (2+1)	SEM VIII

Theory

Definition of mechatronics; measurement system; control systems; microprocessor based controllers; mechatronics approach; sensors and transducers; performance terminology; displacement; position & proximity sensors; photo-electric transducers; flow transducers; optical sensors and transducers; actuators; mechanical actuation systems; hydraulic & pneumatic actuation systems; electrical actuation systems; A.C. Motor, D.C. Motor; stepper motor; signal conditioning process; filtering digital signal; multiplexers; data acquisition; digital signal processing; measurement system; pulse modulation; data presentation systems; system modelling & control; mathematical models; engineering systems; electro-mechanical & hydraulic-mechanical systems; modelling dynamic systems; transfer functions; control modes; PID controller; micro-processor & computer; computer and interfacing; micro-computer structure; micro-controllers; application of microcontrollers; PLC; robotics; robot components; robot classification and specification; work envelopes; other basic parameters of robots; robot applications; robot applications in manufacturing; material transfer and machine loading/unloading; processing operations like welding & painting; assembly operations; inspection automation; future applications.

Practical

Selection of sensor for a particular application from catalogue/internet; design a mechatronics product/system and incorporate application of mechatronics for enhancing product values; to study the hardware and software of mechatronics kit; to move a table in X-direction within the range of proximity sensors using control-X software; to run a motor with PLC; to run a conveyor with computer; to study the movement of actuating cylinders and sensors.

Reference Books

1. Zhang, Dan and Wei, Bin. (2017). Robotics and Mechatronics for Agriculture. CRC Press, Taylor & Francis Group, Boca Raton, Florida.

2. Más, Francisco Rovira, Zhang, Qin and Hansen, Alan C. (2010). Mechatronics and Intelligent Systems for Off-road Vehicles. Springer London Dordrecht Heidelberg, New York.

3. Husain, Ashfaq. (2012). Electric Machines. Dhanpat Rai & Company, New Delhi.

4. Zhang, Q. and Pierce, F. J. (2013). Agricultural automation: fundamentals and practices, CRC Press, Taylor & Francis Group, Boca Raton, Florida.

5. G. C. Onwubolu. (2005). Mechatronics: principles and applications. Elsevier Butterworth-Heinemann, Burlington, Massachusetts, USA.

PROCESSING AND FOOD ENGINEERING

Core Courses:

Course No.	Course Title	Credit Hours	Semester
PFE 201	Engineering Properties of Agricultural Produce	2(1+1)	IV
PFE 301	Agricultural Structures and Environmental Control	3(2+1)	V
PFE 302	Post Harvest Engineering of Cereals; Pulses and Oil Seeds	3(2+1)	V
PFE 390	Skill Development Training-I (Student READY)	5(0+5)	V
PFE 303	Post Harvest Engineering of Horticultural Crops	2(1+1)	VI
PFE 304	Dairy and Food Engineering	3(2+1)	VI
PFE 305	Protected Cultivation and Secondary Agriculture **(For B.Sc. (Hons.) Agriculture)**	2(1+1)	VI/X
PFE 391	Undergraduate Seminar	1(0+1)	VI
PFE 411	Industrial Attachment/ Internship (Student READY)	10 (0+10)	VII
PFE 412	Experiential Learning On campus (Student READY)	10 (0+10)	VII
PFE 490	Skill Development Training-II (Student READY)	5(0+5)	VII
PFE 491	Project Planning and Report Writing (Student READY)	10 (0+10)	VIII
	Total Credits	**56(9+47)**	

Elective Courses (any three):

Course No.	Course Title	Credit Hours	Semester
PFE 401	Food Quality and Control	3(2+1)	VIII
PFE 402	Food Plant Design and Management	3(2+1)	VIII
PFE 403	Food Packaging Technology	3(2+1)	VIII
PFE 404	Development of Processed Products	3(2+1)	VIII
PFE 405	Process Equipment Design	3(2+1)	VIII
	Total Credits	**15(10+5)**	

PFE 201	ENGINEERING PROPERTIES OF AGRICULTURAL PRODUCE	2 (1+1)	SEM IV

Theory

Classification and importance of engineering properties of agricultural produce: shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area of grains, fruits and vegetables; thermal properties; heat capacity; specific heat; thermal conductivity; thermal diffusivity; heat of respiration; co-efficient of thermal expansion; friction in agricultural materials; static friction; kinetic friction; rolling resistance; angle of internal friction; angle of repose; flow of bulk granular materials; aero dynamics of agricultural products; drag coefficients; terminal velocity; rheological properties; force; deformation; stress; strain; elastic; plastic and viscous behaviour; Newtonian and Non-Newtonian liquid; visco-elasticity; Newtonian and Non-Newtonian fluid; pseudo-plastic; dilatant; thixotropic; rheopectic and bingham plastic foods; flow curves. electrical properties; dielectric loss factor; loss tangent; A.C. conductivity and dielectric constant; method of determination. Application of engineering properties in handling processing machines and storage structures.

Practical

Determination of the shape and size of grains; fruits and vegetables; determination of bulk density and angle of repose of grains; determination of the particle density/true density and porosity of solid

grains; finding the co-efficient of external and internal friction of different crops; finding out the terminal velocity of grain sample and study the separating behaviour in a vertical wind tunnel; finding the thermal conductivity of different grains; determination of specific heat of some food grains; determination of hardness of food material and determination of viscosity of liquid foods.

Reference Books:

1. Mohsenin, Nuri N. (1980). Physical Properties of Plant and Animal Materials: Structure, Physical Characteristics and Mechanical Properties. Gordon and Breach Science Publishers, New York, London.
2. Singhal, O. P. and Samuel, D. V. K. (2003). Engineering Properties of Biological Material. Saroj Prakashan.
3. Rao, M.A., Rizvi, S.H., Syed, Datta, K. Ashim and Ahmed, Jasim. (2015). Engineering Properties Foods. Fourth Edition. Morkel Dekker, Inc. New York, Based.
4. Kachru, R. P., Gupta, R. K. and Anwar, Alam (1994). Physico-Chemical Constituent & Engineering- Properties of Food Crops. Scientific Publisher, Jodhpur.
5. Sahay, K. M. and Singh, K. K. (2005) Unit operation of Agricultural Processing. Vikash Publication House Pvt. Ltd. New Delhi.

PFE 301	AGRICULTURAL STRUCTURES AND ENVIRONMENTAL CONTROL	3 (2+1)	SEM V

Theory

Planning and layout of farmstead; scope; importance and need for environmental control; physiological reaction of livestock environmental factors; environmental control systems and their design; control of temperature; humidity and other air constituents by ventilation and other methods; livestock production facilities; BIS standards for dairy; piggery; poultry and other farm structures; design, construction and cost estimation of farm structures, animal shelters, compost pit, fodder silo, fencing and implement sheds; barn for cows, buffalo, poultry etc.; storage of grains; causes of spoilage; water activity for low and high moisture food and its limits for storage; moisture and temperature changes in grain bins; traditional storage structures and their improvements; improved storage structures (CAP; hermetic storage; Pusa bin; RCC ring bins); design consideration for grain storage godowns; bag storage structures; shallow and deep bin; calculation of pressure in bins; storage of seeds; rural living and development; rural roads; their construction cost and repair and maintenance; sources of water supply; norms of water supply for human being and animals; drinking water standards and water treatment suitable to rural community; site and orientation of building in regard to sanitation; community sanitation system; sewage system and its design; cost and maintenance; design of septic tank for small family; estimation of domestic power requirement; source of power supply and electrification of rural housing.

Practical

Measurements for environmental parameters and cooling load of a farm building; design and layout of a dairy farm; design and layout of a poultry house; design and layout of a goat house/sheep house; design of a farm fencing system; design of a feed/fodder storage structures; design of grain storage structures; design and layout of commercial bag and bulk storage facilities; study and performance evaluation of different domestic storage structure; estimation of a farm building.

Reference Books

1. Dixon, John E. and Esmay, Merle L. (1986). Environmental Control for Agricultural Buildings. Westport, Conn. : AVI Pub. Co.

2. Barre, H. (2012). Environmental and Functional Engineering of Agricultural Buildings. Springer Science & Business Media.

3. Pandey, P. H. (2014). Principles and Practices of Agricultural Structures and Environmental Control. Kalyani Publishers.

4. Ojha and Micheal (2005). Principles of Agricultural Engineering Vol 1. Jain Brothers.

5. Lindley, J. A. and Whitaker, J. H. (1996). Agricultural buildings and structures. American Society of Agricultural Engineers (ASAE).

PFE 302	POST HARVEST ENGINEERING OF CEREALS; PULSES AND OIL SEEDS	3 (2+1)	SEM V

Theory

Cleaning and grading, aspiration, scalping, size separators, screens, sieve analysis, capacity and effectiveness of screens; various types of separators: specific gravity, magnetic, disc, spiral, pneumatic, inclined draper, velvet roll, colour sorters, cyclone shape graders; size reduction: principle, Bond's law, Kick's law, Rittinger's law, procedure (crushing; impact; cutting and shearing); size reduction machinery: jaw crusher, hammer mill, plate mill, ball mill: material handling equipment: types of conveyors: belt, roller, chain and screw; elevators: bucket, cranes & hoists; trucks (refrigerated/ unrefrigerated); pneumatic conveying; drying: moisture content and water activity; free; bound and equilibrium moisture content; isotherm; hysteresis effect; EMC determination; psychrometric chart and its use in drying; drying principles and theory; thin layer and deep bed drying analysis; falling rate and constant rate drying periods; maximum and decreasing drying rate period; drying equations; mass and energy balance; Shedd's equation; dryer performance; different methods of drying; batch-continuous; mixing-non-mixing; sun-mechanical; conduction; convection; radiation; superheated steam; tempering during drying; different types of grain dryers: bin, flat bed, LSU, columnar,; RPEC, fluidized, rotary and tray; mixing: theory of mixing of solids and pastes, mixing index, types of mixers for solids, liquid foods and pastes; milling of rice: conditioning and parboiling; advantages and disadvantages; traditional methods; CFTRI and Jadavpur methods; pressure parboiling method; types of rice mills; modern rice milling; different unit operations and equipment; milling of wheat; unit operations and equipment; milling of pulses: traditional milling methods, commercial methods, pre-conditioning, dry milling and wet milling methods: CFTRI and Pantnagar methods; pulse milling machines; milling of corn and its products; dry and wet milling; milling of oilseeds: mechanical expression, screw press, hydraulic press, solvent extraction methods, preconditioning of oilseeds, refining of oil, stabilization of rice bran; extrusion cooking: principle, factors affecting, single and twin screw extruders; by-products utilization.

Practical

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

Reference Books

1. Chakraverty, **Amalendu** (1988). Post Harvest Technology of Cereals: Pulses and Oilseeds. Oxford & IBH Publishing Company.
2. Sahay, K. M. and Singh, K. K. (2005). Unit operation of Agricultural Processing. Vikash Publication House Pvt Ltd. New Delhi.
3. Pandey, P. H. (2007). Principles & Practices of Post Harvest Technology. Kalyani Publishers.
4. Chakraverty, Amalendu, Singh, **R. Paul (2016).** Postharvest Technology and Food Process Engineering. CRC Press.
5. Chakraverty, Amalendu, Mujumdar, Arun S., Ramaswamy, Hosahalli S. (2003) Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. CRC Press.

PFE 303	POST HARVEST ENGINEERING OF HORTICULTURAL CROPS	2 (1+1)	SEM VI

Theory

Importance of processing of fruits and vegetables, spices, condiments and flowers; characteristics and properties of horticultural crops important for processing; peeling: different peeling methods and devices (manual peeling, mechanical peeling, chemical peeling and thermal peeling); slicing of horticultural crops: equipment for slicing, shredding, crushing, chopping, juice extraction etc.; blanching: importance and objectives, blanching methods, effects on food (nutrition, colour, pigment, texture); chilling and freezing: application of refrigeration in different perishable food products; thermophilic; mesophilic & psychrophilic micro-organisms; chilling requirements of different fruits and vegetables; freezing of food: freezing time calculations, slow and fast freezing, equipment for chilling and freezing (mechanical & cryogenic), effect on food during chilling and freezing, cold storage heat load calculations and cold storage design; refrigerated vehicle and cold chain system; dryers for fruits and vegetables; osmo-dehydration; packaging of horticultural commodities; packaging requirements (in terms of light transmittance, heat, moisture and gas proof micro organisms, mechanical strength); different types of packaging materials commonly used for raw and processed fruits and vegetables products; bulk and retail packages and packaging machines; handling and transportation of fruits and vegetables; pack house technology; minimal processing; common methods of storage; low temperature storage; evaporative cooled storage; controlled atmospheric storage; modified atmospheric packaging; preservation technology; general methods of preservation of fruits and vegetables; brief description and advantages and disadvantages of different physical/ chemical and other methods of preservation; flowcharts for preparation of different finished products; important parameters and equipment used for different unit operations; post harvest management and equipment for spices and flowers; quality control in fruit and vegetable processing industry, food supply chain.

Practical

Performance evaluation of peeler and slicer; performance evaluation of juicer and pulper; performance evaluation of blanching equipment; testing adequacy of blanching; study of cold storage and its design; study of CAP and MAP storage; minimal processing of vegetables; preparation of value added products; visit to fruit and vegetable processing industry; visit to spice processing plant.

Reference Books

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

2. **Pandey, P. H**. (1997). Post Harvest Technology of Fruits and Vegetables (principles and Practices). Saroj Prakashan.

3. **Verma,** L. R. **(**2000). Postharvest Technology of Fruits and Vegetables: Handling, Processing, Fermentation, and Waste Management. Indus Publishing.

4. Jacob**, John P**. (2008). A Hand Book on Post Harvest Management of Fruits & Vegetables. Daya Publishing House, Delhi.

