DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW

EVALUATION SCHEME & SYLLABUS

FOR

B. TECH. THIRD YEAR
(Agriculture Engineering)

AS PER
AICTE MODEL CURRICULUM

[Effective from the Session: 2020-21]

THIRD YEAR EVALUATION SCHEME

(AGRICULTURE ENGINEERING)

(Effective from the Session: 2020-21)

SEMESTER- V													
Sl. No.	**Subject Codes**	**Subject**	**Periods**			**Evaluation Scheme**				**End Semester**		**Total**	**Credit**
			L	**T**	**P**	**CT**	**TA**	**Total**	**PS**	**TE**	**PE**		
1	KAG-501	EPAP, Post Harvest Engg. of horticultural, Medicinal and Aromatic Plants	3	1	0	30	20	50		100		150	4
2	KAG-502	Farm Machinery and Equipment	3	1	0	30	20	50		100		150	4
3	KAG-503	Thermodynamics, Refrigeration and Air Conditioning	3	1	0	30	20	50		100		150	4
4	KAG 050-054	Departmental Elective-I	3	0	0	30	20	50		100		150	3
5	KAG 055-059	Departmental Elective-II	3	0	0	30	20	50		100		150	3
6	KAG-551	EPAP, Post Harvest Engg. of horticultural, Medicinal and Aromatic Plants Lab	0	0	2				25		25	50	1
7	KAG-552	Farm Machinery and Equipment Lab	0	0	2				25		25	50	1
8	KAG-553	Thermodynamics, Refrigeration and Air Conditioning Lab	0	0	2				25		25	50	1
9	Mini Project or Internship Assessment*		0	0	2				50			50	1
10	NC Constitution of India / Essence of IndianTraditional Knowledge		2	0	0	15	10	25		50			
11		MOOCs (Essential for Hons. Degree)											
		Total	**17**	**3**	**8**							**950**	**22**

***The Mini Project or internship (4 weeks) conducted during summer break after IV semester and will be assessed during V semester.

ANNEXURE - I

(KAG 050- KAG 054) Departmental Elective- I

KAG 050 Precision Farming Techniques for Protected cultivation
KAG 051 Water Harvesting & Soil and Water Conservation Structures
KAG 052 Human Engineering and Safety
KAG 053 Seed Process Engineering
KAG 054 Developments of Process Products

(KAG 055- KAG 059) Departmental Elective- II

KAG 055 Drying and Storage Engineering
KAG 056 Field Operation and Maintenance of Tractor & Farm Machinery
KAG 057 Renewable Energy Sources
KAG 058 Landscape Irrigation Design and Management
KAG 059 Food Quality & Control

Subject Code	KAG-501					
Category	Departmental Course					
Subject Name	**EPAP, POST HARVEST ENGG OF HORTICULTURAL, MEDICINAL AND AROMATIC PLANTS**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3-1-0	100	30	20	150	4
Pre-requisites (if any)	Basic knowledge of heat flow process, drying and Aromatic plants.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to:		
CO 1	Understand the various engineering properties like physical, thermal, frictional, aerodynamic, rheological and electrical properties of agricultural produce.	K_2
CO 2	Understand the Rheological properties and importance of these properties in handling processing machines and storage structures.	K_2 & K_4
CO 3	Know the different unit operations in processing of major horticultural crops of the country and state.	K_4
CO 4	Know the different means of storage and value addition of fruits and vegetables along with the cold chain.	K_2
CO 5	Remember and understand the history, scope, opportunities, importance, origin, area, production, climatic and Soil requirements, Propagation and nursery techniques, planting, nutritional and water requirements. Harvesting, processing and economics of medicinal and aromatic plants.	K_4& K_2

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1

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.

Module 2

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

Module 3:

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.

Module 4

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.

Module 5:

History, scope, opportunities and constraints in the cultivation and utilization of medicinal And aromatic plants in India. Importance, origin, distribution, area, production, climatic and Soil requirements, Propagation and nursery techniques, planting and aftercare, training and pruning, nutritional and water requirements. Harvesting, processing and economics of under mentioned important medicinal and aromatic plants. Medicinal Plants: Pepper, Cardamom, Clove, Ginger, Turmeric, Betelvine, Periwinkle, Rauvolfia, Dioscorea, Isabgol, Ammimajus, belladonna, Cinchona, pyrethrum and other species relevant to local conditions. Study of chemical composition of a few important medicinal and aromatic plants, their extraction and use. Therapeutic and pharmaceutical uses of important species.

[KAG-551] EPAP, POST HARVEST ENGINEERING OF HORTICULTURAL, MEDICINAL AND AROMATIC PLANTS LAB (0-0-2)

1. Performance evaluation of peeler and slicer.
2. Performance evaluation of juicer and pulper.
3. Performance evaluation of blanching equipment,
4. Testing adequacy of blanching, Study of cold storage and its design,
5. Study of CAP and MAP storage, Minimal processing of vegetables.
6. Preparation of value added products.
7. Visit to fruit and vegetable processing industry, Visit to spice processing plant.
8. Study of characteristics of different medicinal and aromatic plant & Identification of their economic part.
9. Harvesting drying, grading, storage and packaging of medicinal and aromatic plant.
10. Study on preparation of plant materials for extraction and value added products from medicinal and aromatic plants.

LAB OUTCOMES:

By the end of the course the students should be able to-

- Use the different types of sorting, grading, peeling, slicing, blanching and other equipment for processing of fruits and vegetables
- Identify the suitable equipment, materials and methods for storage, processing, packaging and value addition of fruits and vegetables
- Understand the technical and management aspects of operation of fruits and vegetable processing industries.

Suggested Reading:

- Arthey, D. and Ashurst, P. R. 1966. Fruit Processing. Chapman and Hall, New York.
- Pantastico, E.C.B. 1975. Post harvest physiology, handling and utilization of tropical and subtropical fruits and vegetables AVI Pub. Co., New Delhi.
- Pandey, R.H. 1997. Post harvest Technology of fruits and vegetables (Principles and practices). Saroj Prakashan, Allahabad
- Sudheer, K P. and India, V. 2007. Post Harvest Engineering of horticultural crops. New India Publishing House.

Subject Code	KAG-502					
Category	Departmental Course					
Subject Name	**FARM MACHINERY AND EQUIPMENT**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3-1-0	100	30	20	150	4
Pre-requisites (if any)	Basic knowledge of Engg. Mechanics, Soil and Agricultural tools.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to		
CO 1	Familiar with farm mechanization, and able to identify the major functional components and forces acting on various tillage implements. Hitching systems,	K_1& K_2
CO 2	Machinery used for various tillage operations and analyze the measurement of draft and power requirement of tillage machineries.	K_2 & K_4
CO 3	Understand and evaluate the Calibration of seed-drills and planters. Familiar with plant protection equipments. Evaluate the calibration of sprayers.	K_2 &K_4
CO 4	Familiar with inter-culture equipments and understand the harvesting and threshing operation with various implements used for these operations.	K_2
CO 5	Familiar with combines, cotton harvester, and chaff-cutter.	K_2

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1:
Introduction to farm mechanization. Classification of farm machines. Introduction to materials used in construction of farm machines. Heat treatment processes and their requirement in farm machines. Selection of farm machinery and cost estimation. Unit operation in crop production. Hitching systems and controls of farm machinery. Introduction to seed-bed preparation. Familiarization with land reclamation and earth moving equipment.

Module 2:
Machinery used for primary tillage, secondary tillage, rotary tillage, deep tillage, minimum tillage and conservation tillage. Draft measurement of tillage equipment, Methods of Ploughing. Identification and major functional components of mould-board plough, disc plough, chisel plough, sub-soiler, harrows, cultivators, Forces acting on tillage implements. Cost of operation of farm machinery.

Module 3:
Introduction to sowing, planting & transplanting equipment. Study of working of seed drills, no-till drills, happy seeder and strip-till drills. Brief description and working of planters. Study of types of furrow openers and metering systems in drills and planters. Calibration of seed-drills/ planters. Adjustments during operation. Introduction to plant protection equipment – sprayers and dusters. Classification of sprayers. Types of nozzles. Calculations for calibration of sprayers and chemical application rates.

Module 4:
Introduction to inter-culture equipments. Weeder – manual and powered, main components and their functional requirement. Study of harvesting operation – methods and terminology. Study of Reapers, Mowers and windrowers – types, working and adjustments. Importance and 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, factors affecting thresher performance.

