M.Tech. AGRICULTURAL ENGINEERING

(Applicable for batches admitted from 2025-2026)

COURSE STRUCTURE & SYLLABUS

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

R25 M. Tech Agricultural Engineering

I Semester

S. No.	Course Title	L	T	P	C
1	Soil Dynamics in Tillage and Traction	3	1	0	4
2	Design of Farm Machinery-I	3	1	0	4
3	Earth Moving Machines	3	1	0	4
4	Program Elective – I	3	0	0	3
5	Program Elective – II	3	0	0	3
6	Soil Dynamics in Tillage and Traction Lab	0	1	2	2
7	Farm Machinery Design Lab	0	1	2	2
8	Seminar-I	0	0	2	1
	TOTAL	**15**	**5**	**6**	**23**

List of Professional Elective Courses in I Semester (Electives – I & II)

S.No.	Course Title
1	Testing and Evaluation of Agricultural Equipment
2	Management of Farm Power and Machinery System
3	Computer Aided Design of Machinery
4	Applied Instrumentation in Farm Machinery
5	Systems Simulation and Computer Aided Problem Solving in Engineering
6	Experimental Designs (Statistics)
7	Machinery for Horticulture and Protected Agriculture
8	Principles of Automation and Control

@ Minimum 2/3 themes per elective

II Semester

S. No.	Course Title	L	T	P	C
1	Design of Tractor systems	3	1	0	4
2	Design of Farm Machinery-II	3	1	0	4
3	Ergonomics and Safety in Farm Operations	3	1	0	4
4	Program Elective – III	3	0	0	3
5	Program Elective - IV	3	0	0	3
6	Tractor systems Lab	0	1	2	2
7	Ergonomics and Safety in Farm Operations Lab	0	1	2	2
8	Seminar – II	0	0	2	1
	TOTAL	**15**	**5**	**6**	**23**

*During the summer break, students need to pursue Summer Internship/ Industrial Training, it will be evaluated in the III Sem.

List of Professional Elective Courses in II Semester (Electives III & IV)

S.No.	Course Title
1	Principles of Hydraulic and Pneumatic Systems
2	Machinery for Precision Agriculture
3	Engineering Properties of Biological Materials
4	Mechatronics and Robotics in Agriculture
5	Data Analysis Using Statistical Packages (Statistics)
6	Biomass Energy Conversion Technologies
7	Farm Machinery Dynamics, Noise and Vibration
8	Artificial Intelligence

@ Minimum 2/3 themes per elective

III Semester

S. No.	Course Title	L	T	P	C
1	Research Methodology and IPR / Swayam 12 week MOOC course – RM&IPR	3	0	0	3
2	Summer Internship/ Industrial Training (8-10 weeks)*	-	-	-	3
3	Comprehensive Viva#	-	-	-	2
4	Dissertation Part – A$	-	-	20	10
	TOTAL	**3**	**-**	**20**	**18**

* Student attended during summer / year break and assessment will be done in 3rd Sem.
# Comprehensive viva can be conducted courses completed upto second sem.
$ Dissertation – Part A, internal assessment

IV Semester

S. No.	Course Title	L	T	P	C
1	Dissertation Part – B%	-	-	32	16
	TOTAL	**-**	**-**	**32**	**16**

% External Assessment

I Semester	SOIL DYNAMICS IN TILLAGE AND TRACTION	L	T	P	C
		3	1	0	4

Pre-requisite: It is a basic understanding of soil science, soil mechanics, and farm machinery. Students should be familiar with soil physical properties, soil–water relations, strength of materials, and fundamentals of tillage implements to comprehend soil–tool interaction and traction dynamics effectively.

Course Objectives:

1. To impart knowledge on soil physical and mechanical properties influencing tillage and traction performance.
2. To develop understanding of soil–tool and soil–wheel interaction mechanisms.
3. To analyze draft, power, and energy requirements of tillage implements and tractors.
4. To apply principles of soil dynamics for efficient design and operation of tillage and traction systems.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Explain the state of stress at a point in soil and represent it using Mohr's Circle.	1
CO2	Apply Coulomb's law of friction and cohesion to analyze soil shear strength.	3
CO3	Demonstrate the working principles and applications of soil resistance measurement devices such as direct shear box, torsion shear, and tri-axial apparatus.	3
CO4	Analyze the effects of soil water pressure and movement on soil behavior under stress.	4
CO5	Evaluate soil stress–strain relationships and the role of shear rate in critical state soil mechanics.	5
CO6	Interpret experimental data on soil strength and resistance to assess soil behavior in tillage operations.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	L	M	--	--
CO2	H	H	M	M	L	--
CO3	H	M	M	H	M	--
CO4	H	H	M	H	M	--
CO5	H	H	M	H	M	L
CO6	H	H	M	H	M	L