5. Kader, **Adel A.** (2002). Postharvest Technology of Horticultural Crops. (3rd Edition). University of California Agriculture and Natural Resources.

PFE 304	DAIRY AND FOOD ENGINEERING	3 (2+1)	SEM VI

Theory

Deterioration in food products and their controls; physical; chemical and biological methods of food preservation; nanotechnology: history, fundamental concepts, tools and techniques nanomaterials; applications in food packaging and products; implications; environmental impact of nanomaterials and their potential effects on global economics; regulation of nanotechnology, dairy development in India; engineering; thermal and chemical properties of milk and milk products; process flow charts for product manufacture; unit operation of various dairy and food processing systems; principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization, centrifugation and cream separation; preparation methods and equipment for manufacture of cheese, *paneer*, butter and ice cream; filling and packaging of milk and milk products; dairy plant design and layout; plant utilities; principles of operation and equipment for thermal processing, canning, aseptic processing; evaporation of food products: principle, types of evaporators, steam economy, multiple effect evaporation, vapour recompression, drying of liquid and perishable foods: principles of drying, spray drying, drum drying, freeze drying, filtration: principle, types of filters, membrane separation; RO: nano-filtration, ultra filtration and macro-filtration; equipment and applications; non-thermal and other alternate thermal processing in food processing.

Practical

Study of pasteurizers; study of sterilizers; study of homogenizers; study of separators; study of butter churns; study of evaporators; study of milk dryers; study of freezers; study of filtration; design of food processing plants & preparation of layout; visit to multi-product dairy plant; estimation of steam requirements; estimation of refrigeration requirements in dairy & food plant; visit to food industry.

Reference Books

1. Singh, R. P. and Heldman, D. R. (2001). Introduction to food engineering. Gulf Professional Publishing.

2. Fellows, P. J. (2009). Food processing technology: principles and practice. Elsevier.

3. Earle, R. L. (2013). Unit operations in food processing. Elsevier.

4. Tufail, Ahmad. (2004). Dairy Plant Engineering and Management. Kitab Mahal Agencies.

5. Arthur, William Farrall. (1963). Engineering for dairy and food products. Wiley.

PFE 305	PROTECTED CULTIVATION AND SECONDARY AGRICULTURE (For B.Sc. (Hons.) Agriculture)	2 (1+1)	SEM VI/X

Theory

Green house technology: introduction, types of green houses, plant response to green house environment, planning and design of greenhouses; design criteria of green house for cooling and heating purposes,

green house equipments; materials of construction for traditional and low cost green houses, irrigation systems used in greenhouses; typical applications; passive solar green house; hot air green house heating systems; green house drying, cost estimation and economic analysis.

important engineering properties such as physical, thermal and aero & hydrodynamic properties of cereals, pulses and oilseed; their application in PHT equipment design and operation. Drying and dehydration; moisture measurement; EMC; drying theory; various drying method; commercial grain dryer (deep bed dryer; flat bed dryer; tray dryer; fluidized bed dryer, recirculatory dryer and solar dryer). material handling equipment; conveyer and elevators; their principle, working and selection.

Practical

Study of different type of green houses based on shape; determine the rate of air exchange in an active summer winter cooling system; determination of drying rate of agricultural products inside green house; study of green house equipments; visit to various post harvest laboratories; determination of moisture content of various grains by oven drying & infrared moisture methods; determination of engineering properties (shape and size, bulk density and porosity of biomaterials); determination of moisture content of various grains by moisture meter; field visit to seed processing plant.

Reference Books

1. Taft, L. R. (2013). Green House Management: Forcing of Flowers Vegetables and Fruits, Daya Publishing House.
2. Manohar, K. Radha and Igathinathane, C. (2007). Greenhouse: Technology and Management, 2nd Edition, BSP BS Publications, Hyderabad.
3. Tiwari, G. N. (2003). Greenhouse Technology for Controlled Environment, Alpha Science.
4. Chandra, Pitam and More, T.A. (2013). Greenhouse Prodyogiki (In Hindi), ICAR, Govt. of India (Indian Council of Agricultural Research).
5. Ojha, T.P. and Michael, A.M. (2005). Principles of Agricultural Engineering, Jain Brothers, New Delhi

FMPE 390/ PFE 390/ RBEE 390/ SWE 390	**SKILL DEVELOPMENT TRAINING-I (Student READY)**	**5 (0+5)**	**SEM V**

Exposure to industrial and institutional applications in selected fields of interest (Farm Machinery and Power Engineering; Processing & Food Engineering; Renewable & Bio-energy Engineering; Soil & Water Engineering; Information Technology etc.); training report preparation and presentation (students will be required to undergo training of about 4 weeks during semester break after IVth semester).

FMPE 391/ PFE 391/ RBEE 391/ SWE 391	**UNDERGRADUATE SEMINAR**	**1 (0+1)**	**SEM VI**

Topic selection; material collection; slide preparation; presentation and interaction.

FMPE 411/ PFE 411/ RBEE 411/ SWE 411	**INDUSTRIAL ATTACHMENT/ INTERNSHIP (Student READY)**	**10 (0+10)**	**SEM VII**

Attachment with selected industries/organizations dealing with tractors, agril machinery, precision agriculture, irrigation systems, pumps, soil conservation, watershed management, processing, value

addition, renewable and bio-energy and other aspects related to agricultural engineering; to enrich desired skills and practical knowledge of the students

FMPE 412/ PFE 412/ RBEE 412/ SWE 412	**EXPERIENTIAL LEARNING ON CAMPUS (Student READY)**	**10 (0+10)**	**SEM VII**

FMPE: Exposure to production technology; testing and evaluation of agricultural machinery as per standards; interpretation and preparation of test reports.

PFE: Agro-processing; food product development; setting up of model plants for food processing and value addition; processing and packaging of selected grains; fruits and vegetables.

RBEE: Design; development; installation and maintenance of renewable energy appliances/ equipments and use of related softwares.

SWE: Farm planning and development of irrigation and drainage projects; watershed project formulation; design of water harvesting and recycling systems; maintenance and operation of wells and pumps; irrigation and drainage systems; installation of weirs and flumes for water measurement.

FMPE 490/ PFE 490/ RBEE 490/ SWE 490	**SKILL DEVELOPMENT TRAINING-II (Student READY)**	**5 (0+5)**	**SEM VII**

Exposure to an environment in which students are expected to be associated in their future career; preparation of training report technical aspects of the training and presentation (students will be required to undergo training of about 4 weeks during semester break after VIth semester).

FMPE 491/ PFE 491/ RBEE 491/ SWE 491	**PROJECT PLANNING AND REPORT WRITING (Student READY)**	**10 (0+10)**	**SEM VIII**

Field/lab studies; project report writing and presentation.

Elective Courses

(A student can opt need based elective courses equivalent to 9 Credit Hours)

PFE 401	**FOOD QUALITY AND CONTROL**	**3 (2+1)**	**SEM VIII**

Theory

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

Practical

Examination of cereals & pulses from one of go-downs and market shops in relation to FPO and BIS specifications; detection of adulteration and examination of ghee for various standards of AGMARK & BIS standards; detection of adulteration and examination of spices for AGMARK and BIS standards; detection of adulteration and examination of milk and milk products for BIS standards; detection of adulteration and examination of fruit products such as jams, jellys, marmalades for FPO specification; visit to quality control laboratory; case study of statistical process control in food processing industry; study of registration process and licensing procedure under FSSAI; study of sampling techniques from food processing establishments; visit to food processing laboratory and study of records and reports maintained by food processing laboratory.

Reference Books

1. Alli, I. (2016). Food Quality Assurance: Principles And Practices. CRC Press.
2. Ranganna, S. (1986). Handbook of Analysis and Quality Control for Fruit and Vegetable Products. Tata McGraw-Hill Education.
3. Lima, G. P. and Vianello, F. (Eds.). (2013). Food Quality, Safety and Technology. Springer.
4. Jha, S. N. (Ed.). (2010). Nondestructive Evaluation of Food Quality: Theory and Practice. Springer Science & Business Media.
5. Fortin, N. D. (2016). Food Regulation: Law, Science, Policy and Practice. John Wiley & Sons.

PFE 402	FOOD PLANT DESIGN AND MANAGEMENT	3 (2+1)	SEM VIII

Theory

Food plant location, selection criteria, selection of processes, plant capacity, requirements of plant building and its components; project design, flow diagrams, selection of equipment, process and controls; objectives and principles of food plant layout, salient features of processing plants for cereals, pulses, oilseeds, horticultural and vegetable crops; poultry, fish and meat products; milk and milk products. introduction to finance; food product marketing; food business analysis and strategic planning; introduction to marketing; food marketing management; supply chain management for retail food products; entrepreneurship development in food industry; SWOT analysis, generation, incubation and commercialization of ideas and innovations; new product development process, government schemes and incentive for promotion of entrepreneurship; Govt. policy on small and medium scale food processing enterprise; export and import policies relevant to food processing sector; procedure of obtaining license and registration under FSSAI; cost analysis and preparation of feasibility report.

Practical

Preparation of project report; preparation of feasibility report; salient features and layout of pre processing house; salient features and layout of milk and milk product plants; evaluation of given layout; salient features; design and layout of modern rice mill; salient features; design and layout of bakery and related product plant; study of different types of records relating to production of a food plant; study of different types of records relating to finance of a food plant; study of different types of records relating to marketing of a food business; brain storming and SWOT analysis to start a food processing business.

Reference Books

1. Slade, F. H. (1967). Food Processing Plant. Vol. I. Leonard Hill Books.

2. Moran, S. (2015). An Applied Guide to Process and Plant Design. Butterworth-Heinemann.
3. Johnson, A. J. (1986). Process Control Instrumentation Technology. 2nd Ed. Wiley International & ELBS.
4. Backhurst, J. R. and Harker, J. H. (2013). Process Plant Design: Heinemann Chemical Engineering Series. Butterworth-Heinemann.
5. McFarlane, I. (2012). Automatic Control of Food Manufacturing Processes. Springer Science & Business Media.

PFE 403	FOOD PACKAGING TECHNOLOGY	3 (2+1)	SEM VIII

Theory

Factors affecting shelf life of food material during storage; interactions of spoilage agents with environmental factors as water, oxygen, light, pH etc. and general principles of control of the spoilage agents; difference between food infection; food intoxication and allergy; packaging of foods, requirement, importance and scope; frame work of packaging strategy; environmental considerations; packaging systems: types, flexible and rigid, retail and bulk, levels of packaging, special solutions and packaging machines; technical packaging systems and data management packaging systems; different types of packaging materials: their key properties and applications; metal cans; manufacture of two piece and three piece cans; plastic packaging; different types of polymers used in food packaging and their barrier properties; manufacture of plastic packaging materials; profile extrusion; blown film/ sheet extrusion; blow molding; extrusion blow molding; injection blow molding; stretch blow molding; injection molding. glass containers; types of glass used in food packaging; manufacture of glass and glass containers; closures for glass containers; paper and paper board packaging; paper and paper board manufacture process; modification of barrier properties and characteristics of paper/ boards; relative advantages and disadvantages of different packaging materials; effect of these materials on packed commodities; nutritional labelling on packages; CAS and MAP; shrink and cling packaging; vacuum and gas packaging; active packaging; smart packaging; packaging requirement for raw and processed foods; and their selection of packaging materials; factors affecting the choice of packaging materials; disposal and recycle of packaging waste; printing and labelling; lamination; package testing: testing methods for flexible materials; rigid materials and semi rigid materials; tests for paper (thickness. bursting strength. breaking length. Stiffness. tear resistance. folding endurance. ply bond test. surface oil absorption test etc.); plastic film and laminates (thickness. tensile strength. Gloss. Haze. burning test to identify polymer etc.); aluminium foil (thickness. pin holes etc.); glass containers (visual defects. Colour. Dimensions. impact strength etc.); metal containers (pressure test. product compatibility etc.).

Practical

Identification of different types of packaging materials; determination of tensile/ compressive strength of given material/package; to perform different destructive and non-destructive tests for glass containers; vacuum packaging of agricultural produces; determination of tearing strength of paper board; measurement of thickness of packaging materials; to perform grease-resistance test in plastic pouches; determination of bursting strength of packaging material; determination of water-vapour transmission rate; shrink wrapping of various horticultural produce; testing of chemical resistance of packaging materials; determination of drop test of food package and visit to relevant industries.

Reference Books:

1. Robertson, G. L. (2016). Food Packaging: Principles and Practice. CRC press.

2. Lee, D. S., Yam, K. L., and Piergiovanni, L. (2008). Food Packaging Science and Technology. CRC press.
3. Yam, K. L., and Lee, D. S. (Eds.). (2012). Emerging Food Packaging Technologies: Principles and Practice. Elsevier.
4. Paine, F. A. and Paine, H. Y. (2012). A Handbook of Food Packaging. Springer Science & Business Media.
5. Natarajan, S., Govindarajan, M. and Kumar, B. (2014). Fundamentals of Packaging Technology. PHI Learning Pvt. Ltd.

PFE 404	DEVELOPMENT OF PROCESSED PRODUCTS	3 (2+1)	SEM VIII

Theory

Process design; process flow chart with mass and energy balance; unit operations and equipments for processing; new product development; technology for value added products from cereal, pulses and oil seeds; milling; puffing; flaking; roasting; bakery products; snack food; extruded products; oil extraction and refining; technology for value added products from fruits, vegetables and spices; canned foods, frozen foods, dried and fried foods; fruit juices, sauce, sugar based confection, candy, fermented food product, spice extracts; technology for animal produce processing , meat, poultry, fish, egg products, health food, nutra-ceuticals and functional food; organic food.

Practical

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

Reference Books

1. Catherine, Side (2002). Food Product Development: Based on Experience. Iowa State Press.
2. Ulrich, K. T. (2003). Product Design and Development. Tata McGraw-Hill Education.
3. Earle and Earle. (2001). Creating New Foods. Chadwick House Group.
4. Earle, R., Earle, R. and Anderson, A. (2001). Food Product Development. Woodhead Publ.
5. Fuller (2004). New Food Product Development - from Concept to Market Place.