Module 5:
Study of grain combines (Wheat and Paddy), combine terminology, Computation of combine losses, study of combine troubleshooting. Chaff cutters and capacity calculations. Study of Root crop diggers –potato and groundnut. Cotton harvesting mechanisms, study of cotton pickers and strippers. Introduction to vegetables and fruit harvesting equipment and tools.

[KAG-552] FARM MACHINERY AND EQUIPMENT LAB (0-0-2)

1. Introduction to various farm machines.
2. Field capacity and field efficiency measurement for at least two machines/implements.
3. Draft& fuel consumption measurement for different implements under different soil conditions.
4. Construction details, adjustments and working of M.B. plow, disc plow and disc harrow and secondary tillage tools.
5. Construction and working of rotavators and other rotary tillers, measurement of speed & working width.
6. Working of seed-cum-fertilizer drills, planters and their calibration in field.
7. Construction and Working of rice and crop transplanters for potato, sugarcane, cotton etc., and their field operation patterns.
8. Weeding equipment and their use.
9. Study of sprayers and dusters, measurement of nozzle discharge, field capacity etc.
10. Familiarization with various Farm machines related to harvesting, threshing, root harvesting, combine etc.

LAB OUTCOMES:
By the end of the course the students will be able to-
- Know the different components of the farm machines.
- Materials of construction
- Adjustments of different components to enhance performance.

Suggested Reading:

- Bosoi, E.S. (1990). Theory, Construction and Calculation of Agricultural Machines (Vol. 1 and 2). Oxonion Press Pvt. Ltd., New Delhi.
- Donnel Hunt. Farm Machinery and management. Iowa State University Press, Ames, USA.
- Ghosh, P.K, and Swain, S. (1993). Practical Agricultural Engineering. Naya Prokash, Calcutta.
- Kelnin, N.I.,Popov, I.F., and Sakun, V.A. (1985). Agricultural Machines. Amerind Publishers, New Delhi.
- Srivastava, A.C. (1990). Elements of Farm Machinery. Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
- Kepner, R.A., Bainer Roy, and Barges, E.C. (1978). Principals of Farm Machinery, CBS Publishers and Distributors, Delhi - 17.
- Kurtz,G.L., Thompson and Claer, P. (1984). Design of Agricultural Machinery. John Wiley & Sons, New York.
- Michael, A. M. and Ojha, T.P. (1985). Principles of Agricultural Engineering. (Vol. II). Jain brothers, New Delhi.
- Smith Harris Pearson, H.E., and Lambent Herry Wilkes, M.S. (1977). Farm Machinery and Equipment. Tata Mc Graw - Hill Publishing Company Ltd., New Delhi.
- Kanafoshi, C.Z. and Karwawshi, T. (1976). Agricultural Machines, Theory and Construction (Vol. 1 & 2). USDA, Poland.

Subject Code	KAG-503					
Category	Departmental Course					
Subject Name	**THERMODYNAMICS, REFRIGERATION AND AIR CONDITIONING**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3—1—0	100	30	20	150	4
Pre-requisites (if any)	Basic knowledge of mathematics and physics of secondary level.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to		
CO 1	Understand the principles of conduction, convection, radiation.	K_2
CO 2	Understand the principle of various refrigeration cycles.	K_2
CO 3	Understand the refrigeration, refrigerant properties and analyze the design of refrigeration system.	K_2 & K_4
CO 4	Understand the principle of psychometric processes and air conditioning.	K_1 & K_2
CO 5	Analyze the principle and operation of cold storage plant.	K_2 & K_4

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1:
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 process. Carnot cycle, Carnot theorem.

Module 2:
Entropy, physical concept of entropy, change of entropy of gases in thermodynamics process. Otto, diesel and dual cycles. Principles of refrigeration, - units, terminology, and air refrigerators working on reverse Carnot cycle and Bell Coleman cycle, open air refrigeration cycle, merit demerit of air refrigeration. Vapour refrigeration-mechanism, P-V, P-S, P-H diagrams, vapour compression cycles, dry and wet compression, super cooling and sub cooling.

Module 3:
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.

Module 4:
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,

Module 5:
Food preservation, Domestic refrigerators, commercial refrigerators, method of Food freezing. Study of cold storage for fruits and vegetable, freezing load and time calculations for food materials, study of window air conditioners repair and maintenance of refrigeration and air conditioning systems and chilling or ice making and cold storage plants.

[KAG-553] THERMODYNAMICS, REFRIGERATION AND AIR CONDITIONING LAB (0-0-2)

1. Study of vapour compression and vapour absorption systems
2. Solving problems on refrigeration on vapour absorption system
3. Experiments with the refrigeration tutor to study various components of refrigeration
4. Determination of the coefficient of performance of the refrigeration tutor
5. Experiment on humidifier for the determination of humidifying efficiency
6. Experiment on dehumidifier for the determination of dehumidifying efficiency
7. Experiment on the cooling efficiency of a domestic refrigerator
8. Experiments on working details of a cold storage plant and air conditioning unit
9. Experiments with air conditioning tutor to study various components
10. Determination of the coefficient of performance of air conditioning tutor.

LAB OUTCOMES:

By the end of the course the students should be able to-

- Determine refrigeration effect, energy input & COP etc. of refrigeration test rig for preservation of vegetables and storage of cold water.
- Determine cooling load, energy input & COP of air-conditioning test rig.
- Principle and operation of cold storage plant.

Suggested Reading:

- Kothandaraman, C. P., Khajunia; P.R and Arora, SC, 1992. A course in thermodynamics and heat engines. Dhanpat Rai and sons 1982 Nai Sarak New Delhi.
- Khurmi R S. 1992. Engineering Thermodynamics. S Chand and Co. Ltd., Ram Nagar, New Delhi.
- Mathur M L and Mehta F S. 1992. Thermodynamics and Heat Power Engineering. Dhanpat Rai and Sons 1682 Nai Sarak, New Delhi.
- Nag P K. 1995. Engineering Thermodynamics. Tata McGraw Hill Publishing Co. Ltd., 12/4 Asaf Ali Raod, New Delhi.

DEPARTMENTAL ELECTIVE - I

Subject Code	KAG-050					
Category	Departmental Elective- I					
Subject Name	**PRECISION FARMING TECHNIQUES FOR PROTECTED CULTIVATION**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3-0-0	100	30	20	150	3
Pre-requisites (if any)	Basic knowledge of plant protection and irrigation methods.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to-		
CO 1	Understand the importance of protected cultivation in precision farming.	K_2
CO 2	Familiar with design and construction of green houses and cooling systems.	K_2 & K_4
CO 3	Familiar with Greenhouse heating and Irrigation in greenhouse and net house.	K_2
CO 4	Assess different root media, micro-irrigation, fertigation, planting techniques in green house cultivation.	K_4 & K_2
CO 5	Understand Hydroponics, Crop management, pest management and economic aspects of a green house.	K_2

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1

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.

Module 2

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.

Module 3:

Greenhouse heating – necessity, components, methods, design of heating system. Root media –types – soil and soil less media, composition, estimation, preparation and disinfection, bed preparation. Planting techniques in green house cultivation. Irrigation in greenhouse and net house – Water quality, types of irrigation system, components, design, installation and material requirement.

Module 4

Fogging system for greenhouses and net houses –introduction, benefits, design, installation and material requirement. Maintenance of irrigation and fogging systems. Fertilization – nutrient deficiency symptoms

and functions of essential nutrient elements, principles of selection of proper application of fertilizers, fertilizer scheduling, rate of application of fertilizers, methods, automated fertilizer application.

Module 5:

Greenhouse climate measurement, control and management. Insect and disease management in greenhouse and net houses Selection of crops for greenhouse cultivation, major crops in greenhouse – irrigation requirement, fertilizer management, cultivation, harvesting and post harvest techniques; Economic analysis.

Suggested Reading

- Singh Brahma and Balraj Singh. 2014. Advances in protected cultivation, New India Publishing Company.
- Sharma P. 2007. Precision Farming. Daya Publishing House New Delhi.
- Ghosh Arupratan, Green house Technology, the future concept of Horticulture , Kalyani Publishers, Ludhiana.
- Tiwari G.N., Green house Technology for Controlled Environment, Narosa Pub. House Pvt. Ltd., New Delhi.