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Characterization of state of stress in a point: Derivation, representation by Mohr's Circle. Coulomb's law of friction and cohesion. Measurement of soil resistance properties: Direct shear box, torsion shear apparatus, tri-axial apparatus. Soil behaviour considerations: Soil water pressure and movement. Critical state soil mechanics: Soil stress-strain behaviour, shear rate effects.	
UNIT – 2	Soil cutting forces: The universal earthmoving equation, two dimensional cases, smooth vertical blade, smooth and rough raked blades in cohesive soil, unconstrained tool to soil adhesion. The shape of failure surfaces. Hettiaratchi's calculations, effect of soil weight. Soil cutting force by method of trial wedges.	
UNIT – 3	Extension of theory to three dimension: Hettiaratchi, Reece-Godwin and Spoor. Three dimensional wedges: McKyes and Ali, Grisso models. Dynamic effect: Inertial forces, change in soil strength. Concept of critical depth.	
UNIT – 4	Complex tool shapes: Curved tools-shank and foot tools-mould board plough. Soil Loosening and manipulation: Measurement of soil loosening and its efficiency. Draft force efficiency: Loosening and pulverization efficiency. Soil mixing and inversion: Soil properties, tool shape, tool speed and tool spacing.	
UNIT – 5	Traction devices: Tyres, type, size, selection mechanics of traction devices. Maximum traction force: Soil deformation and slip, estimation of contact areas. Sinkage in soil: Rolling resistance, Bekker's formulae, McKyes formulae. Soil compaction by agricultural vehicles and machines.	
	Total	

*Note:

Text Books:

1. McKyes E 2016. Soil Cutting and Tillage: Vol 7. Developments in Agricultural Engineering Elsevier R Science Publisher SBV.
2. Koolen, A J and Kuipers H 1983. Agricultural Soil Mechanics. Springer-Verlag ISBN 13:978-3-642-69012-9.

Reference Books:

1. Gill W R and Van den Berg G E 1968. Soil Dynamics in Tillage and Traction.
2. Handbook 316, Agricultural Research Service, US Department of Agriculture, Washington DC, 1968
3. John B L, Paul K T, David W S and Makoto H 2012. Tractors and their Power Units. 4th Edition. Springer Science & Business Media, ISBN: 81-239-0501-7, ASAE ISBN: 0-929355-72-5.
4. McKYES E 1989, Agricultural Engineering Soil Mechanics, Elsevier science publishers B. V., P.O. Box 211, 1000 AE Amsterdam, the Netherlands.

I Semester	DESIGN OF FARM MACHINERY-I	L	T	P	C
		3	1	0	4

Pre-requisite: The student acquires fundamental knowledge of engineering mechanics, strength of materials, and theory of machines. Students should also be familiar with basic farm machinery, agricultural operations, and soil–tool interactions to effectively understand and apply design principles in developing efficient farm implements and mechanization systems.

Course Objectives:

1. To provide knowledge of principles and concepts involved in designing farm machinery and implements.
2. To develop the ability to analyze forces, stresses, and power requirements in agricultural equipment.
3. To impart skills for applying design standards, materials selection, and safety considerations in machinery design.
4. To enable students to design efficient, durable, and cost-effective farm implements for various agricultural operations.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Explain the fundamental principles and concepts of farm machinery design.	1
CO2	Apply engineering mechanics and strength of materials in analyzing forces and stresses on farm implements.	3
CO3	Analyze the draft, power requirements, and performance parameters of different agricultural implements.	4
CO4	Evaluate the suitability of design materials, components, and standards for farm machinery.	5
CO5	Design simple farm implements considering functionality, durability, and cost-effectiveness.	6
CO6	Demonstrate problem-solving and practical skills in developing efficient farm machinery systems for diverse field operations.	3,6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	L	--	--	--
CO2	H	H	M	M	M	--
CO3	H	H	M	H	M	--
CO4	H	M	H	H	M	L
CO5	H	H	H	H	M	L
CO6	H	H	H	H	H	L