PFE 405	PROCESS EQUIPMENT DESIGN	3 (2+1)	SEM VIII

Theory

Introduction on process equipment design; application of design engineering for processing equipments; design parameters and general design procedure; material specification; types of material for process equipments; design codes; pressure vessel design; design of cleaners. design of tubular heat exchanger; shell and tube heat exchanger and plate heat exchanger; design of belt conveyer; screw conveyer and bucket elevator; design of dryers; design of milling equipments; optimization of design with respect to process efficiency; energy and cost; Computer Aided Design.

Practical

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

Reference Books

1. Phirke, P. S. (2004). Processing and Conveying Equipment Design. Jain Bros.

2. Saravacos, G. D. and Kostaropoulos, A. E. (2002). Handbook of Food Processing Equipment. Springer Science & Business Media.
3. Forsythe, S. J. and Hayes, P. R. (1998). Design of Food Processing Equipment. In Food Hygiene, Microbiology and HACCP. Springer US.
4. Joshi, M. V. and Mahajani, V. V. (1996). Process Equipment Design. Macmillan India.
5. Towler, G. and Sinnott, R. K. (2012). Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design. Elsevier.

RENEWABLE AND BIO-ENERGY ENGINEERING

Core Courses:

Course No.	Course Title	Credit Hours	Semester
RBEE 201	Fundamentals of Renewable Energy Sources	3(2+1)	IV
RBEE 202	Renewable Energy and Green Technology **(For B.Sc. (Hons.) Agriculture)**	2(1+1)	IV/VIII
RBEE 301	Renewable Power Sources	3(2+1)	V
RBEE 390	Skill Development Training-I (Student READY)	5(0+5)	V
RBEE 302	Bio-energy Systems: Design and Applications	3(2+1)	VI
RBEE 391	Undergraduate Seminar	1(0+1)	VI
RBEE 411	Industrial Attachment/ Internship (Student READY)	10(0+10)	VII
RBEE 412	Experiential Learning On campus (Student READY)	10(0+10)	VII
RBEE 490	Skill Development Training-II (Student READY)	5(0+5)	VII
RBEE 491	Project Planning and Report Writing (Student READY)	10(0+10)	VIII
	Total Credits	**52(7+45)**	

Elective Courses:

Course No.	Course Title	Credit Hours	Semester
RBEE 401	Photovoltaic Technology and Systems	3(2+1)	VIII
RBEE 402	Waste and By-products Utilization	3(2+1)	VIII
RBEE 403	Biogas Technology and Mechanism	3(2+1)	VIII
RBEE 404	Solar Energy Utilization	3(2+1)	VIII
RBEE 405	Energy Auditing and Management	3(2+1)	VIII
	Total Credits	**15(10+5)**	

RBEE 201	FUNDAMENTALS OF RENEWABLE ENERGY SOURCES	3 (2+1)	SEM IV

Theory

Renewable Energy Sources (RES): definition, concept and limitation, potential and classification of res. Solar, wind, biomass, geothermal,; ocean energy sources; comparison of renewable energy sources with non-renewable sources; solar energy: energy available, solar radiation, solar energy conversion into heat through flat plate and concentrating collectors; different solar thermal devices; principle of natural and forced convection drying system and green house; solar photovoltaic: p-n junctions, solar cells, spv systems; stand alone and grid connected solar power station; wind energy: energy available, general formula, lift and drag, coefficient of performance (COP), basis of wind energy conversion; effect of density, frequency variances, angle of attack, wind speed and types of wind mill rotors; bio-energy: characteristics of biomass, pyrolysis of biomass to produce solid, liquid and gaseous fuels; biomass gasification and gasifiers and biomass cook-stoves; biogas: fundamentals, biochemistry, factors affecting biogas generation; types of biogas plants: design considerations of domestic biogas plants, uses of biogas and handling of bio-digested slurry.

Practical

Study of solar devices: solar cookers; water heating system; natural and forced convection dryers; desalination unit; green house for agriculture and photovoltaic systems; study of biomass improved cook-stoves and biomass gasifiers; study and performance evaluation of different biogas plants; estimation of calorific value of biomass; biogas and producer gas.

Reference Books

1. Rai, G. D. (1998). Non-Conventional Sources of Energy. Khanna Publ.
2. Twindal, J. W. & Anthony, D. Wier. (1986). Renewable Energy Sources. E&F.N. Spon Ltd.
3. Mital, K. M. (1996). Non-Conventional Energy Systems. Wheeler Publishing, New Delhi.
4. Tiwari G. N. and Ghosal M. K. (2005). Renewable Energy Resources, Narosa Publishing House, New Delhi.
5. Rathore, N. S., Kurchania, A. K.and Panwar, N. L. (2007). Non-conventional Energy Sources. Himanshu Publications

RBEE 202	RENEWABLE ENERGY AND GREEN TECHNOLOGY (For B.Sc. (Hons.) Agriculture)	2 (1+1)	SEM V/VIII

Theory

Classification of energy sources; renewable energy sources and its contribution in agricultural sector; familiarization with biomass utilization for bio-fuel production and their applications; familiarization with different types of biogas plants and gasifiers; biomass briquetting; bio-alcohol; biodiesel and bio-oil production and their utilization; introduction of solar energy; collection and application; familiarization with solar energy gadgets: solar cooker, solar water heater, application of solar energy, solar drying, solar pond, solar distillation and solar photovoltaic system; introduction of wind energy and its application.

Practical

Familiarization with renewable energy gadgets; study of biogas plants, gasifiers; production process of bio-fuels; study of biomass cook-stoves and briquetting machine; study of solar photovoltaic system: solar light, solar pumping, solar fencing and solar rooftop; study of solar cookers, solar water heating systems, solar distillation, solar pond and solar drying system.

Reference Books

1. Rai, G. D. (1998). Non-conventional Sources of Energy. Khanna Publ.
2. Twindal, J. W. and Anthony, D. Wier. (1986). Renewable Energy Sources. E&F.N. Spon Ltd.
3. Mital, K. M. (1996). Non-conventional Energy Systems. Wheeler Publishing, New Delhi.
4. Tiwari, G.N. and Ghosal, M.K. (2005). Renewable Energy Resources. Narosa Publishing House, New Delhi.
5. Sukhatame, S.P. (1996). Solar Energy. Tata McGraw-Hill Education, New Delhi.

RBEE 301	RENEWABLE POWER SOURCES	3 (2+1)	SEM V

Theory

Energy resources and consumption pattern in India; renewable energy options for power generation; their potential and utilization; design of different commercial size biogas plants; purification and bottling of biogas; power generation from biogas; generation of power from urban, municipal and industrial waste; power generation from biomass (gasification & dendro thermal); shaft power generation and thermal application; solar thermal and photovoltaic systems for power generation, central receiver and distributed type solar power plants; ocean thermal energy conversion (OTEC) and magneto hydrodynamic generator (MHD); hydrogen and fuel cell technology; fuel cells and its associated parameters, power generation from wind: wind power generators, working principle of wind power plants, wind farms; mini, micro and small hydel power plants; cost economics of power generation.

Practical

Performance evaluation of a fixed dome and floating drum type biogas plant; estimation of calorific value of biogas and producer gas; diesel engine operation using dual fuel (diesel and biogas) and gas alone. performance evaluation of biomass gasifier engine system; performance evaluation of solar cooker, solar water heater and solar air heater/dryer; performance evaluation of solar photovoltaic system and its characteristics; visit to commercial/ institutional power generation solar and biogas plants.

Reference Books

1. Rai, G. D. (1998). Non-conventional Sources of Energy. Khanna Publ.
2. Twindal, J. W. & Anthony, D. Wier. (1986). Renewable Energy Sources. E&F.N. Spun Ltd.
3. Sukhatame, S. P. (1996). Solar Energy. Tata McGraw-Hill Education, New Delhi.
4. Garg, H. P. (1990). Advances in Solar Energy Technology. D. Publishing Company, Tokyo.
5. Rathore, N. S., Kurchania, A. K. and Panwar, N. L. (2007). Non Conventional Energy Sources. Himanshu Publications.

RBEE 302	BIO-ENERGY SYSTEMS: DESIGN AND APPLICATIONS	3 (2+1)	SEM VI

Theory

Assessment of available biomass and its potential for bio-energy production; biomass preparation techniques (size reduction, densification and drying); fermentation processes and its general requirements; an overview of aerobic and anaerobic fermentation processes and their industrial application; heat transfer processes in anaerobic digestion systems; land fill gas technology and potential; biomass production: wastelands; classification and their use through energy plantation; selection of species; methods of field preparation and transplanting; harvesting of biomass and coppicing characteristics; thermo-chemical degradation of biomass; principles of combustion; concept of excess air; chemistry of gasification; gasifier fuels; properties; preparation and conditioning of producer gas; trans-esterification for biodiesel production; bio-hydrogen production routes; environmental aspect of bio-energy; assessment of greenhouse gas mitigation potential and economics of bio-energy systems.

Practical

Study of anaerobic fermentation system for industrial application; gasification for industrial process heat; biodiesel production system; biomass densification technique (briquetting, pelletization and cubing); integral bio-energy system for industrial application and bio-energy efficiency in industry and commercial buildings; study and demonstration of energy efficiency in building; measuring efficiency of different insulation technique; study of Brayton, Striling and Rankine cycles.

Reference Books

1. Rathore, N. S., Kurchania, A. K. and Panwar, N. L. (2007). Non Conventional Energy Sources. Himanshu Publications.
2. Mathur, A. N. and Rathore, N. S. (1992). Biogas Production Management and Utilization. Himanshu Publications, Udaipur.
3. Khandelwal, K. C. and Mahdi, S. S. (1990). Biogas Technology.
4. British, Bio Gen. (1997). Anaerobic Digestion of Farm and Food Processing Practices- Good Practice Guidelines, London. Available on www.britishbiogen.co.UK.
5. Centre for Biomass Energy. (1998). Straw for energy production, Technology- Environment-Ecology. Available: www.ens.dk.

FMPE 390/ PFE 390/ RBEE 390/ SWE 390	**SKILL DEVELOPMENT TRAINING-I (Student READY)**	**5 (0+5)**	**SEM V**

Exposure to industrial and institutional applications in selected fields of interest (Farm Machinery and Power Engineering; Processing & Food Engineering; Renewable & Bio-energy Engineering; Soil & Water Engineering; Information Technology etc.); training report preparation and presentation (students will be required to undergo training of about 4 weeks during semester break after IVth semester).

FMPE 391/ PFE 391/ RBEE 391/ SWE 391	**UNDERGRADUATE SEMINAR**	**1 (0+1)**	**SEM VI**

Topic selection; material collection; slide preparation; presentation and interaction.

FMPE 411/ PFE 411/ RBEE 411/ SWE 411	**INDUSTRIAL ATTACHMENT/ INTERNSHIP (Student READY)**	**10 (0+10)**	**SEM VII**

Attachment with selected industries/organizations dealing with tractors, agril machinery, precision agriculture, irrigation systems, pumps, soil conservation, watershed management, processing, value addition, renewable and bio-energy and other aspects related to agricultural engineering; to enrich desired skills and practical knowledge of the students

FMPE 412/ PFE 412/ RBEE 412/ SWE 412	**EXPERIENTIAL LEARNING ON CAMPUS (Student READY)**	**10 (0+10)**	**SEM VII**

FMPE: Exposure to production technology; testing and evaluation of agricultural machinery as per standards; interpretation and preparation of test reports.

PFE: Agro-processing; food product development; setting up of model plants for food processing and value addition; processing and packaging of selected grains; fruits and vegetables.

RBEE: Design; development; installation and maintenance of renewable energy appliances/ equipments and use of related softwares.

SWE: Farm planning and development of irrigation and drainage projects; watershed project formulation; design of water harvesting and recycling systems; maintenance and operation of wells and pumps; irrigation and drainage systems; installation of weirs and flumes for water measurement.

FMPE 490/ PFE 490/ RBEE 490/ SWE 490	**SKILL DEVELOPMENT TRAINING-II (Student READY)**	**5 (0+5)**	**SEM VII**

Exposure to an environment in which students are expected to be associated in their future career; preparation of training report technical aspects of the training and presentation (students will be required to undergo training of about 4 weeks during semester break after VIth semester).

FMPE 491/ PFE 491/ RBEE 491/ SWE 491	**PROJECT PLANNING AND REPORT WRITING (Student READY)**	**10 (0+10)**	**SEM VIII**

Field/lab studies; project report writing and presentation.

Elective Courses

(A student can opt need based elective courses equivalent to 9 Credit Hours)

RBEE 401	**PHOTOVOLTAIC TECHNOLOGY AND SYSTEMS**	**3 (2+1)**	**SEM VIII**

Theory

Solar PV technology: advantages, limitations, current status of PV technology, SWOT analysis of PV technology; types of solar cell; wafer based Silicon cell; Thin film amorphous silicon cell; Thin Cadmium Telluride (CdTe) Cell; Copper Indium Gallium Selenide (CiGS) Cell; thin film crystalline silicon solar cell; solar photo voltaic module: solar cell, solar module, solar array, series & parallel connections of cell; mismatch in cell; fill factor, effect of solar radiation and temperature on power output of module; I-V and power curve of module; balance of solar PV system: introduction to batteries, battery classification, lead acid battery, Nickel Cadmium battery, comparison of batteries, battery parameters; charge controller: types of charge controller, function of charge controller, PWM type, MPPT type charge controller; converters: DC to DC converter and DC to AC type converter, application of solar PV system. solar home lighting system; solar lantern; solar fencing; solar street light; solar water pumping system; roof top solar photovoltaic power plant and smart grid.