Subject Code	KAG-051					
Category	Departmental Elective- I					
Subject Name	**WATER HARVESTING & SOIL AND WATER CONSERVATION STRUCTURES**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3-0-0	100	30	20	150	3
Pre-requisites (if any)	Basic knowledge of fluid mechanics, Engineering hydrology concepts.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to-		
CO 1	Familiar with principles, importance, types and techniques of water harvesting.	K_1 & K_2
CO 2	Understand the components, investigation for farm pond site selection, and analyze design criteria, capacity of farm pond	K_2 & K_4
CO 3	Understand the theory behind flow through soil conservation structures and use specific energy and momentum concepts to analyze flow problems.	K_2 & K_3
CO 4	Design permanent soil and water conservation structures like drop spillway.	K_4
CO 5	Analyze the design and familiar with general description, components of chute spillway and drop inlet spillway.	K_1 & K_4

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1:
Water harvesting -principles, importance and issues. Types of water harvesting: Rainwater Harvesting- roof tops, Micro-catchment water harvesting, Macro-catchment water harvesting, Runoff harvesting, – short-term and long-term techniques. Short-term harvesting techniques - Contour Bunds, Semicircular Hoop Trapezoidal Bunds, Graded Bunds, Rock Catchment and Ground Catchment, flood water harvesting- Permeable Rock Dams (for Crops), Water Spreading Bunds (for Crops and Rangeland), Flood Control Reservoir. Groundwater Harvesting- Qanat System.

Module 2:
Long-term harvesting techniques, purpose, Farm ponds: dug-out and embankment, reservoir types, tanks, earthen embankments and subsurface dykes. Farm pond components, site selection, design criteria, capacity, and control of evaporation from reservoirs.

Module 3:
Classification of conservation structures, functional requirements of soil erosion control structures; flow in open channels-types of flow, state of flow, regimes of flow, energy and momentum principles, specific energy and specific force, hydraulic jump and its application, type of hydraulic jump, energy dissipation due to jump, jump efficiency, relative loss of energy.

Module 4:
Straight drop spillway- general description, functional use, advantages and disadvantages, structural parts and functions; Box-type inlet spillways - description, functional use, advantages and disadvantages, straight apron and stilling basin outlet, structural components and functions.

Module 5:
Chute spillway- general description and its components, hydraulic design, energy dissipaters, design criteria of a SAF stilling basin and its limitations, Drop-inlet spillway-general description, functional use, design criteria. Seepage under the structure, equivalent fluid pressure, triangular load diagram for various flow conditions, creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension.

Suggested Reading:

- Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
- Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
- Schwab, G.O., D.D. Fangmeier, W.J. Elliot, R.K. Frevert. 1993. Soil and Water Conservation Engineering.4th Edition, John Wiley and Sons Inc. New York.
- Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.
- OP Gupta, Element of Land/Soil Pollution, Khana Publishing House.
- Samra, J.S., V.N. Sharda and A.K. Sikka. 2002. Water Harvesting and Recycling: Indian Experiences. CSWCR&TI, Dehradun, Allied Printers, Dehradun.
- Theib Y. Oweis, Dieter Prinz and Ahmed Y. Hachum. 2012. Rainwater Harvesting for Agriculture in the Dry Areas. CRC Press, Taylor and Francis Group, London.
- Studer Rima Mekdaschi and Hanspeter Liniger. 2013. Water Harvesting - Guidelines to Good Practice. Centre for Development and Environment, University of Bern, Switzerland.

Subject Code	KAG-052					
Category	Departmental Elective- I					
Subject Name	**HUMAN ENGINEERING AND SAFETY**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3-0-0	100	30	20	150	3
Pre-requisites (if any)	Basic knowledge of ergonomics and environmental science.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to-		
CO 1	Understand the importance of Human Factors / Human Engineering.	K_2
CO 2	Understand the objective, application and its benefit for Farm Machine Design.	K_2 & K_4
CO 3	Understand physiological parameters involved in Human Engineering.	K_2
CO 4	Implement the safety aspects in farm operations.	K_2 & K_3
CO 5	Familiar with tractor as a spring-mass system and understand operational safety, tractor testing and engine test codes.	K_1 & K_2

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1
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 displays

Module 2
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.

Module 3:
Anthropometry: arrangement and utilization of work space, atmospheric conditions, thermo-regulation in human, thermal comfort, environmental factors, air pollution.

Module 4
Dangerous machine (regulation) act, rehabilitation and compensation to accident victims, safety gadgets for spraying, threshing, chaff cutting and tractor & trailer operation etc.

Module 5:
Familiarization with tractor as a spring-mass system. Ergonomic considerations operational safety. Introduction to tractor testing. Deciphering the engine test codes.

Suggested Reading

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

- Dul J. and Weerdmeester B. 1993. Ergonomics for Beginner. A Quick Reference Guide. Taylor and Francis, London.
- Mathews J. and Knight A.A. 1971. Ergonomics in Agricultural Equipment Design. National Institute of Agricultural Engineering.
- Astrand P. and Rodhal K. 1977. Textbook of Work Physiology. Mc Hill Corporation, New York.
- Mark S. Sanders and Ernest James McCormick. 1993. Human Factors in Engineering and Design. Mc Hill Corporation, New York.
- Keegan J J, Radke AO. 1964. Designing Vehicle seats for greater comfort. SAE Journal; 72: 50-5.
- Yadav R. Tewari V.K., 1998. Tractor operator workspace design ‐ a review. Journal of Terra mechanics 35: 41-53.

Subject Code	KAG-053					
Category	Departmental Elective- I					
Subject Name	**SEED PROCESS ENGINEERING**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3-0-0	100	30	20	150	3
Pre-requisites (if any)	Basic knowledge of unit operations, drying and storage concepts.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to-		
CO 1	Understand about seed processing and its importance and machines used for seed processing operations.	K_1 & K_2
CO 2	Understand and analyze seed driers, cleaners, graders and separators.	K_2
CO 3	Understand about seed treatment, precautions regarding the seed treatment, Seed packaging, stitching, bag closing machines, automatic weighing machines and tagging etc.	K_2
CO 4	Illustrate the design and principle of seed storage structures.	K_4
CO 5	Understand about seed conveyors, objectives and concepts of seed certification and analyze the design and construction of seed plant layout.	K_2 & K_4

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1:
Seed processing and its importance, principles of seed processing, seed industry and seed acts; Development of seed industry in India, Preparing seed for processing; Seed conditioning machines. Debearder machines, Hand and power operated shelling machines; Seed cleaning, grading and separating machines& their design.

Module 2:
Seed drying, natural and mechanical, dryers for seeds. Types & operation and maintenance of seed dryers; Seed cleaning; different type of air-screen cleaning/ separating machines, Seed grading; different types of seed graders such as length and breadth separators, disc separators, Indented cylinder separator, gravity

separator; De-stoner; Air classifier Magnetic separators, colour separators and operation, care & maintenance of cleaners and graders.

Module 3:
Seed treatment; types of treatment, methods and related equipments such as liquid treaters, slurry treaters, dust and fumigants, precautions regarding the seed treatment and ISI recommendations; Seed packaging, stitching and bag closing machines, automatic weighing machines and tagging etc.

Module 4:
Seed storage; principles of seed storage, storage structures; Dehumidifiers to control temp, RH and moisture, changes in seed quality during storage. CAP storage of hermetically sealed storages; Grain bins and silos, drying-cum-storage bins and their design.

Module 5:
Seed conveyors; bucket elevators, belt conveyors, screw conveyors, trucks Wagons; Repair and maintenance of different types of conveying devices; Seed plant layout design and construction. Objectives and concepts of seed certification; seed certification agencies, minimum seed certification standards for breeder's seed, certified seeds, field and seed inspection, methods of inspection, Post harvest inspection seed legislation loess.

Suggested Reading:

- Multon,J.L. (1989). Preservation and Storage of Grains, Seeds and their By-Products: Cereals, oil Seeds, Pulses and Animal Feed. CBS Publishing and Distributions, Delhi.
- Vijaya Raghavan, S. (1994). Grain Storage Engineering & Technology. Batra Book Service, New Delhi.
- Chakravarty,A . (1995). Post Harvest technology of Cereals, Pulses and Oil Seeds. Oxford and IBH Pub.Co.Calcutta.
- Majumdar, A.S . (2000). Drying Technology in Agriculture & Food Science. Oxford and IBH Publishing House.
- Agrawal, R.L. "Seed Technology". Oxford & IBH Publication, *Co.* Pvt Ltd, New Delhi-1994.
- Gregg, B.R., Law, A.G. Virdi, S.S. and Balis.J.S. "Seed Processing", National seed corpn. New Delhi, 1990.
- Douglas, J.E. "Seed Certification Mannual" National seeds corpn. New Delhi, 1970.
- Saxena, R.P. "Beej Sansadhan (Hindi). Directorate, Translation and Publication", G.B.Pant University Pantnagar, 1984.
- Douglas. J.E. "Seed Production Mannual". National Seeds Corporation and Rockfeller Foundation. New Delhi, 1969.