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**

UNIT – 1	Farm machinery design: Modern trends, tasks and requirements, economic considerations of durability, reliability and rigidity. Physico-mechanical properties of soils. Technological process of ploughing. Wedge. Working process of mould board plough, determination of basic parameters.	
UNIT – 2	Design of coulters, shares, mould boards. Constructing of mould board working surface. Design of landside, frog, jointer. Forces acting on plough bottom and their effect on plough balance: Trailed, semi mounted and mounted plough.	
UNIT – 3	Draft on ploughs, resistance during ploughing. Design disk ploughs: Concave disk working tools, forces acting. Machines and implements for surface and inter row tillage: Peg toothed harrow, disk harrows, rotary hoes, graders, rollers, cultivators. Design of V shaped sweeps. Rigidity of working tools.	
UNIT – 4	Rotary machines: Trajectory of motion of rotary tiller tynes, forces acting, power requirement. Machines with working tools executing an oscillatory motion. Methods of sowing and planting: Machines, agronomic specifications. Sowing inter-tilled crop. Grain hoppers: Seed metering mechanism, furrow openers and seed tubes.	
UNIT – 5	Machines for fertilizer application: Discs type broadcasters. Organic fertilizer application: Properties of organic manure, spreading machines. Liquid fertilizer distributors. Planting and transplanting: Paddy transplanters, potato planters.	
	Total	

Text Books:

1. Bosoi, E S, Verniaev O V, Smirnov II and Sultan-Shakh E G 1990. Theory, Construction and Calculations of Agricultural Machinery - Vol. I. Oxonian Press Pvt. Ltd. No.56, Connaught Circle, New Delhi.
2. Gill R and Vanden Berg G E 2013. Soil Dynamics in Tillage and Traction. Scientific Publishers(India) ISBN-10: 8172338031

Reference Books:

1. Bernacki C, Haman J. and Kanafajski Cz.1972. Agricultural Machines Theory and Construction. Vol.I. U.S. Dept. of Commerce, National Technical Information Service, Springfield, Virginia 22151.
2. Yatsuk E P 198.1 Rotary Soil Working Machines Construction, Calculation and Design. American Publishing Co. Pvt. Ltd, New Delhi.

I Semester	EARTH MOVING MACHINES	L	T	P	C
		3	1	0	4

Pre-requisite: The student acquires fundamental knowledge of engineering mechanics, soil dynamics, hydraulics, and internal combustion engines. Understanding power transmission, material strength, and machine design is essential. Familiarity with safety standards, maintenance practices, and basic field operations also ensures effective learning, design, and safe handling of these machines.

Course Objectives:

1. To understand the principles, components, and working mechanisms of earth moving machines.
2. To study soil–machine interaction for efficient excavation, loading, and hauling.
3. To analyze power transmission, hydraulics, and operational performance of machines.
4. To ensure safe operation, maintenance, and productivity optimization in field conditions.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	**Explain** the criteria, methods, and inspection techniques used in land leveling, contour adjustment, and earthwork calculations.	1
CO2	**Describe and Compare** the types, construction, capacity, and working of bulldozers, scrapers, graders, shovels, draglines, trenching machines, and compactors.	1
CO3	**Select and Evaluate** suitable drilling equipment such as jack hammers, drifters, and wagon drills for specific site conditions.	3
CO4	**Identify and Demonstrate** safe practices in the handling, storage, and transportation of explosives, blasting caps, and stemming materials.	3
CO5	**Develop and Apply** project schedules using Critical Path Method (CPM) for effective job planning and management.	3, 6
CO6	**Implement** safety engineering measures to minimize risks and improve construction efficiency.	3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	M	M	L	L
CO2	H	M	M	M	M	L
CO3	H	H	M	H	M	M
CO4	M	M	--	--	--	H
CO5	M	M	H	--	M	M

CO6	M	M	M	M	L	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Land leveling: Criteria and methods; Plane profile and plan inspection; Contour adjustment, Earth work calculations;	
UNIT – 2	Types, construction, capacity and working of the following machines: Bulldozer; Scraper; Grader; Shovel; Dragline, calm shell, trenching machine and compactors,	
UNIT – 3	Drilling and blasting: Air operated drilling tools; Jack hammer; Drifter; Wagon drill selection of drilling equipment,	
UNIT – 4	Types of explosive & stemming, Blasting caps and storage; Transportation and handling of explosive; Job planning and management;	
UNIT – 5	Application of CPM; Safety engineering for construction	
	Total	

Text Books:

1. Michael, A.M. Irrigation: Theory and Practice. Vikas Publishing House Pvt. Ltd., New Delhi,1987.
2. Nichols, H.L. Moving the Earth, Second Edition, Golotia Publishing house, New Delhi-1,1962

Reference Books:

1. Peurifoy, R.L. Construction, Planning Equipment and Methods, Third Edition, McGrew Hill International Book Co., 1979

I Semester	TESTING AND EVALUATION OF AGRICULTURAL EQUIPMENT	L	T	P	C
		3	0	0	3

Pre-requisite: The student acquires knowledge about fundamentals in farm machinery, soil dynamics, and crop production practices**.** Students should possess basic knowledge of mechanics, material properties, and instrumentation to analyze machine performance. Familiarity with field operations and safety aspects is essential for effective learning.