Practical

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

Reference Books

1. Rai, G. D. (1998). Non-conventional Sources of Energy. Khanna Pub.
2. Rathore, N. S., Kurchania, A. K. and Panwar, N. L. (2006). Renewable Energy. Theory & Practice, Himanshu Publications.
3. Solanki, C. S. (2011). Solar Photovoltaic: Fundamentals, Technologies and Applications, PHI Learning Private Ltd.
4. Meinel and Meinel. (1976). Applied Solar Energy. Addison- Warley Educational Publishers Inc
5. Derrick, Francis and Bokalders. (1989). Solar Photo-voltaic Products. ITDG Publishing,

RBEE 402	**WASTE AND BY-PRODUCTS UTILIZATION**	**3 (2+1)**	**SEM VIII**

Theory

Types and formation of by-products and waste; magnitude of waste generation in different food processing industries; uses of different agricultural by-products from rice mill, sugarcane industry, oil mill etc.; concept, scope and maintenance of waste management and effluent treatment, temperature, pH, oxygen demands (BOD, COD), fat, oil and grease content; metal content; forms of phosphorous and sulphur in waste waters; microbiology of waste; other ingredients like insecticide, pesticides and fungicides residues; waste utilization in various industries, furnaces and boilers run on

agricultural wastes and byproducts; briquetting of biomass as fuel; production of charcoal briquette; generation of electricity using surplus biomass; producer gas generation and utilization; waste treatment and disposal, design, construction; operation and management of institutional community and family size biogas plants; concept of vermin-composting; pre-treatment of waste: sedimentation; coagulation; flocculation and floatation; secondary treatments: biological and chemical oxygen demand for different food plant waste– trickling filters; oxidation ditches; activated sludge process; rotating biological contractors; lagoons; tertiary treatments: advanced waste water treatment process-sand; coal and activated carbon filters ; phosphorous, sulphur, nitrogen and heavy metals removal; assessment, treatment and disposal of solid waste; and biogas generation; effluent treatment plants; environmental performance of food industry to comply with ISO-14001 standards.

Practical

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

Reference Books

1. Markel, I. A. (1981). Managing Livestock Waste, AVI Publishing Co.
2. Joshi, V. K. and Sharma, S. K. (2011) Food Processing Waste Management: Treatment & Utilization. New India Publishing Agency.
3. Prashar, Anupama and Bansal, Pratibha. (2007-08). Industrial Safety and Environment. S.K. Kataria and sons, New Delhi
4. Garg, S. K. (1998). Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering. Khanna Publishers, New Delhi
5. Bhatia, S. C. (2001). Environmental Pollution and Control in Chemical Process Industries. Khanna Publishers, New Delhi.

RBEE 403	BIOGAS TECHNOLOGY AND MECHANISM	3 (2+1)	SEM VIII

Theory

Biogas technology: introduction and potential of biogas in relation to environment, ecology, agriculture, health and sanitation; digestion process; factors enhancing/inhibiting biogas production; bio-chemical and microbial aspects: biogas mechanism; enhancement of biogas production by different additives (chemicals, organic substances, enzymes) pretreatment process etc. ;scrubbing process; bottling; need for bottling of biogas; liquefaction of biogas; various uses of biogas and its merits and demerits; biogas plant: systems, types of biogas plants, classification, design of a biogas plant (cow dung and organic waste) and structural strength; selection of site and size; construction technique; material requirement; recent advances in high rate bio-methanation reactors; design and material; night soil linked biogas plant; cold condition biogas plant design concept; cost and financial viability; biogas distribution and utilization: properties of biogas; different uses; design of biogas distribution system; pressure and flow measuring devices; safety devices; biogas fittings; principles of dual fuel biogas engines; its limitations; biogas appliances including thermal and cooking efficiency test; effluent: handling of effluent of biogas plant (cow dung based; sanitary latrine attached and agro industrial wastes); effluent treatment and management effect of slurry on crop and fish production; integrated recycling of organic wastes; alternate feed material: study of biogas plant

for distillery and sugar mills effluent; willow dust; agro-wastes; agro and processing industry wastes; repair and maintenance of biogas plants.

Practical

Study of different equipments in lab; study of different models of biogas plants; determination of N; P and K contents of the fresh and digested slurry by chemical analysis; analysis of biogas to determine its constituents (gas chromatography; Orsate gas Analyzer); study on constructional details of different designs of biogas plants; testing of biogas burner for heat transfer; thermal and cooking efficiency; testing of biogas lamp; determination of BOD/COD; determination of calorific value of biogas; visit to industrial biogas plants; BIS code for efficiency testing of biogas appliances.

Reference Books

1. Markel, I. A. (1981). Managing Livestock Waste, AVI Publishing Co.
2. Khoiyangbam, R. S., Navindu, Gupta and Kumar, Sushil. (2011). Biogas Technology: Towards sustainable development. TERI Press, New Delhi.
3. Nijaguna, B.T. (2006). Biogas Technology. New Age International, New Delhi.
4. Mathur, A.N. and Rathore, N.S. (1992). Biogas Production Management & Utilization. Himanshu Publications, Udaipur.
5. Khandelwal, K.C. and Mahdi, S.S.. (1990). Biogas Technology.

RBEE 404	SOLAR ENERGY UTILIZATION	3 (2+1)	SEM VIII

Theory

Solar radiation : sun and its characteristics; structure of the sun; extraterrestrial solar radiation; the solar constant; solar radiation on earth's surface; beam and scattered radiation; variation in extraterrestrial radiations; diffuse radiation; attenuation of beam and diffused radiation at the ground; basic earth sun angles; solar time and equation of time; day length; solar radiation measurements and estimation: solar energy measuring instruments, estimation of average solar radiation; solar collectors : flat plate collector, material for flat plate collector and their properties; thermal analysis of flat-plate collectors; collector efficiency factor and heat removal factor; focussing collectors; types and applications of focussing collectors; solar energy applications: introduction and principle of operation of solar cookers; solar air heaters; solar water heaters; solar distillation; solar pond; solar refrigeration and air-conditioning; solar thermal power generation; green house etc.; solar thermal storage: types of energy storage, thermal storage, material characteristics for thermal storage.

Practical

Measurement of solar radiation; solar energy measuring instruments; study of flat plate collector; performance testing of solar cooker; solar water heater; natural and forced convection solar dryer; solar tunnel dryer; solar green house; solar cooling systems; solar pond and visit to various sites of solar energy applications and solar power plants.

Reference Books

1. Rai, G. D. (1998). Non-conventional Sources of Energy. Khanna Publ.
2. Twindal, J. W. and Anthony, D. Wier. (1986). Renewable Energy Sources. E&F.N. Spon Ltd.
3. Sukhatame, S. P. (1996). Solar Energy, Tata McGraw-Hill Education. New Delhi.
4. Garg, H. P. (1990). Advances in Solar Energy Technology, D. Publishing Company, Tokyo.
5. Yucu, H., Paykoc, E. and Yener, Y. (1978). Solar Energy Utilization. ISBN: 978-94-010-8124-5 (Print) 978-94-009-3631-7 (Online)

RBEE 405	ENERGY AUDITING AND MANAGEMENT	3 (2+1)	SEM VIII

Theory

Energy forms and units : conventional and non-conventional forms of energy; pattern of energy consumption; sources of energy; norms and scenario in agriculture and agro-based industries; energy accounting methods and measurement; second law of thermodynamics and efficiency analysis of system; energy audit : energy auditing, type of energy auditing, energy accounting, energy analysis techniques and methods; energy balance; output and input ratio; resource utilization; data collection and conservation of energy sources; energy auditing of different sectors viz. industrial; agriculture and electrical auditing. energy conservation: energy conservation planning and practices; energy forecasting; energy economics; energy pricing and factors affecting energy economics; energy conservation and management in agriculture; agro-processing industries and domestic sector; co-generation: cogeneration with alternative energy system, waste heat recovery and scope of renewable energy in industries.

Practical

Study of different energy audit techniques; study of instruments required for energy audit; energy audit of selected industries; study of energy use pattern and management strategies for various agro-industries; scope of renewable energy techniques in industries and visit to related agro-industries.

Reference Books

1. Patrick, D. R. and Fardo, S. W. (1982) Energy Management and Conservation, Prentice Hall, Inc., Englewood Cliffs, NJ07632.
2. Abbi, Y. P. (2014). Handbook on Energy Audit and Environment Management. TERI Press, New Delhi.
3. Kreith, Frank, Goswami, D. and Yogi. (2007). Energy Management and Conservation Handbook, CRC Press.
4. Thumann, Albert, Niehus, Terry, Younger and William J. (2017). Handbook of Energy Audits. Pie mental Press.
5. Haimes, Yacov Y. (1980). Energy Auditing and Conservation: Methods, Measurements, Management, and Case Studies. Taylor & Francis Inc. U.K.

SOIL AND WATER ENGINEERING

Core Courses:

Course No.	Course Title	Credit Hours	Semester
SWE 101	Introductory Soil and Water Conservation Engineering **(For B.Sc. (Hons.) Agriculture)**	2(1+1)	II/VI
SWE 201	Watershed Hydrology	2(1+1)	IV
SWE 202	Irrigation Engineering	3(2+1)	IV
SWE 203	Sprinkler and Micro Irrigation Systems	2(1+1)	IV
SWE 301	Soil and Water Conservation Engineering	3(2+1)	V
SWE 302	Watershed Planning and Management	2(1+1)	V
SWE 303	Drainage Engineering	2(1+1)	V
SWE 390	Skill Development Training-I (Student READY)	5(0+5)	V
SWE 304	Water Harvesting and Soil Conservation Structures	3(2+1)	VI
SWE 305	Groundwater; Wells and Pumps	3(2+1)	VI
SWE 391	Undergraduate Seminar	1(0+1)	VI
SWE 411	Industrial Attachment/ Internship (Student READY)	10(0+10)	VII
SWE 412	Experiential Learning On campus (Student READY)	10(0+10)	VII
SWE 490	Skill Development Training-II (Student READY)	5(0+5)	VII
SWE 491	Project Planning and Report Writing (Student READY)	10(0+10)	VIII
	Total Credits	**61(12+49)**	

Elective Courses (any three):

Course No.	Course Title	Credit Hours	Semester
SWE 401	Management of Canal Irrigation System	3(2+1)	VIII
SWE 402	Remote Sensing and GIS Applications	3(2+1)	VIII
SWE 403	Precision Farming Techniques for Protected Cultivation	3(2+1)	VIII
SWE 404	Landscape Irrigation Design and Management	3(2+1)	VIII
SWE 405	Water Quality and Management Measures	3(2+1)	VIII
SWE 406	Plastic Applications in Agriculture	3(2+1)	VIII
SWE 407	Information Technology for Land and Water Management	3(2+1)	VIII
SWE 408	Minor Irrigation and Command Area Development	3(2+1)	VIII
SWE 409	Wasteland Development	3(2+1)	VIII
SWE 410	Floods and Control Measures	3(2+1)	VIII
	Total Credits	**30(20+10)**	

SWE 101	INTRODUCTORY SOIL AND WATER CONSERVATION ENGINEERING (For B.Sc. (Hons.) Agriculture)	2 (1+1)	SEM II/VI

Theory

Introduction to soil and water conservation; causes, types and agents of soil erosion; water erosion: its type, mechanics and factors affecting it; gully erosion: process of gully development, its classification and control measures; soil loss estimation by Universal Loss Soil Equation; erosion control measures: agronomical measures, contour farming, strip cropping and mulching; introduction to contour and graded bund; bench terracing and area lost in bench terrace; grassed water

ways and their design; wind erosion: mechanics of wind erosion, types of soil movement, factors affecting it and its control measures; water harvesting and its techniques.

Practical

General status of soil conservation in India; calculation of erosion index; numericals on soil loss estimation; design of shelter belt; design of grassed water ways; design of contour bunds; design of graded bunds; design of bench terracing system; problem on wind erosion.

Reference Books

1. Suresh, R. (2012). Soil and Water Conservation Engineering. Standard Publishers Distributors, New Delhi-11006.
2. Michael, A.M. and Ojha, T.P. (2013). Principles of Agricultural Engineering (Volume-II). Jain Brothers, New Delhi-110005
3. Murty, V. V. N. and Jha, Madan K. (2015). Land and Water Management Engineering. Kalyani Publishers, Ludhiana-141008.
4. Chandra, Mal Bimal. (2005). Introduction to Soil and Water Conservation Engineering. Kalyani Publishers, Ludhiana-141008.
5. Ghanshyam, Das. (2000). Hydrology and Soil Conservation Engineering. Prentice Hall of India, New Delhi-110001.

SWE 201	WATERSHED HYDROLOGY	3 (2+1)	SEM IV

Theory

Hydrologic cycle; precipitation and its forms; rainfall measurement and estimation of mean rainfall; frequency analysis of point rainfall, mass curve, hyetograph, depth-area-duration curves and intensity-duration-frequency relationship; hydrologic processes-interception, infiltration -factors influencing, measurement and indices; rainfall probability analysis; 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; Hydrograph - Components; base flow separation; unit hydrograph theory; S-curve; synthetic hydrograph; applications and limitations; stream gauging - discharge rating curves; flood peak; design flood; flood routing – channel and reservoir routing; drought – classification; causes and impacts; drought management strategy.

Practical

Visit to meteorological observatory and study of different instruments; design of rain gauge network; exercise on intensity - frequency - duration curves; exercise on depth - area - duration and double mass curves; analysis of rainfall data and estimation of mean rainfall by different methods; exercise on frequency analysis of hydrologic data and estimation of missing data; test for consistency of rainfall records; exercise on computation of infiltration indices; computation of peak runoff and runoff volume by Cook's method and rational formula; computation of runoff volume by SCS curve number method; study of stream gauging instruments - current meter and stage level recorder; exercise on runoff hydrograph; exercise on unit hydrograph ; exercise on synthetic hydrograph ; exercise on flood routing.