Subject Code	KAG-054					
Category	Departmental Elective- I					
Subject Name	**DEVELOPMENT OF PROCESSED PRODUCTS**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3-0-0	100	30	20	150	3
Pre-requisites (if any)	Basic knowledge of unit operations, storage techniques and engineering properties of food materials.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to-		
CO 1	Understand unit operations and equipment used for different food processing operations with technology for value added products from cereal pulses and oil seeds.	K_2 & K_4
CO 2	Analyze the technology for value added products from fruits, vegetables and spices.	K_4
CO 3	Understand technology for animal produce processing.	K_2
CO 4	Familiarized with shelf life of food material.	K_2
CO 5	Understand objective, principles of food plant layout and salient features of processing plants for cereals, pulses, oil seeds, horticulture and vegetable crops, poultry, fish and meat products, milk and milk products.	K_2 & K_4

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1

Process design process flow chart with mass and energy balance, unit operations and equipments for processing, process of new product development, technology for value added products form cereal pulses and oil seeds, milled, puffed, flaked, roasted and malted products, value addition of millets, bakery products, and snack food.

Module 2

Extruded products, technology for value added products from fruits, vegetables and spices, value addition of forest produce as mahua and tamarind, canned foods, frozen foods, dried and fried foods, fruit juices, sauce, sugar based confectionery, candy, fermented food product, spice extracts,

Module 3

Technology for animal produce processing, meat, poultry, fish, egg products, health food, nutraceuticals and functional food, organic food.

Module 4

Factor affecting shelf life of food material during the storage, Interactions, of spoilage agents with Environmental factors as water. Oxygen light Ph etc.

Module 5

Objectives and principles of food plant layout. Salient features of processing plants for cereals, pulses, oil seeds, horticulture and vegetable crops, poultry, fish and meat products, milk and milk products.

Suggested Reading:

- Geankoplis C. J. Transport processes and unit operations, Prentice-Hall.
- Rao, D. G. Fundamentals of Food Engineering PHI Learning Pvt. Ltd, New Delhi.
- Norman N. Potter and Joseph H. Hotchkiss. Food Science. Chapman and Hall Pub.
- Acharya, K T. Everyday Indian Processed foods. National Book Trust.
- Mudambi Sumati R., Shalini M. Rao and M V Rajgopal. Food Science. New Age International Publishers.
- Negi H.P.S., Savita Sharma, K. S. Sekhon. Hand book of Cereal Technology. Kalyani Pub.

DEPARTMENTAL ELECTIVE – II

Subject Code	KAG-055					
Category	Departmental Elective- II					
Subject Name	**DRYING AND STORAGE ENGINEERING**					
Scheme and Credits	L-T-P	Theory Marks	Sessional		Total	Credit
			Test	Assig/Att.		
	3-0-0	100	30	20	150	3
Pre-requisites (if any)	Basic knowledge of Refrigeration & Air Conditioning and Heat & Mass Transfer Concepts.					

COURSE OUTCOMES		
	Course Outcome (CO)	Bloom's Knowledge Level
At the end of this course, the student will be able to-		
CO 1	Apply the knowledge of drying and dehydration in food industries	K_3
CO 2	Analyze the different drying and dehydration models for various food commodity	K_2 & K_4
CO 3	Compute the drying and dehydration behavior for different food commodity	K_5
CO 4	Select the appropriate dryer for selected food commodity	K_2 & K_3
CO 5	Analyze the economic aspects of storage and understand storage condition for various fruits and vegetables under cold and CAP storage system.	K_4 & K_5

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1:
Moisture content and methods for determination, importance of EMC and methods of its determination, EMC curve and EMC model, principle of drying, theory of diffusion, mechanism of drying- falling rate, constant rate, thin layer, deep bed and their analysis, critical moisture content, drying models.

Module 2:
Calculation of drying air temperature and air flow rate, air pressure within the grain bed, Shred's and Hukill's curve, different methods of drying including puff drying, foam mat drying, freeze drying, etc. Study of different types of dryers- performance, energy utilization pattern and efficiency, study of drying and dehydration of agricultural products.

Module 3:
Types and causes of spoilage in storage, conditions for storage of perishable products, functional requirements of storage, control of temperature and relative humidities inside storage, calculation of refrigeration load; modified atmospheric storage and control of its Environment, air movement inside the storage,

Module 4:
Storage of grains: destructive agents, respiration of grains, moisture and temperature changes in stored grains; conditioning of environment inside storage through natural ventilation, mechanical ventilation, artificial drying, traditional, improved and modern grain storage structures, warehouse - design and control of environment.

Module 5:

Storage of cereal grains and their products, storage of seeds, hermetically sealed and air cooled storages-refrigerated, controlled atmosphere, modified atmospheric and frozen storages. Storage condition for various fruits and vegetables under cold and CAP storage system. Economic, aspects of storage.

Suggested Reading:

- Earle, R.L. (1985). Unit Operations in Food Processing. Pergamon Press, Oxford.U.K.
- Handerson, S.M and Perry, R.L. (1955). Agrl. Process Engg. John,Willey & Sons, New York.
- Majumdar, A.S . (2000). Drying Technology in Agriculture & Food Science. Oxford and IBH Publishing House.
- Multon, J.L. (1989). Preservation and Storage of Grains, Seeds and their By - Products: Cereals, oil Seeds, Pulses and Animal Feed. CBS Publishing and Distributions, Delhi.
- Pande, P.H. (1994). Principles of Agricultural Processing - A Text Book. Kalyani Publishers, Ludhiyana.
- Sahay, K.M and Singh, K.K. (1994). Unit Operation of Agrl. Processing. Vikas Publishing House Pvt Ltd, New Delhi.
- Vijaya Raghavan, S. (1994). Grain Storage Engg.& Technology. Batra Book Service, New Delhi.

Subject Code	KAG-056					
Category	Departmental Elective- II					
Subject Name	**FIELD OPERATION AND MAINTENANCE OF TRACTOR & FARM MACHINERY**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3-0-0	100	30	20	150	3
Pre-requisites (if any)	Basic concepts of Farm machinery and Farm Power.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to-		
CO 1	Familiarization with different makes and models of tractors. And Identify the different tractor systems including fuel system, cooling system, transmission system, steering and hydraulic systems.	K_2 & K_3
CO 2	Familiarize with controls on a tractor, safety rules and precautions to be observed while driving a tractor. Also understand the field patterns while operating tillage implement.	K_2 & K_3
CO 3	Understand hitching & de-hitching to the tractor and Introduction to trouble shooting in tractors.	K_2
CO 4	Familiarization with tools for maintenance, fuel saving tips. Care and maintenance procedure of agricultural machinery during operation and off-season. Repair and maintenance of implements – adjustment of functional parameters in tillage implements.	K_2 & K_3
CO 5	Replacement of broken components in tillage implements, Maintenance of cutter bar in a reaper. Adjustments in a thresher for different crops. Setting of agricultural machinery workshop.	K_2 & K_3

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1:
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.

Module 2:
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.

Module 3:
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.

Module 4:
Familiarization with tools for general and special maintenance. Introduction to scheduled maintenance after 10, 100, 300, 600, 900 and 1200 hours of operation. Safety hints. Top end overhauling. Fuel saving tips. Preparing the tractor for storage. Care and maintenance procedure of agricultural machinery during operation and off-season. Repair and maintenance of implements – adjustment of functional parameters in tillage implements.

Module 5:
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.

Suggested Reading:

- Ghosh R. K. and S. Swan. Practical Agricultural Engineering.
- Black P. O. and W.E. Scahill. Diesel Engine Manual.
- Southorn N. Tractor operation and maintenance.
- Jain S.C. and C.R. Rai. Farm Tractor Maintenance and Repair. Operators' manuals of tractors. Service manuals provided by manufacturers.
- Roy Bainer, Kepner R.A. and Berger, E.L. "Principles of Farm Machinery", John Wiley and Sons, 3rd Ed., 1978.
- Smith. H.P. and Pearson, "Farm Machinery and Equipment", Tata McGraw Hill Pub. Co. Ltd.,1964.
- Nakra, C.P. "Farm Machines and Equipment".
- Lal, Radhey and Dutta, A.C. "Agricultural Engineering through solved examples".
- Gill William, R. and Glen.E. Vandenberg, "Soil Dynamics in Tillage and Traction Agricultural Handbook", Vo1.316, Agricultural Research Service, USDA, 1993.