Course Objectives:

1. To develop skills in assessing the performance, efficiency, and reliability of agricultural machinery under field and laboratory conditions.
2. To impart knowledge of standard testing procedures, safety regulations, and evaluation criteria.
3. To enable students to identify design limitations and suggest improvements for better adaptability.
4. To train students in accurate data collection, analysis, and report preparation for certification and recommendations.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	**Apply** engineering principles to evaluate the performance of agricultural machinery.	3
CO2	**Conduct** standardized field and laboratory tests on farm equipment	3
CO3	**Analyze** test data to assess efficiency, durability, and suitability of machines.	4
CO4	**Evaluate** operational limitations and **recommend** design or operational improvements.	5
CO5	**Create** professional evaluation reports for certification and practical applications.	6
CO6	**Demonstrate** awareness of safety, quality standards, and sustainability in equipment testing.	2

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	M	L	L	L
CO2	H	H	M	M	M	M
CO3	H	H	M	H	M	M
CO4	H	H	H	H	M	M
CO5	H	M	M	H	H	H
CO6	h	H	M	M	M	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Importance and significance of testing and types of testing. Test equipment, usage and limitations. Test procedures and various test codes: National and International.	
UNIT – 2	Laboratory and field testing of tillage and sowing machinery: Sub-soiler, laser land leveler, mould board Plough, disc plough, rotavator, cultivator, disc harrow, seed cum fertilizer drill and planter.	
UNIT – 3	Laboratory and field testing of manual and power operated intercultural machinery and plant protection machine.	
UNIT – 4	Laboratory and field testing of reaper, thresher and chaff cutter.	
UNIT – 5	Laboratory and field testing of straw combine and combine harvester. Review and interpretation of test reports. Importance and need of standardization of components of agricultural equipment.	
	Total	

Text Books:

1. Barger E L, Liljedahl J B and McKibben E C 1967. Tractors and their Power Units. Eastern Wiley 4th Edition.
2. Indian Standard Codes for Agricultural Implements. Published by BIS, New Delhi

Reference Books:

1. Inns F M 1986. Selection, Testing and Evaluation of Agricultural Machines and Equipment. FAO Service Bull. No.115.
2. Mehta M L, Verma S R, Rajan P and Singh S K 2019. Testing and Evaluation of Agricultural Machinery. Daya Publishing House, Delhi.
3. Nebraska Tractor Test Code for Testing Tractor, Nebraska, USA.
4. Smith D W, Sims B G and O'Neill D H 2001. Testing and Evaluation of Agricultural Machinery and Equipment -Principle and Practice. FAO Agricultural Services Bull. 110.

I Semester	MANAGEMENT OF FARM POWER AND MACHINERY SYSTEM	L	T	P	C
		3	0	0	3

Pre-requisite: The student acquires knowledge of internal combustion engines, tractor systems, and machinery working principles, along with familiarity in crop production practices and field operations to ensure effective learning and application.

Course Objectives:

1. To provide knowledge on effective utilization and management of farm power and machinery resources.
2. To develop skills in planning, selection, scheduling, and allocation of machinery for different farm operations.
3. To enable students to analyze machinery costs, efficiency, and economics for sustainable use.
4. To impart understanding of machinery maintenance, energy management, and safety practices in farm operations.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	**Explain** the role of different power sources and machinery systems in farm operations.	2
CO2	**Apply** principles of machinery management in planning and scheduling farm operations.	3
CO3	**Analyze** machinery performance, energy use, and cost effectiveness under varying conditions.	4
CO4	**Evaluate** alternative power and machinery options for sustainability and profitability.	5
CO5	**Develop** strategies for efficient utilization and maintenance of farm machinery systems.	6
CO6	**Demonstrate** awareness of safety, energy conservation, and environmental aspects in farm machinery management.	3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	L	L	M	L
CO2	H	H	M	M	M	L
CO3	H	H	M	H	H	M
CO4	H	H	M	H	M	M
CO5	H	H	H	H	H	M
CO6	M	M	L	M	M	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Importance and objectives of farm mechanization in Indian agriculture, its impact, strategies, myths and future needs. Estimation of operating cost of tractors and farm machinery. Management and performance of power, operator, labour.	
UNIT – 2	Economic performance of machinery, field capacity, field efficiency and factors affecting field efficiency. Tractor power performance in terms of PTO, drawbar and fuel consumption.	
UNIT – 3	Power requirement problems to PTO, DBHP. Selection of farm machinery, size selection, timeliness of operation, optimum width and problem related to its power selection. Reliability of agricultural machinery.	
UNIT – 4	Replacement of farm machinery and inventory control of spare parts. Systems approach to farm machinery management and application of programming techniques to farm machinery selection and scheduling.	
UNIT – 5	Network Analysis: Transportation, CPM and PERT, dynamic programming, Markov chain.	
	Total	