Reference Books

1. Subramanya, K. (2008). Engineering Hydrology. 3rd Edition, Tata McGraw-Hill Publishing Co., New Delhi
2. Suresh, R. (2005). Watershed Hydrology. Standard Publishers Distributors, Delhi.

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

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

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

SWE 202	IRRIGATION ENGINEERING	3 (2+1)	SEM IV

Theory

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

Practical

Measurement of soil moisture by different soil moisture measuring instruments; measurement of irrigation water; measurement of infiltration characteristics; determination of bulk density; field capacity and wilting point; estimation of evapotranspiration; land grading methods; design of underground pipeline system; estimation of irrigation efficiency; study of advance; recession and computation of infiltration opportunity time; infiltration by inflow-outflow method; evaluation of border irrigation method; evaluation of furrow irrigation method; evaluation of check basin irrigation method.

Reference Books

1. Michael, A. M. (2012). Irrigation: Theory and Practice. Vikas Publishing House New Delhi.

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

3. Allen, R. G., Pereira, L. S., Raes, D., Smith, M. (1998). Crop Evapotranspiration Guidelines for Computing Crop Water Requirement. Irrigation and drainage Paper 56, FAO of United Nations, Rome.

4. Murthy, V.V.N. (2013). Land and Water Management Engineering. Kalyani Publishers, New Delhi.

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

SWE 203	SPRINKLER AND MICRO IRRIGATION SYSTEMS	2 (1+1)	SEM IV

Theory

Sprinkler irrigation, adaptability, problems and prospects; types of sprinkler irrigation systems; design of sprinkler irrigation system: layout selection, hydraulic design of lateral, sub-main and

main pipe line; design steps; selection of pump and power unit for sprinkler irrigation system; performance evaluation of sprinkler irrigation system: uniformity coefficient and pattern efficiency;

Micro irrigation systems: types-drip, spray & bubbler systems, merits and demerits, different components; design of drip irrigation system: general considerations, wetting patters, irrigation requirement, emitter selection; hydraulics of drip irrigation system: design steps, necessary steps for proper operation of a drip irrigation system, maintenance of micro irrigation system; clogging problems: filter cleaning, flushing and chemical treatment; fertigation: advantages and limitations of fertigation, fertigation frequency, duration and injection rate; methods of fertigation.

Practical

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

Reference Books

1. Keller, Jack and Bliesner, Ron D. (2001). Sprinkle and Trickle Irrigation. Springer Science business Media, New York .
2. Mane, M. S. and Ayare, B. L. (2007). Principles of Sprinkler Irrigation systems, Jain Brothers, New Delhi.
3. Mane, M. S. and Ayare, B. L. and Magar, S. S. (2006). Principles of Drip Irrigation systems, Jain Brothers, New Delhi.
4. Michael, A. M., Shrimohan and Swaminathan, K. R. (1972) Design and evaluation of irrigation methods, (IARI Monograph No.1). Water Technology Centre, IARI New Delhi.
5. Michael, A.M. (2012). Irrigation: Theory and Practice. Vikas Publishing Vikas Pub. House New Delhi.

SWE 301	SOIL AND WATER CONSERVATION ENGINEERING	3 (2+1)	SEM V

Theory

Soil erosion: introduction, causes and types - geological and accelerated erosion; agents; factors affecting and effects of erosion; water erosion: mechanics and forms – splash, sheet, rill, gully, ravine and stream bank erosion; Gullies: classification, stages of development; soil loss estimation: universal soil loss equation (USLE) and modified USLE; rainfall erosivity; estimation by KE>25 and EI_{30} methods; soil erodibility: topography, crop management and conservation practice factors; measurement of soil erosion: runoff plots, soil samplers; water erosion control measures: agronomical measures- contour farming, strip cropping, conservation tillage and mulching; engineering measures- bunds and terraces; bunds: contour and graded bunds- design and surplussing arrangements; terraces: level and graded broad base terraces; bench terraces – planning, design and layout procedure; contour stonewall and trenching; gully and ravine reclamation - principles of gully control - vegetative measures; temporary structures and diversion drains. grassed waterways- design; wind erosion- factors affecting; mechanics; soil loss estimation and control measures - vegetative; mechanical measures; wind breaks and shelter belts and stabilization of sand dunes; land capability classification.; rate of sedimentation; silt monitoring and storage loss in tanks.

Practical

Study of different types and forms of water erosion; exercises on computation of rainfall erosivity index; computation of soil erodibility index in soil loss estimation; determination of length of slope (LS) and cropping practice (CP) factors for soil loss estimation by USLE and MUSLE; exercises on soil loss estimation/measuring techniques; estimation of sediment rate using coshocton wheel sampler and multi-slot devisor; determination of sediment concentration through oven dry method; design and layout of contour bunds; design and layout of graded bunds; design of broad base terraces; design and layout of bench terraces; design of vegetative waterways; exercises on rate of sedimentation and storage loss in tanks; design of shelterbelts and wind breaks for wind erosion control; visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures.

Reference Books

1. Singh, Gurmel, Venkataraman, C., Sastry, G. and Joshi, B. P. (1996). Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Ghanshyam, Das. (2008). Hydrology and Soil Conservation Engineering: Including Watershed Management. 2nd Edition, Prentice-Hall of India Learning Pvt. Ltd., New Delhi.
3. Michael, A.M. and Ojha, T.P. (2003). Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
4. Murthy, V.V.N. (2002). Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
5. Suresh, R. (2014). Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

SWE 302	WATERSHED PLANNING AND MANAGEMENT	2 (1+1)	SEM V

Theory

Watershed - introduction and characteristics; watershed development - problems and prospects, investigation, topographical survey, soil characteristics, vegetative cover, present land use practices and socio-economic factors; watershed management – concept, objectives, factors affecting watershed planning based on land capability classes; hydrologic data for watershed planning; watershed codification, delineation and prioritization of watersheds – sediment yield index; water budgeting in a watershed; management measures - rainwater conservation technologies - *in-situ* and *ex-situ* storage; water harvesting and recycling; effect of cropping systems land management and cultural practices on watershed hydrology; watershed programme – execution, follow-up practices, maintenance, monitoring and evaluation; participatory watershed management - role of watershed associations; user groups and self-help groups; planning and formulation of project proposal for watershed management programme including cost-benefit analysis.

Practical

Exercises on delineation of watersheds using toposheets; surveying and preparation of watershed map; quantitative analysis of watershed characteristics and parameters; watershed investigations for planning and development; analysis of hydrologic data for planning watershed management; water budgeting of watersheds; prioritization of watersheds based on sediment yield index; study of watershed management technologies; practice on softwares for analysis of hydrologic parameters of watershed; study of role of various functionaries in watershed development programmes; techno-economic viability analysis of watershed projects; visit to watershed development project areas.

Reference Books

1. Das, Ghanshyam. (2008). Hydrology and Soil Conservation Engineering: Including Watershed Management. 2nd Edition, Prentice-Hall of India Learning Pvt. Ltd., New Delhi.
2. Katyal, J. C., Singh, R. P., Sharma, Shriniwas, Das, S. K., Padmanabhan, M. V. and Mishra, P. K. (1995). Field Manual on Watershed Management. CRIDA, Hyderabad.
3. Mahnot, S. C. (2014). Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service. New Delhi.
4. Sharda, V. N., Sikka, A.K. and Juyal, G.P.(2006). Participatory Integrated Watershed Management: A Field Manual. Central Soil and Water Conservation Research and Training Institute,Dehradun.
5. Singh, G. D. and Poonia, T. C. (2003). Fundamentals of Watershed Management Technology. Yash Publishing House, Bikaner.

SWE 303	DRAINAGE ENGINEERING	2 (1+1)	SEM V

Theory

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

Practical

In-situ measurement of hydraulic conductivity by single auger hole and inverse auger hole method; estimation of drainage coefficients; installation of piezometer and observation wells; preparation of iso-bath and isobar maps; determination of drainable porosity; design of surface drainage systems; design of gravel envelop; design of subsurface drainage systems; determination of chemical properties of soil and water; study of drainage tiles and pipes; installation of sub-surface drainage system.

Reference Books

1. Bhattacharya, A. K. and Michael, A. M. (2013). Land Drainage, Principles, Methods and Applications. Vikas Publication House, Noida (UP). 174 Report of the ICAR Fifth Deans' Committee
2. Ritzema, H. P. (1994) Drainage Principles and Applications, ILRI Publication 16, Second Edition (Completely Revised).
3. Michael, A. M. and Ojha, T. P. (2014). Principles of Agricultural Engineering Vol-II 5th Edition. Jain Brothers Publication, New Delhi.
4. Kadam U. S., Thokal R. T., Gorantiwar S. D. and Powar A. G. (2007). Agricultural Drainage-Principles and Practices, Westville Publishing House.
5. FAO Irrigation and Drainage Paper No. 6, 9, 15, 16, 28 and 38. Rome, Italy.

SWE 304	WATER HARVESTING AND SOIL CONSERVATION STRUCTURES	3 (2+1)	SEM VI

Theory

Water harvesting –principles, importance and issues; water harvesting techniques - classification based on source, storage and use; runoff harvesting – short-term and long-term techniques; short-term harvesting techniques - terracing and bunding; long-term harvesting techniques – purpose, 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; percolation pond - site selection, design and construction details; 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; energy –depth relationship for rectangular, triangular and trapezoidal channels; hydraulic jump and its application; drop spillway - applicability; types - straight drop; box-type inlet spillways – description, functional use, advantages and disadvantages; straight apron and stilling basin outlet; structural components and functions; loads on head wall; variables affecting equivalent fluid pressure; triangular load diagram for various flow conditions; creep line theory; uplift pressure estimation; safety against sliding; overturning; crushing and tension; chute spillway – description, components, energy dissipaters, design criteria of Saint Antony Falls (SAF) stilling basin and its limitations; drop inlet spillway – description, functional use and design criteria.

Practical

Study of different types of farm ponds; computation of storage capacity of embankment type of farm ponds; design of dugout farm ponds; design of percolation pond and *nala* bunds; exercise on energy-depth relationship; exercise on hydraulic jump; exercise on energy dissipation in water flow; hydrologic; hydraulic and structural design of drop spillway and stability analysis; design of SAF stilling basins in chute spillway; hydrologic; hydraulic and structural design of drop inlet spillway; design of small earthen embankment structures; practice on softwares for design of soil and water conservation structures; field visit to watershed project areas treated with soil and water conservation measures / structures.

Reference Books

1. Singh, Gurmel, Venkataraman, C., Sastry, G. and Joshi, B. P. (1996). Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Michael, A. M. and Ojha, T. P. (2003). Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
3. Murthy, V.V.N. (2002). Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
4. Schwab, G. O., Fangmeier,D.D., Elliot,W.J., Frevert, R.K.. (1993). Soil and Water Conservation Engineering.4th Edition, John Wiley and Sons Inc. New York.
5. Suresh, R. (2014). Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

SWE 305	GROUNDWATER; WELLS AND PUMPS	3 (2+1)	SEM VI

Theory

Occurrence and movement of ground water; aquifer and its types; classification of wells; fully penetrating tubewells and open wells; familiarization of various types of bore wells; design of open wells; groundwater exploration techniques; methods of drilling of wells, percussion, rotary, reverse rotary, design of tubewell and gravel pack; installation of well screen; completion and development of well; governing equations of groundwater flow in confined and unconfined aquifers; steady flow in confined and unconfined aquifers; groundwater hydraulics-determination of aquifer parameters by different method such as theis; Jacob and Chow's; theis recovery method; well interference; multiple well systems; estimation of ground water potential; quality of ground water; artificial groundwater recharge techniques; pumping systems: water lifting devices; different types of pumps; classification

of pumps; component parts of centrifugal pumps; priming; pump selection; installation and trouble shooting; performance curves; effect of speed on capacity; head and power; effect of change of impeller dimensions on performance characteristics; hydraulic ram; propeller pumps; mixed flow pumps and their performance characteristics; deep well turbine pump and submersible pump.

Practical

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

Reference Books

1. Michael, A. M., Khepar, S. D. and Sondhi, S. K. (2008). Water Well and Pumps, 2nd Edition, Tata Mc-Graw Hill, New Delhi
2. Todd, David Keith and Larry, W. Mays. (2004). Groundwater Hydrology, 3rd Edition, John Wiley & Sons, New York (International Book Distributing Company Lucknow).
3. Michael, A. M. and Ojha, T. P. (2014). Principles of Agricultural Engineering Vol-II, 5th Edition. Jain Brothers Publication, New Delhi.
4. Murthy, V.V.N. (2002). Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
5. Michael, A. M. (2012). Irrigation: Theory and Practice. Vikas Publishing House New Delhi.

FMPE 390/ PFE 390/ RBEE 390/ SWE 390	**SKILL DEVELOPMENT TRAINING-I (Student READY)**	**5 (0+5)**	**SEM V**

Exposure to industrial and institutional applications in selected fields of interest (Farm Machinery and Power Engineering; Processing & Food Engineering; Renewable & Bio-energy Engineering; Soil & Water Engineering; Information Technology etc.); training report preparation and presentation (students will be required to undergo training of about 4 weeks during semester break after IVth semester).

FMPE 391/ PFE 391/ RBEE 391/ SWE 391	**UNDERGRADUATE SEMINAR**	**1 (0+1)**	**SEM VI**

Topic selection; material collection; slide preparation; presentation and interaction.

FMPE 411/ PFE 411/ RBEE 411/ SWE 411	**INDUSTRIAL ATTACHMENT/ INTERNSHIP (Student READY)**	**10 (0+10)**	**SEM VII**

Attachment with selected industries/organizations dealing with tractors, agril machinery, precision agriculture, irrigation systems, pumps, soil conservation, watershed management, processing, value addition, renewable and bio-energy and other aspects related to agricultural engineering; to enrich desired skills and practical knowledge of the students

FMPE 412/ PFE 412/ RBEE 412/ SWE 412	**EXPERIENTIAL LEARNING ON CAMPUS (Student READY)**	**10 (0+10)**	**SEM VII**

FMPE: Exposure to production technology; testing and evaluation of agricultural machinery as per standards; interpretation and preparation of test reports.