Subject Code	KAG-057					
Category	Departmental Elective-II					
Subject Name	**RENEWABLE ENERGY SOURCES**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3-0-0	100	30	20	150	3
Pre-requisites (if any)	Basic knowledge of Physics.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to-		
CO 1	Identify the non conventional resources and understand solar cell material, array, power plant and its limitations.	K_2 & K_3
CO 2	Understand about solar thermal energy, collectors and analyze solar thermal power plant for power generation, energy storage for heating and cooling purposes.	K_2, K_3 & K_4
CO 3	Understand about Geothermal Energy, Principle of working of MHD Power plant and Fuel Cells.	K_2 & K_4
CO 4	Familiar with Wind energy and energy conversion system.	K_2 & K_3
CO 5	Understand Bio-mass and familiar with OTEC and Waste Recycling Plants.	K_4 & K_5

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1:
Introduction: Various non-conventional energy resources- Introduction, availability, classification, relative merits and demerits. Solar Cells: Theory of solar cells. Solar cell materials, solar cell array, solar cell power plant, limitations.

Module 2:
Solar Thermal Energy: Solar radiation, flat plate collectors and their materials, applications and performance, focusing of collectors and their materials, applications and performance; solar thermal power plants, thermal energy storage for solar heating and cooling, limitations.

Module 3:
Geothermal Energy: Resources of geothermal energy, thermodynamics of geothermal energy conversion-electrical conversion, non-electrical conversion, environmental considerations. Magneto-hydrodynamics (MHD): Principle of working of MHD Power plant, performance and limitations. Fuel Cells: Principle of working of various types of fuel cells and their working, performance and limitations.

Module 4:
Thermo-electrical and thermionic Conversions: Principle of working, performance and limitations. Wind Energy: Wind power and its sources, site selection, criterion, momentum theory, classification of rotors, concentrations and augments, wind characteristics. Performance and limitations of energy conversion systems.

Module 5:
Bio-mass: Availability of bio-mass and its conversion theory. Ocean Thermal Energy Conversion (OTEC): Availability, theory and working principle, performance and limitations. Wave and Tidal Wave: Principle of working, performance and limitations. Waste Recycling Plants.

Suggested Reading:

- Raja etal, "Introduction to Non-Conventional Energy Resources" Scitech Publications.
- John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006.
- M.V.R. Koteswara Rao, "Energy Resources: Conventional & Non-Conventional" BSP Publications,2006.
- D.S. Chauhan,"Non-conventional Energy Resources" New Age International.
- C.S. Solanki, "Renewal Energy Technologies: A Practical Guide for Beginners" PHI Learning.
- Peter Auer, "Advances in Energy System and Technology". Vol. 1 & II Edited by Academic Press.
- Godfrey Boyle," Renewable Energy Power For A Sustainable Future", Oxford University Press.

Subject Code	KAG-058					
Category	Departmental Elective-II					
Subject Name	**LANDSCAPE IRRIGATION DESIGN AND MANAGEMENT**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3-0-0	100	30	20	150	3
Pre-requisites (if any)	Basic knowledge of engineering hydrology and irrigation & drainage engineering concepts.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to-		
CO 1	Understand about conventional method of landscape irrigation.	K_2
CO 2	Understand about different landscapes and methods of landscape irrigation.	K_2
CO 3	Understand about the components of modern landscape irrigation systems.	K_2
CO 4	Analyze and design automation system for landscape irrigation.	K_4
CO 5	Understand land management and cultural practices on watershed hydrology and analyze people's participation in watershed management programmes.	K_2 & K_4

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1:
Conventional method of landscape irrigation- hose irrigation system, quick release coupling system and portable sprinkler with hose pipes;

Module 2:
Types of landscapes and suitability of different irrigation methods, water requirement for different landscapes, Modern methods of landscape irrigation- pop-up sprinklers, spray pop-up sprinkler, shrub adopter, drip irrigation and bubblers;

Module 3:
Main components of modern landscape irrigation systems and their selection criteria; type of pipes, pressure rating, sizing and selection criteria. Merits and demerits of conventional and modern irrigation systems,

Module 4:
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.

Module 5:
Land management and cultural practices on watershed hydrology; evaluation and monitoring of watershed programmes; people's participation in watershed management programmes.

Suggested Reading:

- Dhruva, Narayana,V.V., Sastri,G. and Patnaik,U.S. (1990). Watershed Management. ICAR, New Delhi. ICAR. Soil and Water Conservation Research in India.
- Singh, G.,Venkataraman,C.,Sastri,C.,Joshi,B.P. (1985). Manual of Soil Water conservation practices. Oxford IBM Publishing Co Pvt.Ltd. New Delhi.
- Singh, R.V. (2000). Watershed Planning and Management. Yash Publishing House, Bikaner.

Subject Code	KAG-059					
Category	Departmental Elective-II					
Subject Name	**FOOD QUALITY & CONTROL**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3-0-0	100	30	20	150	3
Pre-requisites (if any)	Basic knowledge of engineering properties of food materials concepts.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to-		
CO 1	Understand aim of food quality, causes of food spoilage and factors that affect food quality.	K_2
CO 2	Identity the quality parameters of food and determine the quality of foods by Instrumental Methods.	K_2 & K_4
CO 3	Determine the quality of foods by Physical Methods and understand the Sensory attributes.	K_4 & K_2
CO 4	Analyze the Statistical quality control, Sensory evaluation methods, Food adulteration and food safety.	K_4
CO 5	Understand the National and International food laws and regulations	K_2

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1:
Importance of food quality, Causes of food borne diseases, Indicators of quality in different foods, Specifications for cereals, pulses, oils seeds, fruits and vegetables, Factors affecting food quality- Pre Harvest factors, Animal Production, Environmental factors, Storage, Transport and Trade Conditions, Post harvest handling, Processing, Storage conditions: Humidity, Temperature, Transportation.

Module 2:
Quality parameters- texture, Colour, Flavour. Determination of quality of foods- Instrumental Methods: Measuring texture, Viscometers, Percent Sag. Measurement of colour- Spectrophotometer, Taste measurement- E-Tongue. Flavour measurement- Electronic nose.

Module 3:
Physical methods- Weight, Volume, Specific volume, Index to volume, Specific gravity, Drying, Karl Fischer Titration, Wettability, Cell structure, Non destructive methods of texture measurement- Colour Dictionaries, Coloured chips. Analytical instruments for chemical analysis, Physico-chemical methods, Microscopic examination. Sensory attributes.

Module 4:
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.

Module 5:
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.

Suggested Reading:

- Devendra kumar Bhat and Priyanka Tomar - An Introduction to food science technology and quality management (pp 327-392) , New Delhi, Kalyani Publishers.
- Production practices and quality assessment of food crops, Vol.3 Quality handling and Evaluation. Ed. Ramadane Dris and Mohan Jain. Kuwer Academic Publishers.
- S. Akharamk. Patil S. K. Patil & Associates and Kenneth Yahl .Microscopy—A Powerful Tool for Food Scientists, technology transfer column Cereal foods world.
- Douglas B.MacDougall, colour in food; improving quality, pp 80
- Meilgaard, M., G. V. Civille and B. T. Carr (2007). Sensory Evaluation Techniques, 4th Ed. New Boca Raton, FL: CRC Press, 6: 72 – 79.
- B.M. Watts limaki, L.E. Jeffery, L.G. Elias, (1989) Basic sensory methods for food evaluation
- Ranganna S. Hand book of Analysis and Quality Control for Fruit and Vegetable Products. Srilakshmi B, Food Science.
- Sharma Avanthi. A text book of Food Science and Technology.
- Mudambi Sumati R, Rao Shalini M and Rajagopal M.V. Food Science. Potter NN and Hotchkiss JH, Food Science.
- Dev Raj, Rakesh Sharma and Joshi V.K, Quality for Value Addition in Food Processing. The Food Safety and Standards Act along with Rules & Regulations. Commercial Law Publishers (India) Pvt. Ltd.
- Ooraikul, B and Stiles, M.E. (1992). Modified atmosphere Packaging of Food. Ellis Horwood Publication, New York.