Text Books:

1. Hunt D 1979. Farm Power and Machinery Management. Iowa State University Press, USA
2. Kapoor V K 2012. Operation Research: Concepts, Problems and Solutions. Sultan Chand
and Sons, India.

Reference Books:

1. Culpin C 1996. Profitable Farm Mechanization. Lock Wood and Sons, London.
2. Singh, S and Verma, S R. Farm Machinery Maintenance and Management. DIPA, ICAR,
KAB-I, New Delhi.
3. Carveille, L A 1980. Selecting Farm Machinery. Louisiana Cooperative Extn. Services Publication.
4. FAO 1990. Agricultural Engineering in Development: Selection of Mechanization Inputs.
FAO, Agri service Bulletin.

I Semester	COMPUTER AIDED DESIGN OF MACHINERY	L	T	P	C
		3	0	0	3

Pre-requisite: It is a solid foundation in engineering graphics, engineering mechanics, and theory of machines**.** Students should be familiar with strength of materials, kinematics, and dynamics of machinery, along with basic knowledge of computer applications and CAD software tools to effectively design and analyze machine components.

Course Objectives:

1. To provide knowledge of CAD tools and techniques for designing and analyzing machine components.
2. To develop skills in applying engineering principles for virtual modeling and simulation of machinery systems.
3. To enable students to evaluate design alternatives using computer-aided methods for efficiency and reliability.
4. To impart competence in preparing accurate design documentation, assembly drawings, and reports using CAD software.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Explain the fundamentals of computer-aided design and its applications in machinery development.	2
CO2	Apply CAD software tools to create 2D drawings and 3D models of machine components.	3
CO3	Analyze stresses, deformations, and performance of machine elements using simulation techniques	4
CO4	Evaluate different design alternatives based on strength, reliability, and efficiency.	5
CO5	Develop optimized designs and assemblies of machinery systems using CAD tools.	6
CO6	Prepare professional design documentation, technical drawings, and reports for manufacturing and validation.	3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	M	L	M	L
CO2	H	M	H	M	H	L
CO3	H	H	H	H	H	L
CO4	H	H	H	H	M	M
CO5	H	H	H	H	H	M
CO6	M	M	H	M	M	L

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Learning 2D drafting: Controlling display settings, setting up units, drawing limits and dimension styles. Drawing and dimensioning simple 2D drawings, keyboard shortcuts. Working with blocks, block commands. Exercise in simple assembly in orthographic. Exercise in measuring and drawing simple farm machinery parts.	
UNIT – 2	Learning 3D Drafting: Advantages of virtual prototyping-starting the 3D drafting environment, self-learning tools, help and tutorials. Familiarizing with user interface, creating files and file organization, structuring and streamlining. Features of document window.	
UNIT – 3	Concept of coordinate system: Working coordinate system, model coordinate system, screen coordinate system, graphics exchange standards and database management system. Working with feature manager and customizing the environment. Planning and capturing design intent. Documentation of design. Using design journal and design binder. Preliminary design review and layout.	
UNIT – 4	Practice in drawing 2D sketches with sketcher and modifying sketch entries. Adding Reference geometry: Planes and axes. Adding relations and working with relations. Dimensioning a sketch. Exercises. Parts and features: Sketched features and applied features, pattern and mirror features. Documenting design. Assembly: Creating and organizing assemblies, connecting parts and subassemblies with mates. Organizing the assembly by using layouts.	
UNIT – 5	Exercise in creating drawing: Setting up and working with drawing formats, creating drawing views from the 3D model, making changes and modifying dimensions. Case studies: Measuring and drawing assemblies of farm implements and their components.	
	Total	

Text Books:

1. Jankowski G and Doyle R 2007. SolidWorks® For Dummies®, 2nd Edition, Published by Wiley Publishing, Inc. ISBN: 978-0-470-12978-4
2. Shih R H 2014. AutoCAD 2014 Tutorial-First Level: 2D Fundamentals. SDC Publications

Reference Books:

1. Zeid, I**.** – *CAD/CAM: Theory and Practice*, McGraw-Hill.
2. Groover, M.P. and Zimmers, E.W**.** – *CAD/CAM: Computer-Aided Design and Manufacturing*, Pearson.
3. Chandrupatla, T.R. and Belegundu, A.D**.** – *Introduction to Finite Elements in Engineering*, Pearson.
4. Reddy, J.N. – *An Introduction to the Finite Element Method*, McGraw-Hill.