PFE: Agro-processing; food product development; setting up of model plants for food processing and value addition; processing and packaging of selected grains; fruits and vegetables.

RBEE: Design; development; installation and maintenance of renewable energy appliances/ equipments and use of related softwares.

SWE: Farm planning and development of irrigation and drainage projects; watershed project formulation; design of water harvesting and recycling systems; maintenance and operation of wells and pumps; irrigation and drainage systems; installation of weirs and flumes for water measurement.

FMPE 490/ PFE 490/ RBEE 490/ SWE 490	**SKILL DEVELOPMENT TRAINING-II (Student READY)**	**5 (0+5)**	**SEM VII**

Exposure to an environment in which students are expected to be associated in their future career; preparation of training report technical aspects of the training and presentation (students will be required to undergo training of about 4 weeks during semester break after VIth semester).

FMPE 491/ PFE 491/ RBEE 491/ SWE 491	**PROJECT PLANNING AND REPORT WRITING (Student READY)**	**10 (0+10)**	**SEM VIII**

Field/lab studies; project report writing and presentation.

Elective Courses

(A student can opt need based elective courses equivalent to 9 Credit Hours)

SWE 401	**MANAGEMENT OF CANAL IRRIGATION SYSTEM**	**3 (2+1)**	**SEM VIII**

Theory

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

Practical

Estimation of water requirement of canal commands; determination of canal capacity; layout of canal alignments on topographic maps; drawing of canal sections in cutting; full banking and partial cutting and partial banking; determination of longitudinal section of canals; design of irrigation canals based on silt

theories; design of lined canals; formulation of warabandhi; study of canal outlets; regulators; escapes and canal falls.

Reference Books

1. Arora, K. R. (2001). Irrigation, Water Power and Water Resources Engineering. Standard Publishers Distributors, Delhi.
2. Garg, S. K. (2014). Irrigation Engineering and Hydraulic Structures, Khanna Publishers, New Delhi.
3. Sahasrabudhe, S.R. (2011). Irrigation Engineering and Hydraulic structures. SK Kataria & Sons Reprint 2015.
4. Murthy, V.V.N. (2013). Land and Water Management Engineering. Kalyani Publishers New Delhi.
5. Das, Ghanshyam. (2008). Hydrology and Soil Conservation Engineering: Including Watershed Management. 2nd Edition, Prentice-Hall of India Learning Pvt. Ltd., New Delhi.

SWE 402	REMOTE SENSING AND GIS APPLICATIONS	3 (2+1)	SEM VIII

Theory

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

Practical

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

Reference Books

1. Reddy, Anji M. (2006). Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad.
2. Elangovan, K. (2006). GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi.
3. George, Joseph. (2005). Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad.

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

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

SWE 403	PRECISION FARMING TECHNIQUES FOR PROTECTED CULTIVATION	3 (2+1)	SEM VIII

Theory

Protected cultivation: introduction, history, origin, development, national and international scenario; components of green house; perspective, types of green houses; polyhouses /shed nets; cladding materials; plant environment interactions – principles of limiting factors; solar radiation and transpiration; greenhouse effect, light, temperature, relative humidity, carbon dioxide enrichment, design and construction of green houses – site selection: orientation, design, construction, design for ventilation requirement using exhaust fan system; selection of equipment; greenhouse cooling system – necessity; methods – ventilation with roof and side ventilators; evaporative cooling; different shading material fogging; combined fogging and fan-pad cooling system; design of cooling system; maintenance of cooling and ventilation systems; pad care etc. greenhouse heating – necessity, components,methods, irrigation in greenhouse and net house – water quality, types of irrigation system, components, design, installation and material requirement; fogging system for greenhouses and net houses – introduction, benefits, design, installation and material requirement; maintenance of irrigation and fogging systems; fertigation scheduling; rate of application of fertilizers; methods; automated fertilizer application; greenhouse climate measurement; control and management; major crops in greenhouse – irrigation and fertilizer requirements.

Practical

Visit to greenhouses; estimation of material requirement for construction of greenhouse; determination of irrigation and fertilization schedule and rate of application for various crops; design and installation of irrigation system; design and installation of fogging system ; greenhouse heating; study of different greenhouse environment control instruments; study of operation maintenance and fault detection in irrigation system; study of operation maintenance and fault detection in fogging system; economic analysis of greenhouses and net houses.

Reference Books

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

2. Sharma, P. (2007). Precision Farming. Daya Publishing House New Delhi.

3. Qin, Zhang (2016) Precision Agriculture Technology for Crop Farming. CNC Press

4. Sharma, Premjit (2017). Precision Farming . Gene Tech Books, New Delhi

5. Dan, Ess and Mark, Morgan, (2010). The Precision Farming Guide for Agriculturists. Deere & Co

SWE 404	LANDSCAPE IRRIGATION DESIGN AND MANAGEMENT	3 (2+1)	SEM VIII

Theory

Conventional method of landscape irrigation- hose irrigation system; quick release coupling system and portable sprinkler with hose pipes; modern methods of landscape irrigation- pop-up sprinklers; spray pop-up sprinkler; drip irrigation and bubblers; merits and demerits of conventional and modern

irrigation systems; types of landscapes and suitability of different irrigation methods; water requirement for different landscapes; segments of landscape irrigation systems; main components of modern landscape irrigation systems and their selection criteria; types of pipes; pressure ratings; sizing and selection criteria; automation system for landscape irrigation- main components, types of controllers and their application; design of modern landscape irrigation systems, operation and maintenance of landscape irrigation systems.

Practical

Study of irrigation equipments for landscapes; design and installation of irrigation system for landscape; determination of water requirement; determination of power requirement; pump selection; irrigation scheduling of landscapes; study of irrigation controllers and other equipments; use of autoCAD in irrigation design: blocks & symbols; head layout; zoning and valves layout; pipe sizing; pressure calculations etc.; visit to landscape irrigation system and its evaluation.

Reference Books

1. Singh, Neeraj Partap. (2010). Landscape Irrigation and Floriculture Terminology, Bangalore
2. Smith, Stepehen W. Landscape Irrigation and Management. Amazon. com.
3. Murthy, V.V.N. (2013). Land and Water Management Engineering. Kalyani Publishers, New Delhi.
4. Michael, A.M. (2012). Irrigation: Theory and Practice. Vikas Publishing House New Delhi.
5. Singh, Gurmel, Venkataraman, C., Sastry, G. and Joshi, B.P. Manual of Soil and Water Conservation Practices

SWE 405	WATER QUALITY AND MANAGEMENT MEASURES	3 (2+1)	SEM VIII

Theory

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

Practical

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

Reference Books

1. Gray, N. F. Water Technology. Raj Kamal Electric Press, Kundli, Haryana.
2. Hussain, S. K. (1986). Text Book of Water Supply and Sanitary Engineering. Oxford & IBH Publishing Co. New Delhi.
3. McGauhey, P. H. (1968). Engineering Management of water quality. McGraw Hill Book Company, New York.

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

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

SWE 406	PLASTIC APPLICATIONS IN AGRICULTURE	3 (2+1)	SEM VIII

Theory

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

Practical

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

Reference Books

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

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

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

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

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

SWE 407	INFORMATION TECHNOLOGY FOR LAND AND WATER MANAGEMENT	3 (2+1)	SEM VIII

Theory

Concept of Information Technology (IT) and its application potential; role of IT in natural resources management; existing system of information generation and organizations involved in the field of land and water management; application and production of multimedia; internet application tools and web technology; networking system of information; problems and prospects of new information and communication technology; development of database concept for effective natural resources management; application of remote sensing; geographic information system (GIS) and GPS; rational data base management system; object oriented approaches; information system; decision support systems and expert systems; agricultural information management systems - use of mathematical models and programmes; application of decision support systems; multi sensor data loggers and overview of software packages in natural resource management; video-conferencing of scientific information.

Practical

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

Reference Books

1. Climate-Smart Agriculture – Source Book. (2013). Food and Agriculture Organization, Rome
2. Daniel, P. Loucks and Eelco, van Beek. (2005). Water Resources Systems Planning and Management - An Introduction to Methods, Models and Applications. UNESCO, Paris.
3. Dipak, De and Basavaprabhu, Jirli (Eds.). (2010). Communication Support for Sustainable Development. Ganga Kaveri Publishing House, Varanasi – 221001.
4. FAO (1998). Land and Water Resources Information Systems. FAO Land and Water Bulletin 7, Rome
5. Soam, S. K., Sreekanth, P.D. and Rao, N.H. (Eds.). (2013). Geospatial Technologies for Natural Resources Management. New India Publishing Agency, Delhi.

SWE 408	MINOR IRRIGATION AND COMMAND AREA DEVELOPMENT	3 (2+1)	SEM VIII

Theory

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

Practical

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

Reference Books

1. Arora, K. R. (2001). Irrigation, Water Power and Water Resources Engineering. Standard Publishers Distributors, Delhi.
2. Garg, S. K. (2014). Irrigation Engineering and Hydraulic Structures, Khanna Publishers New Delhi.
3. Michael, A. M. (2012). Irrigation: Theory and Practice. Vikas Publishing Vikas Publ.House New Delhi.
4. Sahasrabudhe, S. R. (2011). Irrigation Engineering and Hydraulic structures. SK Kataria & Sons Reprint 2015.
5. Ojha,T. P. and Michael, A. M., (2012), Principles of Agricultural Engineering - I. Jain Brothers, Karol Bagh, New Delhi.

SWE 409	WASTELAND DEVELOPMENT	3 (2+1)	SEM VIII

Theory

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

Practical

Mapping and classification of wastelands; identification of factors causing wastelands; estimation of vegetation density and classification; planning and design of engineering measures for reclamation of wastelands; design and estimation of different soil and water conservation structures under arid; semiarid and humid conditions; planning and design of micro-irrigation in wasteland development; cost estimation of the above measures / structures; visit to wasteland development project sites.

Reference Books

1. Abrol, I. P., and Dhruvanarayana, V.V. (1998). Technologies for Wasteland Development. ICAR, New Delhi.
2. Ambast, S. K., Gupta, S. K. and Singh, Gurcharan (Eds.) (2007). Agricultural Land Drainage -Reclamation of Waterlogged Saline Lands. Central Soil Salinity Research Institute, Karnal,Haryana.
3. Yadav, Hridai Ram. (2013). Management of Wastelands. Concept Publishing Company. New Delhi.
4. Karthikeyan, C., Thangaraja, K., Fernandez, C. Cinthia and Chandrakandon, K. (2009).

Dryland Agriculture and Wasteland Management. Atlantic Publishers and Distributors Pvt. Ltd., New Delhi.

5. Lal, Rattan and Stewart, B.A. (Ed.). (2015). Soil Management of Smallholder Agriculture. Volume 21 of Advances in Soil Science. CRC Press, Taylor and Francis Group, Florida, USA.

SWE 410	FLOODS AND CONTROL MEASURES	3 (2+1)	SEM VIII

Theory

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

Practical

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

Reference Books

1. Michael, A.M. and Ojha, T.P. (2003). Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
2. Murthy, V.V.N. (2002). Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
3. Suresh, R. (2014). Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.
4. Mutreja, K.N. (1990). Applied Hydrology. Tata McGraw-Hill Publishing Co., New York, Delhi.
5. Subramanya, K. (2008). Engineering Hydrology. 3rd Edition, Tata McGraw-Hill Publishing Co.,New Delhi.

BASIC ENGINEERING

Course No.	Course Title	Credit Hours	Semester
Civil Engineering			
CE 101	Surveying and Levelling	3(1+2)	I
CE 102	Engineering Mechanics	3(2+1)	I
CE 103	Fluid Mechanics and Open Channel Hydraulics	3(2+1)	II
CE 104	Strength of Materials	2(1+1)	II
CE 201	Soil Mechanics	2(1+1)	III
CE 202	Design of Structures	2(1+1)	III
CE 203	Building Construction and Cost Estimation	2(2+0)	IV
	Total Credits	**17(10+7)**	
Electrical and Electronics Engineering			
EE 101	Web Designing and Internet Applications	2(1+1)	II
EE 201	Electrical Machines and Power Utilization	3(2+1)	III
EE 202	Applied Electronics and Instrumentation	3(2+1)	IV
EE 301	Computer Programming and Data Structures	3(1+2)	VI
	Total Credits	**11(6+5)**	
Mechanical Engineering			
ME 101	Engineering Drawing	2(0+2)	I
ME 102	Heat and Mass Transfer	2(1+1)	I
ME 103	Workshop Technology and Practice	3(1+2)	II
ME 104	Theory of Machines	2(1+1)	II
ME 201	Machine Design	2(1+1)	III
ME 202	Thermodynamics; Refrigeration and Air Conditioning	3(2+1)	III
ME 203	Auto CAD Applications	2(0+2)	IV
	Total Credits	**16(6+10)**	

CIVIL ENGINEERING

CE 101	SURVEYING AND LEVELLING	3 (1+2)	SEM I

Theory

Surveying: introduction, classification and basic principles; linear measurements; chain surveying; cross staff survey; compass survey; planimeter; errors in measurements; their elimination and correction; plane table surveying; levelling; leveling difficulties and error in leveling; contouring; computation of area and volume; theodolite traversing; introduction to setting of curves; total station; electronic theodolite; introduction to GPS survey.

Practical

Chain survey of an area and preparation of map; compass survey of an area and plotting of compass survey; plane table surveying; levelling; L section and X sections and its plotting; contour survey of an area and preparation of contour map; introduction of software in drawing contour; theodolite surveying; ranging by theodolite; height of object by using theodolite; setting out curves by theodolite; minor instruments; use of total station.