THIRD YEAR EVALUATION SCHEME

(AGRICULTURE ENGINEERING)
(Effective from the Session: 2020-21)

SEMESTER- VI													
Sl. No.	**Subject Codes**	**Subject**	**Periods**			**Evaluation Scheme**				**End Semester**		**Total**	**Credit**
			L	**T**	**P**	**CT**	**TA**	**Total**	**PS**	**TE**	**PE**		
1	KAG-601	Irrigation & Drainage Engineering	3	1	0	30	20	50		100		150	4
2	KAG-602	Farm Power, Tractor & Engine	3	1	0	30	20	50		100		150	4
3	KAG-603	Post Harvest Engineering of Cereals, Pulses & Oil Seeds	3	1	0	30	20	50		100		150	4
4	KAG 060-064	Departmental Elective-III	3	0	0	30	20	50		100		150	3
5		Open Elective-I	3	0	0	30	20	50		100		150	3
6	KAG-651	Irrigation & Drainage Engineering Lab	0	0	2				25		25	50	1
7	KAG-652	Farm Power, Tractor & Engine Lab	0	0	2				25		25	50	1
8	KAG-653	Post Harvest Engineering of Cereals, Pulses & Oil Seeds Lab	0	0	2				25		25	50	1
10	NC Constitution of India / Essence of IndianTraditional Knowledge		2	0	0	15	10	25		50			
11		MOOCs (Essential for Hons. Degree)											
		Total	**17**	**3**	**6**							**900**	**21**

ANNEXURE – II

	(KAG 060- KAG 064) Departmental Elective- III	**Open Elective –I**
KAG 060	Hydraulic drives and control	1
KAG 061	Mechanics of Tillage and Traction	2
KAG 062	Remote Sensing and GIS	3
KAG 063	Dairy and Food Engineering	4
KAG 064	Building Materials and Agriculture structures	5

SEMESTER- VI

Subject Code	KAG-601					
Category	Departmental Course					
Subject Name	**IRRIGATION & DRAINAGE ENGINEERING**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3—1—0	100	30	20	150	4
Pre-requisites (if any)	Basic knowledge of fluid mechanics, engineering hydrology and surveying & levelling.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to		
CO 1	Remember about the irrigation schemes and present status of water resources in india. Also understand the various methods for the measurement of irrigation water.	K_1& K_2
CO 2	Analyze the design of open channel water conveyance system, underground pipe conveyance system & control and distribution of on-farm structures for water conveyance.	K_4
CO 3	Solve the real world problem of land grading and understand the soil-water-plant relationship.	K_2& K_4
CO 4	Apply the concept of ET to determine the water requirement of crops. Also able to remember the adaptability, merits, demerits, specification and analyze the design considerations of border, check basin, furrow irrigation, drip and sprinkler irrigation methods	K_1, K_3& K_4
CO 5	Analyze agricultural land drainage problems and suggest scientific remedial measures for them.	K_3& K_4

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1:
Major and medium irrigation schemes of India, purpose of irrigation, environmental impact of irrigation projects, source of irrigation water, present status of development and utilization of different water resources of the country, canal command area development programmes, measurement of irrigation water: weir, flumes and orifices and other methods.

Module 2:
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.

Module 3:
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.

Module 4:
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, furrow irrigation, Drip and sprinkler Irrigation - adaptability, merit, demerit, specification and design considerations.

Module 5:
Sub-surface drainage purpose and benefits, investigations of design parameters, hydraulic conductivity, drainable porosity, water table etc., types of use of subsurface drainage system, steady and unsteady state methods for drain depth and spacing, installation and cost estimation, drainage of salt affected soils and leaching requirement inter-relation of irrigation and drainage.

[KAG- 651] IRRIGATION & DRAINAGE ENGINEERING LAB (0-0-2)

1. Measurement of infiltration rate by double ring infiltrometer.
2. Computation of evapotranspiration by Pan Evaporation method
3. Measurement of advance and recession in border irrigation and estimation of irrigation efficiency.
4. Measurement of uniformity coefficient of sprinkler irrigation method.
5. Measurement of uniformity coefficient of drip irrigation method.
6. Determination of drainage coefficients.
7. Measurement of soil moisture content by tensiometer.
8. Measurement of irrigation water by circular orifice.
9. Measurement of irrigation water by different weirs.
10. Measurement of irrigation water by parshall and cut throat flume.
11. Determination of chemical properties of soil and water.
12. Determination of gypsum requirement for land reclamation.

LAB OUTCOMES:
By the end of the course the students should be able to-
- Measure the soil moisture content by tensiometer.
- Measure discharge through weirs, flumes and orifices.
- To measure infiltration.
- Measurement of advance and recession in border and furrow irrigation, cut-off stream in furrow irrigation and irrigation efficiency etc.
- Measure the bulk density, field capacity and wilting point
- Evaluate the border, the furrow and the check basin irrigation methods.

Suggested Reading:

- Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing House New Delhi.
- Majumdar D. K. 2013. Irrigation Water Management Principles. PHI learning Private Limited New Delhi 2nd Edition.
- Allen R. G., L. S. Pereira, D. Raes, M. Smith. 1998. Crop Evapotranspiration guidelines for computing crop water requirement. Irrigation and drainage Paper 56, FAO of United Nations, Rome.
- Murthy VVN. 2013. Land and Water Management Engineering. Kalyani Publishers, New Delhi.
- Israelsen O W. and Hansen V. E and Stringham G. E. 1980. Irrigation Principles and Practice, John Wiley & Sons, Inc. USA.
- Bhattacharya AK and Michael AM. 2013. Land Drainage, Principles, Methods and Applications. Vikas Publication House, Noida (UP)
- Ritzema H.P.1994 Drainage Principles and Applications, ILRI Publication 16, Second Edition (Completely Revised)

- Michael AM. and Ojha TP. 2014. Principles of Agricultural Engineering Vol-II 5th Edition. Jain Brothers Publication, New Delhi
- Kadam U.S., Thokal R.T., Gorantiwar S.D. and Powar A.G. 2007. Agricultural Drainage- Principles and Practices, Westville Publishing House

Subject Code	KAG-602					
Category	Departmental Course					
Subject Name	**FARM POWER, TRACTOR & ENGINE**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3-1-0	100	30	20	150	4
Pre-requisites (if any)	Basic knowledge of physics, thermodynamics and tractor.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to		
CO 1	Identify the conventional & non-conventional energy sources for farm power. And understand thermodynamic principles of IC (CI & SI) engines and deviation from ideal cycle.	K_2 & K_4
CO 2	Understand the engine valve systems, air cleaner and fuel supply system in CI and SI engines. Familiar with fuel injection and engine governing systems.	K_2
CO 3	Understand the ignition, cooling electrical system of IC engines.	K_2& K_3
CO 4	Familiar with the basics of engine testing with reference to BIS code. Understand about tractors various systems, mechanism and power outlets.	K_2
CO 5	To illustrate traction, its mechanics, basic Ergonomics and basic knowledge of tractor system testing.	K_2& K_3

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1

Study of sources of farm power –conventional & non-conventional energy sources. Energy requirement for crop production. Energy equivalents for direct and indirect source of energy. IC engines. Review of thermodynamic principles of IC (CI & SI) engines and deviation from ideal cycle. 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.

Module 2

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 IC 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.

Module 3

Engine governing – need of governors, governor types and governor characteristics. Study of ignition system of SI and CI engines. Study of electrical system including battery, starting motor, battery charging, cut-out, etc. Comparison of dynamo and alternator. 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 lubrication system: need, types, functional components. Study of lubricants: physical properties, additives and their application. Familiarization with the basics of engine testing with reference to BIS code.

Module 4

Introduction about tractor: History Classification of tractors, Study of power transmission system: clutch, gear box, differential unit and final drive mechanism. Familiarization with Steering System: Ackerman and hydraulic steering, Brake mechanism, Hydraulic control system and Hitching. Tractor power outlets: PTO, belt, pulley, drawbar, etc.

Module 5

Traction, Weight Transfer and Ballasting, Tractor chassis mechanism, methods of centre of gravity determination and design for tractor stability. Ergonomic considerations and operational safety: seat, noise and vibration. Introduction of tractor testing: Steering, Drawbar and Brake.

[KAG-652] FARM POWER, TRACTOR & ENGINE LAB (0-0-2)

1. To study about working principle of biogas plant and solar power plant.
2. To study about various functional components of an IC engine and identification of its.
3. To study about thermodynamics cycle of an IC engine with PV and TS diagram.
4. To study of functional components of valve mechanism and valve timing diagram.
5. To study about working principle of an IC engine (two stroke and four stroke).
6. To study about types of materials used for manufacturing of engine components.
7. To study about air cleaning system in IC engine and types of air cleaners.
8. To study about fuel supply system and properties of fuels.
9. To study about Working principle of carburetor and its functional components.
10. To study about working principle of governing system of an IC engine.
11. To study about working principle of injector nozzle and their types.
12. To study about different lubrication system and properties of lubricants.
13. To study about different cooling system and thermostats valve, types of coolants.
14. To study about electrical system including battery, dynamo, and alternator of tractor.