I Semester	APPLIED INSTRUMENTATION IN FARM MACHINERY	L	T	P	C
		3	0	0	3

Pre-requisite: The student acquires the knowledge of basic electrical and electronic principles, sensors, and measurement systems. Students should understand the working of farm machinery and power units**,** along with basics of mechanics, fluid power, and data acquisition methods, to effectively learn instrumentation and its applications in agricultural machinery.

Course Objectives:

1. To provide knowledge of sensors, transducers, and data acquisition systems used in farm machinery applications.
2. To develop skills in measuring, monitoring, and analyzing performance parameters of agricultural equipment.
3. To enable students to integrate instrumentation systems for automation, control, and precision farming.
4. To impart competence in interpreting experimental data for improving efficiency, safety, and reliability of farm machinery.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Explain the principles and applications of sensors, transducers, and instrumentation systems in agriculture.	2
CO2	Identify suitable instruments for measuring speed, torque, fuel consumption, vibration, and other machinery parameters.	3
CO3	Operate data acquisition systems and software tools for recording and monitoring machinery performance	3
CO4	Analyze experimental data to evaluate efficiency, accuracy, and reliability of farm machinery.	4
CO5	Evaluate instrumentation-based solutions for automation, precision farming, and safety enhancement.	5
CO6	Design/Develop instrumentation setups for testing and improving performance of agricultural equipment.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	L	L	M	L
CO2	H	H	M	M	H	L
CO3	H	M	M	M	H	L
CO4	H	H	M	H	H	M
CO5	H	H	H	H	H	M
CO6	H	H	H	H	H	M

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Strain gauges, types and applications in two and three dimensional force measurement in farm machinery. Various methods of determining strain/stresses experimentally. Design, selection and analysis of strain gauges.	
UNIT – 2	Introduction to transducers (sensors). Active and passive transducers, analog and digital modes, null and deflection methods. Performance characteristics of instruments including static and dynamic characteristics.	
UNIT – 3	Load cells, torque meters, flow meters' types and principles of working. Devices for measurement of temperature, relative humidity, pressure, sound, vibration, displacement (LVDT) etc.	
UNIT – 4	Recording devices and their types. Measuring instruments for calorific value of solid, liquid, and gaseous fuels. Basic signal conditioning devices, data acquisition system.	
UNIT – 5	Micro computers for measurement and data acquisition. Data storage and their application including wireless communication. Application of sensors in farm machinery and power: Tractor and selected farm machinery.	
	Total	

Text Books:

1. Doeblin E O 2004. Measurement System- Application and Design. Tata McGrawHill
2. Nakra B C and Choudhary K K 1985. Instrumentation, Measurement and Analysis.2nd Edition Tata McGraw Hill.

Reference Books:

1. Nachtigal C L (Editor) 1990. Instrumentation and Control. Fundamentals and Application. Wiley Series in Mechanical Engineering
2. Ambrosius E E 1966. Mechanical Measurement and Instruments. The Ronald Press Company.
3. Oliver F J 1971. Practical Instrumentation Transducers. Hayden book company Inc

I Semester	SYSTEMS SIMULATION AND COMPUTER AIDED PROBLEM SOLVING IN ENGINEERING	L	T	P	C
		3	0	0	3

Pre-requisite: The student acquires the knowledge of basic of computer programming, algorithms, and modeling concepts, along with familiarity in mechanics and engineering systems**,** to effectively simulate and solve real-world engineering problems using computational tools.

Course Objectives:

1. To impart knowledge of mathematical modeling and simulation techniques for engineering systems.
2. To develop skills in applying numerical methods and computational tools for problem solving.
3. To enable students to analyze and simulate dynamic behavior of engineering processes.
4. To train students in using computer-aided techniques for optimization, decision-making, and performance evaluation of systems.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Explain the fundamentals of system modeling, simulation, and computer-aided problem solving.	2
CO2	Apply numerical methods and algorithms to solve engineering problems using computational tools.	3
CO3	Develop mathematical models to represent physical and engineering systems.	3
CO4	Analyze simulation results to study the dynamic behavior and performance of systems.	4
CO5	Evaluate different computational approaches for accuracy, stability, and efficiency in problem solving.	5
CO6	Design/Implement computer-aided simulation programs for optimization and decision-making in engineering applications.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	M	M	M	L
CO2	H	H	M	M	H	L
CO3	H	H	H	H	H	M
CO4	H	H	M	H	H	M
CO5	H	H	H	H	H	M
CO6	H	H	H	H	H	M