Reference Books

1. Kochher, C. L. (2012). A test Book of Surveying. Dhanpat Rai Publishing Company

2. De, Alak. Plane Surveying. S. Chand & Co.
3. Bannister, Arthur & others. Surveying. Darling Kindersley (India) Pvt. Ltd.
4. Kanetkar, T.P. and Kulkarni S.V. Surveying and Levelling. Vidhyarathi Griha Parkashan
5. Pumia, P.C. Surveying and Levelling

CE 102	ENGINEERING MECHANICS	3 (1+2)	SEM I

Theory

Basic concepts of engineering mechanics; force systems; centroid; moment of inertia; free body diagram and equilibrium of forces; frictional forces analysis of simple framed structures using methods of joints; methods of sections and graphical method; simple stresses; shear force and bending moment diagrams; stresses in beams; torsion; analysis of plane and complex stresses.

Practical

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

Reference Books

1. Kiran, S. Rajase, Shnkara subramanian, G., 1st (1999). Engineering Mechanics. Vikash ublishing House Pvt. Ltd.
2. Hassan, Ali & Khan, R.A. (2010) Fundamentals of Engineering Mechanics, Acme Learning Pvt. Ltd.
3. Bansal, R.K. Text of Engg. Mech. Luxmi Publication
4. Velamurli. Engineering Mechanics. Oxford Publication
5. Timoshenkoo, S. Engineering Mechanics. McGraw Hill

CE 103	FLUID MECHANICS AND OPEN CHANNEL HYDRAULICS	3 (1+2)	SEM II

Theory

Properties of fluids: ideal and real fluid; pressure and its measurement; Pascal's law; pressure forces on plane and curved surfaces; centre of pressure; buoyancy; meta centre and meta centric height; condition of floatation and stability of submerged and floating bodies; kinematics of fluid flow: Lagrangian and Eulerian description of fluid motion; continuity equation; path lines; streak lines and stream lines; stream function; velocity potential and flow net; types of fluid flow; translation; rotation; circulation and vorticity; vortex motion; dynamics of fluid flow; Bernoulli's theorem; venturimeter; orifice meter and nozzle; siphon; laminar flow: stress strain relationships; flow between infinite parallel plates both plates fixed; one plate moving; discharge; average velocity; laminar and turbulent flow in pipes; general equation for head loss Darcy; equation; Moody's diagram; minor and major hydraulic losses through pipes and fittings; flow through network of pipes;

hydraulic gradient and energy gradient; flow through orifices (measurement of discharge; measurement of time); flow through mouthpieces; flow over notches ; flow over weirs; Chezy's formula for loss of head in pipes; flow through simple and compound pipes; open channel design and hydraulics: Chezy's formula; Bazin's formula; Kutter's Manning's formula; velocity and pressure profiles in open channels; dimensional analysis and similitude: Rayleigh's method and Buckingham's `Pi' theorem; types of similarities; dimensional analysis; dimensionless numbers; introduction to fluid machinery.

Practical

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

Reference Books

1. Kothandaraman, C. P. and Rudramoorthy, R. (2011). Fluid Mechanics and Machinery. Newage International Publisher
2. Gupta, Vijay and Gupta, S. K. Fluid Mechanics and its applications. Newage International Publisher
3. Modi, P.N. and Seth. Hydraulic and Fluid Mechanics. Standard Book House
4. Bansal, R.K. A text of Fluid Mechanics. Luxmi Publication
5. Monthy, A.K. Fluid Mechanics. PHI Learning Pvt. Ltd.

CE 104	STRENGTH OF MATERIALS	2 (1+1)	SEM II

Theory

Slope and deflection of beams using integration techniques; moment area theorems and conjugate beam method; columns and struts; stability of masonry dams; analysis of statically intermediate beams; propped beams; fixed and continuous beam analysis using superposition; three moment equation and moment distribution methods.

Practical

To perform the tension test on metal specimen (M.S., C.I.); to observe the behaviour of materials under load; to calculate the value of E; ultimate stress; permissible stress; percentage elongation etc.; and to study its fracture; to perform the compression test on; concrete cylinders &cubes; M.S., C.I. & Wood specimens and to determine various physical and mechanical properties; to perform the bending test on the specimens; M.S. Girder; wooden beam; plain concrete beams & R.C.C. beam; and to determine the various physical and mechanical properties; to determine young's modulus of elasticity of beam with the help of deflection produced at centre due to loads placed at centre & quarter points; to study the behaviour of materials (G.I. pipes; M.S.; C.I.) under torsion and to evaluate various elastic constants; to study load deflection and other physical properties of closely coiled helical spring in tension and compression; to perform the Rockwell; Vicker's and Brinell's Hardness tests on the given specimens; to perform the drop hammer test; Izod Test and Charpay's impact tests on the given specimens; to determine compressive strength of cement and concrete after making cubes; to measure workability of concrete (slump test; compaction factor test); torsion test on

mild steel specimen; to determine fatigue strength of a given specimen; to write detail report emphasizing engineering importance of performing tension; compression; bending; torsion; impact and hardness tests on the materials.

Reference Books

1. Gosh, D. and Datta, A.K. (2011). A text book of Strength of Material. Newage International Publisher
2. Bhavikatti, S.S. (2009). Strength of Materials. Vikash Publishing House
3. Ramamurtham, S. (2010). Strength of Materials. Dhanpat Rai Publishing Pvt. Ltd.
4. Bansal, R.K. Text Book of Strength Material. Luxmi Publication
5. Rattan, S.S. Strength of Material. Tata McGraw Hill

CE 201	SOIL MECHANICS	2 (1+1)	SEM III

Theory

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

Practical

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

Reference Books

1. Ranjan, Gopa and Rao, A.S.R. (2014). Basic of Applied Soil Mechanics. Newage International Publisher
2. Punmia, B.C. Soil Mechanics & Foundation Engineering. Standard Book House Delhi
3. Lamby, T. William and Whiteman. Soil Mechanics. John Willey and Sons
4. Terzaghi, Karl. Soil Mechanics in Engineering Practice. John Willey and Sons
5. Arora, K.R. Soil Mechanics & Foundation Engineering. Standard Publisher and Distributors

CE 202	DESIGN OF STRUCTURES	2 (1+1)	SEM III

Theory

Loads and use of BIS Codes (IS 456; IS 800); design of riveted and welded connections; design of structural steel members in tension, compression and bending; design of steel roof truss; analysis and design of singly and doubly reinforced sections; shear, bond and torsion; design of flanged beams, slabs, columns, foundations, retaining walls and silos.

Practical

Design and drawing of single reinforced beam; double reinforced beam; design and drawing of steel roof truss; design and drawing of one way; two way slabs; design and drawing of RCC building; design and drawing of retaining wall.

Reference Books

1. Raju, N. Krishna (2007). Structural Design and Drawing. Universities Press
2. Ramamrtham, S. Design of Reinforced Conc. Structure and Steel Tables. Dhanpat Rai Publishing (P) Ltd.
3. Bandhyopadhyay, J. N. (2010). Design of Conc. Structure. PHI Learning Pvt. Ltd.
4. Ram, K.S. Sai (2013). Design of Steel Structures. Pearson, Dorling Kindersley (India) Pvt. Ltd.
5. Arya, A.S. and Ajmani. Design of Steel Structures. Nemchand and Brothers Pvt. Ltd. (IS456 and IS800 are also required Steel Tables)

CE 203	BUILDING CONSTRUCTION AND COST ESTIMATION	2 (2+0)	SEM IV

Theory

Building materials: rocks, stones, bricks properties and varieties of tiles, lime, cement, concrete, sand, glass, rubber, plastics, iron, steel, aluminium, copper, nickel, timber, building components, lintels, arches, stair cases; different types of floors; finishing: damp proofing and water proofing; plastering; pointing; white washing and distempering – painting; building design; design procedures; technology; building construction; types of agricultural buildings and related needs; application of design theory and practice to the conservation; sloped and flat roof buildings; construction economics: preliminary estimates; detailed estimates of buildings source of cost information; use of cost analyses for controlling design; factors affecting building costs; cost evaluation of design and planning alternatives for building and estate development; measurement and pricing; economic methods for evaluating investments in buildings and building systems: cost-in-use; benefit-to-costs and savings-to-investment ratios; rate of return; net benefits; payback.

Reference Books

1. Punmia, B. C. and Jain, A. K. and others. Building Construction. Luxmi Publications Pvt. Ltd.
2. Varghese, P. C. Building Construction. PHI Leaning Pvt. Ltd.
3. Duggal, S. K. Building Materials. Newage International Publishing
4. Mahajan, D. C. Estimating and Costing. Rainbow Book Company
5. Dutta, B. N. & Dutta, S. Estimate and Costing Civil. UBS Publishers and Distributors

ELECTRICAL AND COMPUTER ENGINEERING

EE 101	WEB DESIGNING AND INTERNET APPLICATIONS	2 (1+1)	SEM II

Theory

Basic principles in developing a web designing; planning process; five golden rules of web designing;

designing navigation bar; page design; home page layout; design concept. basics in web design; brief history of internet; world wide web; creation of a web site; web standards; audience requirement. introduction to JavaScript; variables & functions; working with alert; confirm and prompt; connectivity of web pages with databases; project.

Practical

FLASH: animation concept FPS; understanding animation for web; flash interface; working with tools; DREAM WEAVER :exploring dreamweaver interface; planning & setting web site structure; working with panels; understanding and switching views; using property inspector; formatting text; JAVA script: working with alert; confirm and prompt; understanding loop; arrays; creating rollover image; working with operator; GIF animation: learning to use FTP; Setting FTP; uploading of site; using control panel; FTP uploading site: understanding gif animation interface; knowing GIF file format; creating basic web banners; creating web banners with effects; creating animated web buttons.

Reference Books

1. Jenkin (2007). Web Design (Edition1st). Willey India
2. Godbole, Achyut, Kahate, Atul (2005). Web Technologies. (Edition 2nd). Tata McGraw Hill
3. Falke and Morris (2013) Basic Web Design: HTML 5 & CSS 3. (Edition 2nd). Addison- Wesley
4. Vora, Pawan (2009) Web Application Design Pattern. (Edition1st). M K Publications
5. Joshi, Hiren (2011) Web Technology and Application Development. (Edition 2nd). Dreamtech Press

EE 201	ELECTRICAL MACHINES AND POWER UTILIZATION	3 (2+1)	SEM III

Theory

Electro motive force; reluctance; laws of magnetic circuits; determination of ampere-turns for series and parallel magnetic circuits; hysteresis and eddy current losses; transformer: principle of working; construction of single phase transformer; EMF equation; phasor diagram on load; leakage reactance; voltage regulation; power and energy efficiency; open circuit and short circuit tests; principles; operation and performance of DC machine (generator and motor); EMF and torque equations; armature reaction; commutation; excitation of DC generator and their characteristics; DC motor characteristics; starting of shunt and series motor; starters; speed control methods-field and armature control; polyphase induction motor: construction; operation; phasor diagram; effect of rotor resistance; torque equation; starting and speed control methods; single phase induction motor: double field revolving theory; equivalent circuit; characteristics; phase split; shaded pole motors; various methods of three phase power measurement; power factor; reactive and apparent power; concept and analysis of balanced poly-phase circuits; series and parallel resonance.

Practical

To obtain load characteristics of DC shunt/series /compound generator; to study characteristics of DC shunt/ series motors; to study DC motor starters; to Perform load-test on 3 ph. induction motor & to plot torque V/S speed characteristics; to perform no-load & blocked –rotor tests on 3 ph. induction motor to obtain equivalent ckt. parameters & to draw circle diagram; to study the speed control of 3 ph. induction motor by cascading of two induction motors; i.e. by feeding the slip power of one motor into the other motor; to study star- delta starters physically and (a) to draw electrical connection diagram (b) to start the 3 ph. induction motor using it. (c) to reverse the direction of 3 ph. I.M.; to start a 3-phase slip –ring induction motor by inserting different levels of resistance in the rotor ckt. and to plot torque –speed characteristics; to perform no load & blocked –rotor test on 1 ph. induction motor & to determine the parameters of equivalent ckt. drawn on the basis of double revolving field theory;

to perform load –test on 1 ph. induction motor & plot torque –speed characteristics; to study power consumed in a three-phase circuit; two lights in series controlled by one switch; two lights in parallel controlled by one switch.

Reference Books

1. Theraja, B. L. and Theraja, A. K. (2010). Electrical Technology Vol-II. (1st Edition). S Chand & company
2. Bimbhra, P. S. (2004). Electrical Machines2nd Edition. Khanna Publishers
3. Mehta, V. K. and Mehta, Rohit. (2002). Principle of Electrical Machines (3rd Edition). S. Chand & company
4. Chapman, Stephan J. (2002). Electrical Machinery & Power System Fundamentals (2nd Edition). McGraw Hill
5. Sawhney, A. K. (2014). Electrical Machine Design (2nd Edition). Dhanpat Rai

EE 202	APPLIED ELECTRONICS AND INSTRUMENTATION	3 (2+1)	SEM IV

Theory

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

Practical

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

Reference Books

1. Milliman, J. and Halkias, C. (1995). (Edition 2nd) Integrated Electronics. Tata McGraw Hill
2. Boylestad, Nashelsky (2004). (Edition 2nd). Electronic Devices & Circuits. PHI
3. Malvino and Leach (2005). (Edition 4th). Digital Principles & applications. McGraw Hill
4. Gayakwad, R. A. (2000). (Edition 4th). OP-AMPs and linear Integrated Circuits. PHI
5. Rangan, C.S., Sharma, G.R., and Mani, V.S.V. (2014). (32nd reprint) Instrumentation Devices and systems. McGraw Hill

EE 301	COMPUTER PROGRAMMING AND DATA STRUCTURES	3 (1+2)	SEM VI

Theory

Introduction to high level languages; primary data types and user defined data types; variables; typecasting; operators; building and evaluating expressions; standard library functions; managing input and output; decision making; branching; looping; arrays; user defined functions; passing arguments and returning values; recursion; scope and visibility of a variable; string functions; structures and union; pointers; stacks; push/pop operations; queues; insertion and deletion operations; linked lists.