LAB OUTCOMES:

By the end of the course the students will be able to-

- Identify different systems of internal combustion engines.
- To study the working principle, maintenance and adjustment of different engine systems

Suggested Reading:

- Tractors and their Power Units, John B. Lijiedahal, Paul K. Turnquist :CBS Publication
- Farm Tractor maintenance and repair, S.C.Jain; Standard Publishers Distributors.
- Frazeee, Irving and Philip, V.E. Tractors and Crawlers.

Subject Code	KAG-603					
Category	Departmental Course					
Subject Name	**POST HARVEST ENGINEERING OF CEREALS, PULSES & OIL SEEDS**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3-1-0	100	30	20	150	4
Pre-requisites (if any)	Basic knowledge of mathematics, physics of secondary level and engineering properties of biological materials.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to-		
CO 1	Know the different unit operations in processing of major cereals, pulses and oilseeds.	K_2
CO 2	Understand about various Size separators, Size reduction machinery and conveyors.	$K_{2,}$
CO 3	Apply the various unit operations in Legumes and Oilseeds Processing	K_2& K_3
CO 4	Apply the various unit operations in processing of Wheat.	K_2& K_3
CO 5	Apply the various unit operations in processing of Paddy and Corn.	K_2& K_3

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1:
Introduction to Food Grains: structure and chemical composition of cereals, pulses and oilseeds. Applications of unit operations and principles in cleaning and grading, aspiration, scalping, Drying: moisture and its removal, utilities, M.C. determination methods: direct and indirect methods, EMC: its importance, Determination methods, EMC models, Hysteresis effects, Psychrometric chart. Drying methods: Traditional &Mechanical drying, Thin layer Drying, Deep bed Drying, Drying rate periods. Principles and operation of different types of Dryers.

Module 2:
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), and 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, Pneumatic conveying.

Module 3:
Legumes Processing: Pretreatment of pulses for milling, Methods of milling of pulses, Factors affecting milling of pulses, Pulse based processed products. Oilseeds Processing for Oil Extraction: Preparation of oilseeds, Mechanical and Solvent extraction methods of oil extraction, Oil refining, hydrogenation, Utilization of de-oiled cake.

Module 4:
Processing of Wheat: Structure of wheat grain, Wheat milling- basic concepts, products and by-products, Flour milling, Turbo grinding and air-classification, Flour grades and their suitability for baking purposes.

Module 5:
Paddy milling: Milling of Paddy- basic concepts, traditional and modern methods of milling, Parboiling techniques. Corn milling: Dry and wet milling of corn, corn starch and its conversion products.

[KAG-653] POST HARVEST ENGINEERING OF CEREALS, PULSES & OIL SEEDS LAB (0-0-2)

1. Performance evaluation of different types of cleaners and separators.
2. Determination of separation efficiency,
3. Study of different size reduction machines and performance evaluation,
4. Determination of fineness modulus and uniformity index.
5. Study of different types of mixers.
6. Measurement of moisture content: dry basis and wet basis,
7. Study on drying characteristics of grains and determination of drying constant,
8. Determination of EMC (Static and dynamic method),
9. Type of process flow charts with examples relating to processing of cereals pulses and oil seeds,
10. Study of different types of conveying and elevating equipments.
11. Visit to grain processing industries.

LAB OUTCOMES:
By the end of the course the students should be able to-

- Determine the drying characteristics of different food grains with an understanding to control the drying process for retaining the quality of produce.
- Find out the fineness modulus and uniformity index of ground materials and separation effectiveness of different separators and graders
- Develop the skill of operating and monitoring the different grain processing machines.
- Prepare process charts for different grain processing operations.

Suggested Reading:

- Chakraverty, A. Post Harvest Technology of cereals, pulses and oilseeds. Oxford & IBH publishing Co. Ltd., New Delhi.
- Dash, S.K., Bebartta, J.P. and Kar, A. Rice Processing and Allied Operations. Kalyani Publishers, New Delhi.
- Sahay, K.M. and Singh, K.K. 1994. Unit operations of Agricultural Processing. Vikas Publishing house Pvt. Ltd. New Delhi.
- Geankoplis C. J. Transport processes and unit operations, Prentice Hall of India Pvt Ltd, New Delhi
- Earle, R.L. 2003. Unit Operations in Food Processing. Pergamon Press. Oxford. U.K.
- Henderson, S.M., and Perry, R. L. Agricultural Process Engineering, Chapman and hall, London
- McCabe, W.L., Smith J.C. and Harriott, P. Unit operations of Chemical Engineering. McGraw Hill.
- Singh, R. Paul. and Heldman, R.Dennis. 2004. Introduction to Food Engineering. 3rd Edition. Academic Press, London.
- Corn: Chemistry and Technology by Watson SA & Ramstad PE., AACC
- Manuals on Rice and its processing by CFTRI Mysore and IIT Kharagpur.
- Cereal Technology by Potter NN. AVI Publication.
- Bakery Science & Cereal Technology by NeelamKhatarpaul, Rajbala Grewal &SudeshJood (Daya publishing house).

DEPARTMENTAL ELECTIVE – III

Subject Code	KAG-060					
Category	Departmental Elective-III					
Subject Name	**HYDRAULIC DRIVES AND CONTROL**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3-0-0	100	30	20	150	3
Pre-requisites (if any)	Basic concepts of fluid mechanics and tractor systems.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to-		
CO 1	Understand the basic principles of hydraulic power system.	K_2
CO 2	Analyze and design the components of Hydraulic system.	K_4
CO 3	Familiar with applications and maintenance of Hydraulic system.	K_2
CO 4	Illustrate Troubleshooting of Valves Hydraulic Circuit.	K_2 & K_3
CO 5	Understand the Application of pneumatic and hydraulic power in other agricultural machines.	K_2

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1:
Hydraulic Basics: Pascal's Law, Flow, Energy, Work, and Power. Hydraulic Systems, Color Coding, Reservoirs, Strainers and Filters, Filtering Material and Elements.

Module 2:
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.

Module 3:
Hydraulic Actuators, Cylinders, Construction and Applications, Maintenance, Hydraulic Motors. Valves, Pressure-Control Valves, Directional- Control Valves, Flow-Control Valves, Valve.

Module 4:
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.

Module 5:
Pneumatics: Air services, logic units, Fail safe and safety systems Robotics: Application of Hydraulics and Pneumatics drives in agricultural systems, Programmable Logic Controls (PLCs).

Suggested Reading:

- Anthony Esposito. Fluid Power with applications. Pearson Education.

- Blackburn, J.F., G. Reethof and J.L. Shearer. Fluid Power Control. New York, Technology Press of M.I.T. and Wiley.
- 3Blaine W. Andersen. The analysis and design of pneumatic systems. John Wiley and Sons, Inc.
- Ernst, W. Oil Hydraulic Power and its Industrial applications. New York: Mc Graw Hill.
- Fitch, Jr., E.C. Fluid Power Control Systems. Mc Graw Hill, New York.

Subject Code	KAG-061					
Category	Departmental Elective- III					
Subject Name	**MECHANICS OF TILLAGE AND TRACTION**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3-0-0	100	30	20	150	3
Pre-requisites (if any)	Basic knowledge of mechanics, soil mechanics and farm machinery.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to-		
CO 1	Know mechanics of tillage tools and various engineering properties of soil.	K_2
CO 2	Analyze the design of tillage tools, principles of soil cutting and Measurement of draft.	K_2, K_3 & K_4
CO 3	Understand and analyze the mechanics of traction.	K_2 & K_4
CO 4	Know the geometry of different traction devices such as tyres and tracks also analyze the use of GIS in soil dynamics.	K_2 & K_4
CO 5	Analyze the weight transfer and tractor loading including placement and traction aids.	K_4

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1:
Introduction to mechanics of tillage tools, methods of soil testing, engineering properties of soil, principles and concepts, stress strain relationship. Measurement of static and dynamic soil parameter and soil compaction and plant growth.

Module 2:
Design of tillage tools, principles of soil cutting, design equation, force acting on tillage tools such as MB plough & cultivator, application of dimensional analysis in soil dynamics of tillage tools. Measurement of draft of various tillage tools like passive and oscillatory.

Module 3:
Introduction to traction and mechanics, off road traction and mobility, traction model, traction improvement, traction prediction.