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Mathematical modeling and engineering problem solving: Conservation laws and engineering. Computers and software: Software development, structured programming, logical representation. Modular programming. Approximation: Round off errors, truncation errors, significant figures, accuracy and precision	
UNIT – 2	Nature of simulation: Systems models and simulation, discreet event simulation, time advance mechanisms, components of discrete event simulation model, simulation of single server queuing system.	
UNIT – 3	Program organization and logic, development of algorithm. Simulation of an inventory system. Solving roots of equation using computers. Application in: Ideal and non-ideal gas laws, open channel flows, design of an electric circuit, vibration analysis.	
UNIT – 4	Solving linear algebraic equation on computers: Naïve Gauss Elimination, techniques for improving solutions, LU decomposition and matrix inversion. Application in: Steady state analysis of chemical reactors, statically determinate truss, current and voltage in circuits, spring mass systems	
UNIT – 5	Optimization techniques. Search techniques: Golden Sections, quadratic interpolation. Application: Optimum design of tank, least cost treatment of waste water, power transfer for circuits. Solving ordinary differential equation on computers: Modeling engineering systems with ordinary differential equation, solution techniques using computers.	
	Total	

Text Books:

1. Chapra S C and Canale R P 1994. Introduction to Computing for Engineers. 2nd Edition McGraw Hill International Edition, New York.
2. Law A M 2015. Simulation Modeling and Analysis. McGraw Hill International Edition, New York.

Reference Books:

1. Dent J B and Blackie M J 1979. System Simulation in Agriculture. Applied Science Publishers Ltd., London.
2. Schilling R J and Harries S L 2002. Applied Numerical Methods for Engineers Using MATLAB and C.Thomson Asia Pvt .Ltd. Singapore.
3. Balagurusamy E 2000. Numerical Methods.Tata McGraw Hill Publishing Company limited, New Delhi.
4. Veerarajan T and Ramachnadran T 2004. Numerical Methods with Programmes in C and C++. Tata McGraw Hill Publishing company limited, New Delhi

I Semester	EXPERIMENTAL DESIGNS	L	T	P	C
		3	0	0	3

Pre-requisite: Students should be familiar with data collection methods**,** measures of central tendency, dispersion, and hypothesis testing**.** Knowledge of agricultural experiments, field trials, and research methodology will help in effectively applying statistical designs for planning and analyzing experiments.

Course Objectives:

1. To impart knowledge of principles and concepts of statistical designs for agricultural and engineering experiments.
2. To develop skills in planning, conducting, and analyzing experiments with accuracy and reliability.
3. To enable students to select appropriate experimental designs for different research problems.
4. To train students in interpreting results and drawing valid scientific conclusions for decision-making.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	To train students in interpreting results and drawing valid scientific conclusions for decision-making.	2
3CO2	Identify suitable statistical tools and designs for different types of experiments.	3
CO3	Plan and conduct field and laboratory experiments using proper design techniques	3
CO4	Analyze experimental data using statistical methods to test hypotheses.	4
CO5	Evaluate the efficiency and validity of various experimental designs in real-world research.	5
CO6	Prepare scientific reports and make valid recommendations based on experimental findings.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	M	M	M	L
CO2	H	H	M	M	H	L
CO3	H	H	H	H	H	M
CO4	H	H	M	H	H	M
CO5	H	H	H	H	H	M
CO6	M	M	H	M	M	L

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control.	
UNIT – 2	Uniformity trials, size and shape of plots and blocks, Analysis of variance, Completely randomized design, randomized block design and Latin square design.	
UNIT – 3	Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom. Concept of confounding.	
UNIT – 4	Split plot and strip plot designs, analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, Balanced Incomplete Block Design, resolvable designs and their applications,	
UNIT – 5	Lattice design, alpha design - concepts, randomization procedure, analysis and interpretation of results. Response surfaces. Combined analysis.	
	Total	

Text Books:

1. Cochran WG and Cox GM. 1957. Experimental Designs. 2 nd Ed. John Wiley.
2. Dean AM and Voss D. 1999. Design and Analysis of Experiments. Springer.

Reference Books:

1. Montgomery DC. 2012. Design and Analysis of Experiments, 8 th Ed. John Wiley.
2. Federer WT. 1985. Experimental Designs. MacMillan.
3. Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.
4. Nigam AK and Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.