Practical

Familiarizing with Turbo C IDE; building an executable version of C program; debugging a C program; developing and executing simple programs; creating programs using decision making statements such as if; go to & switch; developing program using loop statements while; do & for; using nested control structures; familiarizing with one and two dimensional arrays; using string functions; developing structures and union; creating user defined functions; using local; global & external variables; using pointers; implementing stacks; implementing push/pop functions; creating queues; developing linked lists in C language; insertion/deletion in data structures.

Reference Books

1. Kanetkar, Y. S. (2009) (Edition 15th) Let Us C. BPB Publications
2. Ritchie, Dennis M. and Kerrigham, Brian W (2005). (Edition 4th) The C Programming Language PHI
3. King, K. N. (1996). (Edition 2nd). C Programming- A Modern Approach. W W Nortan & Co
4. Tenenbaum, A. M. (2001). (Edition 1st). Data Structures using C. PHI
5. Ashok, Kamthane (2009) Programming & Data Structures (Edition 2nd). Pearson.

MECHANICAL ENGINEERING

ME 101	ENGINEERING DRAWING	2 (0+2)	SEM I

Practical

Introduction of drawing scales; first and third angle methods of projection; principles of orthographic projections; reference planes; points and lines in space and traces of lines and planes; auxiliary planes and true shapes of oblique plain surface; true length and inclination of lines; projections of solids (change of position method; alteration of ground lines); section of solids and interpenetration of solid surfaces; preparation of working drawing from models and isometric views; drawing of missing views; different methods of dimensioning; concept of sectioning; revolved and oblique sections; types of rivet heads and riveted joints; processes for producing leak proof joints; symbols for different types of welded joints; nomenclature; thread profiles; multi start threads; left and right hand threads; conventional representation of threads; forms of screw threads; square headed and hexagonal nuts and bolts; different types of lock nuts; studs; machine screws; cap screws and wood screws; foundation bolts; bolts- headed centre; stud screws; set screws; butt; hexagonal and square; keys- types; taper; sunk taper; hollow saddle etc.

Reference Books

1. Dhawan, R. K. (2015-16). A Text Book of Engineering Drawing. Publisher, S.Chand
2. Bhatt, N. D. (53rd edition 2016). Engineering Drawing. Charotkar publisher
3. Gill, P. S. (13th edition, reprint 2017). Engineering Drawing. Publisher S.K. Kataria & Sons

ME 102	HEAT AND MASS TRANSFER	2 (1+1)	SEM I

Theory

Concept; modes of heat transfer; thermal conductivity of materials; measurement; general differential equation of conduction; one dimensional steady state conduction through plane and composite walls; tubes and spheres with and without heat generation; electrical analogy; insulation materials; fins, free and forced convection; Newton's law of cooling; heat transfer coefficient in convection; dimensional analysis of free and forced convection; useful non dimensional numbers; equation of laminar boundary layer on flat plate and in a tube; laminar forced convection on a flat plate and in a tube; combined free and forced convection; absorptivity; reflectivity and transmissivity of radiation; black body and monochromatic radiation; Planck's law; Stefan-Boltzman law; Kirchoff's law; grey bodies and emissive power; solid angle; intensity of radiation; radiation exchange between black surfaces; geometric configuration factor; heat transfer analysis involving conduction; convection and radiation by networks; types of heat exchangers; fouling factor; log mean temperature difference; heat exchanger performance; transfer units; heat exchanger analysis restricted to parallel and counter flow heat exchangers; steady state molecular diffusion in fluids at rest and in laminar flow; Flick's law; mass transfer coefficients, Reynold's analogy.

Practical

Investigate and verify Fourier's Law for linear heat conduction; study of parallel flow and counter flow of heat; study of heat transfer through plane and composite wall for natural convection; determine thermal conductivity and temperature distribution across the width of the composite wall; study of heat transfer through plane and composite wall for forced convection; study of temperature distribution; heat transfer and fin efficiency of a pin fin in natural and forced convection; emissivity measurement; study LMTD; overall heat transfer coefficient and effectiveness of a heat exchanger in parallel flow and counter flow mode.

Reference Books:

1. Kumar, D.S. (9th edition, reprint 2017). HMT Text Book. Publisher S.K. Kataria & Sons
2. Rajput, R.K. (2016). HMT Text Book. Publisher S. Chand
3. Sukhatme, S.P. (4th edition 2013). HMT Text Book. Universities press
4. Domkundwar. (2017). HMT Text Book. Dhanpat Rai & Co
5. Domkundwar. (2016). HMT Data Book. Dhanpat Rai & Co.

ME 103	WORKSHOP TECHNOLOGY AND PRACTICE	3 (1+2)	SEM II

Theory

Introduction to various carpentry tools; materials; types of wood and their characteristics and processes or operations in wood working; introduction to smithy tools and operations; introduction to welding; types of welding; oxyacetylene gas welding; types of flames; welding techniques and equipment; principle of arc welding; equipment and tools; casting processes; classification; constructional details of center lathe; main accessories and attachments; main operations and tools used on center lathes; types of shapers; constructional details of standard shaper; work holding devices; shaper tools and main operations; types of drilling machines; constructional details of pillar types and radial drilling machines; work holding and tool holding devices; main operations; twist drills; drill angles and sizes; types and classification; constructional details and principles of operation of column and knee type universal milling machines; plain milling cutter; main operations on milling machine.

Practical

Preparation of simple joints: cross half lap joint and T-Halving joint; preparation of dovetail joint; mortise and tenor joint; jobs on bending; shaping etc.; jobs on drawing; punching; rivetting; introduction to tools and measuring instruments for fitting; jobs on sawing; filing and right angle fitting of MS Flat; practical in more complex fitting job; operations of drilling; reaming; and threading with tap and dies; introduction to tools and operations in sheet metal work; making different types of sheet metal joints using G.I. sheets. introduction to welding equipment; processes tools; their use and precautions; jobs on ARC welding – lap joint; butt joint; T-Joint and corner joint in arc welding; gas welding practice – lap; butt and T-Joints; introduction to metal casting equipment; tools and their use; mould making using one-piece pattern and two pieces pattern; demonstration of mould making using sweep pattern; and match plate patterns; introduction to machine shop machines and tools; demonstration on processes in machining and use of measuring instruments; practical jobs on simple turning; step turning; practical job on taper turning; drilling and threading; operations on shaper and planer; changing a round MS rod into square section on a shaper; demonstration of important operations on a milling machine; making a plot; gear tooth forming and indexing; any additional job.**Reference Books**

1. Jain, R. K. (18th edition). Production Technology. Khanna Publishers
2. Khurmi, R. S. (2015-16). Workshop Technology. S.Chand
3. Raghuwanshi, B. S. (10th reprint 2017). Workshop Tech. Vol I&II . Jain Book Depot
4. Khanna, O. P. (17th edition). W.Tech. and Production Tech. Vol-I &II. Dhanpat Rai & Co.
5. Kalpakjian, Serope. (7th Edition). Manufacturing Engg & Technology. Pearson Education India publisher

ME 104	THEORY OF MACHINES	2 (1+1)	SEM II

Theory

Elements, links, pairs, kinematics chain and mechanisms; classification of pairs and mechanisms; lower and higher pairs; four bar chain; slider crank chain and their inversions; determination of velocity and acceleration using graphical (relative velocity and acceleration) method; instantaneous centers; types of gears; law of gearing; velocity of sliding between two teeth in mesh; Involute and Cycloidal profile for gear teeth; spur gear; nomenclature; interference and undercutting; introduction to helical; spiral; bevel and worm gear; simple; compound; reverted; and epicyclic trains; determining velocity ratio by tabular method; turning moment diagrams; coefficient of fluctuation of speed and energy; weight of flywheel; flywheel applications; belt drives; types of drives; belt materials; length of belt; power transmitted; velocity ratio; belt size for flat and V belts; effect of centrifugal tension; creep and slip on power transmission; chain drives; types of friction; laws of dry friction; friction of pivots and collars; single disc; multiple disc; and cone clutches; rolling friction; anti friction bearings; types of governors; constructional details and analysis of Watt; Porter; Proell governors; effect of friction; controlling force curves; sensitiveness; stability; hunting; iso-chronism; power and effort of a governor; static and dynamic balancing; balancing of rotating masses in one and different planes.

Practical

Study of mechanisms; analysis of 4-bar mechanism; slider crank mechanism and their inversions; study of gears; gear trains and analysis-tabular method; synthesis of gear trains for a desired speed ratio; study of flywheel and governor action; study of cam profile for a desired follower motion; study on the cam follower demonstration machine for follower displacement as a function of cam rotation angle and phenomenon of follower jump; demonstration of static and dynamic balancing.

Reference Books

1. Khurmi, R. S. (2016). Theory of Machines. S. Chand Publications
2. Rattan, S. S. (4th edition 2014). Theory of Machines. Tata Mcgraw Hill
3. Ballaney, P. L. (25th edition). Theory of Machines. Khanna Publishers
4. Bansal, R. K. & Brar, J. S. (5th edition, Revised 2016). Theory of Machines. Laxmi Publications
5. Singh, Sadhu. (3rd Edition). Theory of Machines. Pearson education

ME 201	MACHINE DESIGN	2 (1+1)	SEM III

Theory

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

Practical

Tutorials on solution of design considerations towards material and properties; problems based on load/stress analysis of machine components; problems based on practical application of theories of failure and fatigue and determination of factor of safety; problems on design of shafts; keys and coupling; problems in selection; design of belts; problems on design of helical and leaf spring.

Reference Books

1. Khurmi, R. S. (2016). Machine Design text book. S.Chand
2. Bhandari, V. B. (4th edition 2016). Design of Machine Elements. Tata McGraw Hill
3. Kumar, Arun. (4th edition 2017). Data Book for Designing Machine Elements. S.K. Kataria & Sons
4. Norton, Robert, L. (2nd Edition) Machine Design: An Integrated Approach, 2/E, Pearson Education
5. KulKarni, S. G. (2008) Machine Design, TMH publisher

ME 202	THERMODYNAMICS; REFRIGERATION AND AIR CONDITIONING	3 (2+1)	SEM III

Theory

Thermodynamics properties; closed and open system; flow and non-flow processes; gas laws; laws of thermodynamics; internal energy. application of first law in heating and expansion of gases in non-flow processes; first law applied to steady flow processes; Carnot cycle; Carnot theorem; entropy; physical concept of entropy; change of entropy of gases in thermodynamics process; Otto; diesel and dual cycles; principles of refrigeration; - units; terminology; production of low temperatures; air refrigerators working on reverse Carnot cycle and Bell Coleman cycle; vapour refrigeration-mechanism; P-V;P-S;P-H diagrams; vapor compression cycles; dry and wet compression; super cooling and sub cooling; vapour absorption refrigeration system; common refrigerants and their properties; design calculations for refrigeration system. cold storage plants; thermodynamic properties of moist air; perfect gas relationship for approximate calculation; adiabatic saturation

process; wet bulb temperature and its measurement; psychometric chart and its use; elementary psychometric process; air conditioning – principles –type and functions of air conditioning; physiological principles in air conditioning; air distribution and duct design methods; fundamentals of design of complete air conditioning systems – humidifiers and dehumidifiers – cooling load calculations; types of air conditioners – applications.

Practical

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

Reference Books

1. Khurmi, R.S. (2016). Thermal Engg. Publisher S.Chand
2. Khurmi, R.S. (2016). RAC Text book. Publisher S.Chand
3. Prasad, Manohar. R. (2nd edition, reprint 2015). AC Data Book**.** New Age Int.
4. Rajput, R.K. (3rd edition, reprint 2016). RAC Text Book. SkKataria
5. Nag, P.K. (5th edition, 2013). Engineering Thermodynamics. TMH
6. Khurmi, R.S. (2015-16). Steam Table, Refrigeration Tables with Charts. S. Chand
7. Kothandaramn, C.P. (4th edition, 2015). Steam Tables. New age International Publisher.

ME 203	AUTO CAD APPLICATIONS	2 (0+2)	SEM IV

Practical

Application of computers for design; CAD- overview of CAD window – explanation of various options on drawing screen; study of draw and dimension tool bar; practice on draw and dimension tool bar; study of OSNAP; line thickness and format tool bar; practice on OSNAP; line thickness and format tool bar; practice on mirror; offset and array commands; practice on trim; extend; chamfer and fillet commands; practice on copy; move; scale and rotate commands; drawing of 2 D- drawing using draw tool bar; practice on creating boundary; region; hatch and gradient commands; practice on editing polyline- PEDIT and explode commands; setting of view ports for sketched drawings; printing of selected view ports in various paper sizes; 2D- drawing of machine parts with all dimensions and allowances- foot step bearing and knuckle joint; sectioning of foot step bearing and stuffing box; drawing of hexagonal nut and bolt and other machine parts; practice on 3-D commands-extrusion and loft; practice on 3-D commands-on sweep and press pull; practice on 3-D Commands-revolving and joining; demonstration on CNC machine and simple problems.

Reference Books

1. Groover, M. (6th impression). CAD/CAM text book. Pearson publications
2. Rao, P. N. (3rd edition, 2010). CAD/CAM:Principles and Applications. TMH
3. Zeid, Ibrahim. (2nd edition, 2006). Mastering CAD/CAM (SIE), TMH
4. Zeid, Ibrahim and Sivasubramanian, R. (2nd edition 2009). CAD/CAM: THEORY & PRACTICE. TMH
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