Module 4:
Tyre size, tyre lug geometry and their effects, tyre testing Variability and geo statistic, application of GIS in soil dynamics.

Module 5:
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.

Suggested Reading

- Jones, F.R. Farm Gas Engines and Tractors
- Barger, E.L.; Lijedehl, J.B; Carleton, W.B. and Mc Kibben, E.G. Tractors and their Power Units.
- Moses and Frost. Farm Power.
- Smith HP and LH Wilkey. Farm Machinery and Equipment.
- Culpin Claude. Farm Machinery.
- Gill and Vandenberg.1968. Soil Dyanamics in Tillage and Traction. Agricultural Research Service, USDA, Govt. Printing Press, Washington, D.C.
- Macmillan, R.H.2002. The Mechanics of Tractor-Implement Performance. International Development Technologies Centre, University of Melbourne.
- Terzaghi, K and P. Ralph B. 1967. Soil Mechanics in Engineering Practices. John Willey & Sons.

Subject Code	KAG-062					
Category	Departmental Elective-III					
Subject Name	**REMOTE SENSING AND GIS APPLICATIONS**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3-0-0	100	30	20	150	3
Pre-requisites (if any)	Basic knowledge of physics, Computer, Surveying & levelling and Soil & water conservation concepts.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to-		
CO 1	Familiar with remote sensing and GIS software.	K_2
CO 2	Familiar with Spectral reflectance curve and different types of sensors and platforms.	K_2
CO 3	Understand and analyze aerial photography and preparation of maps for local planning.	K_2 & K_4
CO 4	Analyze digital image processing, scanning and digitization of maps.	K_3 & K_4
CO 5	Understand the components of GIS and data management.	K_2

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1:
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.

Module 2:
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.

Module 3:
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.

Module 4:
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.

Module 5:
GIS and basic components, different sources of spatial data, basic spatial entities, major components of spatial data, Basic classes of map projections and their properties, Methods of data input into GIS, Data editing, spatial data models and structures, Attribute data management, integrating data (map overlay) in GIS, Application of remote sensing and GIS for the management of land and water resources.

Suggested Reading:

- Reddy Anji, M. 2006. Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad.
- Elangovan, K. 2006. GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi.
- George Joseph. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad.
- Jensen, J.R. 2013. Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education Limited, UK.
- Lillesand, T., R.W. Kiefer and J. Chipman. 2015. Remote Sensing and Image Interpretation. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.

Subject Code	KAG-063					
Category	Departmental Elective-III					
Subject Name	**DAIRY AND FOOD ENGINEERING**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3-0-0	100	30	20	150	3
Pre-requisites (if any)	Basic knowledge of Refrigeration & Air Conditioning and Heat & Mass transfer concepts.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to-		
CO 1	Know dairy development and understand various properties of milk, Preparation methods of various dairy products.	K_2
CO 2	Understand the Principles of operation and equipment for dairy products and analyze dairy Plant design.	K_2,& K_3
CO 3	Understand the importance of drying of liquid and perishable foods and their preservation.	K_2
CO 4	Know about fundamental concepts of Nanotechnology in dairy technology.	K_2
CO 5	Understand about equipment and applications in filtration & separation process and analyze the estimation of steam requirements and refrigeration requirements in dairy & food plant.	K_2 & K_4

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1:
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 and their study. Preparation methods and equipment for manufacture of cheese, paneer, butter and ice cream, Filling and packaging of milk and milk products;

Module 2:
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.

Module 3:
Drying of liquid and perishable foods: principles of drying, spray drying, drum drying, freeze drying, Deterioration in food products and their controls, Physical, chemical and biological methods of food preservation.

Module 4:
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,

Module 5:

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. Study of Separator, butter, Churns, evaporators and milk driers, freezers and filtration, design of food processing plants and preparation of layout. Estimation of steam requirements and refrigeration requirements in dairy & food plant.

Suggested Reading:

- Brennan, J.G., Butters, J.R. Cowell, N.D. and Lilly, A.E.V. 1976. Food Engineering Operations Applied Science Publihers
- Farrall, A.W. 1967. Engineering for Dairy and Food Products Wiley Eastern Pvt. Ltd. New Delhi.
- Kessler, H.G. 1981. Food Engineering and Dairy Technology Verlag A. Kessler, Freising, F.R. Germany
- Ahmed, T. 1997. Dairy Plant Engineering and Management. 4th Ed. Kitab Mahal.
- McCabe, W.L. and Smith, J. C. 1999. Unit Operations of Chemical Engineering. McGraw Hill.
- Rao, D.G. Fundamentals of Food Engineering. PHI learning Pvt. Ltd. New Delhi.
- Singh, R.P. & Heldman, D.R. 1993. Introduction to Food Engineering. Academic Press.
- Toledo, R. T. 1997. Fundamentals of Food Process Engineering. CBS Publisher.

Subject Code	KAG-064					
Category	Departmental Elective-III					
Subject Name	**BUILDING MATERIALS AND AGRICULTURE STRUCTURES**					
Scheme and Credits	**L-T-P**	**Theory Marks**	**Sessional**		**Total**	**Credit**
			Test	**Assig/Att.**		
	3-0-0	100	30	20	150	3
Pre-requisites (if any)	Basic knowledge of Martial Science, Engineering Drawing and Surveying and Levelling concepts.					

COURSE OUTCOMES		
	Course Outcome (CO)	**Bloom's Knowledge Level**
At the end of this course, the student will be able to-		
CO 1	Understand the importance of various building materials for construction work and analyze design of roof trusses.	K_2
CO 2	Know about Bricks, Building components, Finishing, Types of agricultural buildings, and analyze construction economics of buildings.	K_2 & K_4
CO 3	Understand the importance of planning and layout of a farmstead.	K_2
CO 4	Know about various standards for various dairy, piggery, poultry and different farm storage structures, silos, compost pit, implement sheds, farm houses, threshing floors, farm roads, fencing,	K_2
CO 5	Understand Rural living and development, farm roads, sources of water supply, norms of water supply for human being and animals, Site and orientation of building in regard to sanitation, analyze the design of septic tank for small family.	K_2 & K_4

K_1- Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5-Evaulate, K_6- Create

DETAILED SYLLABUS

Module 1:
Properties and classification of conventional building materials, like bricks, lime, cement, sand, coarse aggregates etc. Classification of seasoning and preservation of timbers. Use of materials like plywood, asbestos, plastic and PVC, glass, aluminium etc. Buildings and sheds. Use of flyash and flyash products in construction and waterproofing materials for concrete. Design of roof trusses.

Module 2:
Bricks properties and varieties of Tiles. Glass, Rubber, Plastics, iron, Steel, Aluminium, Copper, Nickle. Timber. Building components: Lintels, Arches, stair cases, Different types of floors. Finishing: Damp Proofing and water proofing, Plastering, pointing, white washing and distempering –Painting, Types of agricultural buildings and related needs. Construction economics: Preliminary estimates, Factors affecting building costs; cost evaluation of design and planning,

Module 3:
Planning and layout of farmstead. 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.

Module 4:
B.I.S standard for dairy, poultry, piggery and other farm structures. Design, construction, building materials, methods of cost estimation and cost estimation of farm residence, farm structures; animal shelters, compost pits, fodder silos, fencing and implements sheds, barn for cows, buffalos, and poultry etc.

Module 5:
Rural living and development, rural roads, 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.

Suggested Reading:

- Punmia B.C. Ashok Kumar Jain and Arun Kumar Jain. Building Construction. Laxmi Publications (P) ltd., New Delhi.
- Duggal S K. Building material. New Age International Publishers.
- Sane Y.S. Planning and Designing of Buildings.
- Rangwala S C. 1994. Engineering Materials. Charotar Publishing House, Anand.
- Dutta B.N. 2000. Estimating and Costing. UBS publishers.
- Pandey, P.H. Principles and practices of Agricultural Structures and Environmental Control, Kalyani Publishers, Ludhiana.
- Ojha, T.P and Michael, A.M. Principles of Agricultural Engineering, Vol. I, Jain Brothers, Karol Bag, New Delhi.
- Nathonson, J.A. Basic Environmental Technology, Prentice Hall of India, New Delhi.
- Venugopal Rao, P. Text Book of Environmental Engineering, Prentice Hall of India, New Delhi.
- Garg, S.K. Water Supply Engineering, Khanna Publishers, New Delhi-6.
- Dutta, B.N. Estimating and Costing in Civil Engineering, Duttta & CO, Lucknow.