I Semester	MACHINERY FOR HORTICULTURE AND PROTECTED AGRICULTURE	L	T	P	C
		3	0	0	3

Pre-requisite: Students should have prior knowledge of horticultural operations, greenhouse structures, and irrigation methods**,** along with basics of farm power and machinery systems**,** to effectively learn about specialized equipment for horticulture and protected cultivation.

Course Objectives:

1. To provide knowledge of different machines and tools used in horticultural operations and protected cultivation.
2. To develop skills in selection, operation, and maintenance of machinery suited for horticulture and greenhouse farming.
3. To enable students to analyze performance, efficiency, and adaptability of specialized equipment for various crops.
4. To impart understanding of mechanization strategies for improving productivity, labor efficiency, and sustainability in horticulture and protected agriculture.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Explain the types, functions, and importance of machinery used in horticulture and protected farming	2
3CO2	Identify suitable machines and tools for different horticultural and greenhouse operations.	3
CO3	Operate and demonstrate the use of horticultural and protected agriculture machinery safely and effectively.	3
CO4	Analyze the performance, efficiency, and adaptability of specialized equipment for various crops.	4
CO5	Evaluate mechanization strategies for enhancing productivity, labor efficiency, and sustainability.	5
CO6	Design/Recommend appropriate machinery systems for horticulture and protected agriculture under different farming conditions.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	M	M	M	L
CO2	H	H	M	M	H	L
CO3	H	M	H	M	H	M
CO4	H	H	M	H	H	M
CO5	H	H	H	H	H	M
CO6	H	H	H	H	H	M

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Vegetable cultivation, nursery machinery, tray seeders, grafting machines, vegetable trans-planters. Machinery for planting crops on raised beds, mulch laying and planting machines. Harvesting of vegetable crops: Harvesting platforms and pickers.	
UNIT – 2	Machinery for orchard crops: Pit diggers, inter-cultivators and basin forming equipment for orchards. Machinery for transplanting of trees. Harvesters for fruit crops: Shaker harvesters, types and principle of operation. Elevated platforms for orchard management and harvesting. Pruning machines.	
UNIT – 3	Machinery for orchards, vineyard machinery spraying machines, inter-cultivation machines. High clearance machines and special purpose machinery for crops on trellis. Machinery for special crops: Tea leaf harvesters, pruners and secateurs.	
UNIT – 4	Machinery for lawn and garden: Grass cutters, special machinery for turf maintenance. Turf aerators and lime applicators.	
UNIT – 5	Protected agriculture: Principles, mechanical systems of greenhouse, ventilation systems, shading system, water fogging system, irrigation system, sensors, electrical and electronic system. Intelligent Control system for greenhouses. Machinery for processing of growth media, tray filling machines-tray sowing machines, transplanting machines. Robotic grafting machines. Weeding and thinning equipment. Crop protection and harvest under protected agriculture.	
	Total	

Text Books:

1. Good Agricultural Practices for Greenhouse Vegetable Production in the South East European countries FAO Rome 2017
2. Bell B and Cousins S 1997. Machinery for Horticulture. Old Pond Publishing Ltd ISBN-10: 0852363699, ISBN-13: 978-0852363690

Reference Books:

1. Ponce P, Molina A, Cepeda P, Lugo E and MacCleery B 2014. Greenhouse Design and Control. CRC Press, ISBN 9781138026292 - CAT K23481, 1st Edition

I Semester	PRINCIPLES OF AUTOMATION AND CONTROL	L	T	P	C
		3	0	0	3

Pre-requisite: Students should be familiar with control system fundamentals, sensors, actuators, and instrumentation concepts**,** along with basic knowledge of mathematics, differential equations, and computer programming, to effectively learn automation principles and their applications in engineering systems.

Course Objectives:

1. To impart fundamental knowledge of automation, feedback control, and system dynamics.
2. To develop skills in modeling, analyzing, and designing control systems for engineering applications.
3. To enable students to understand the role of sensors, actuators, and controllers in automation.
4. To train students in applying automation and control principles for improving efficiency, safety, and reliability of engineering systems.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Explain the basic concepts of automation, control systems, and feedback mechanisms.	2
3CO2	Apply mathematical modeling techniques to represent dynamic systems.	3
CO3	Analyze the stability and response of control systems using classical and modern methods.	4
CO4	Evaluate the performance of automation and control strategies for engineering applications.	5
CO5	Design simple automation and control systems using sensors, actuators, and controllers.	6
CO6	Demonstrate the role of automation in improving productivity, efficiency, and safety of engineering processes.	3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	M	M	M	L
CO2	H	H	M	M	H	L
CO3	H	H	M	H	H	M
CO4	H	H	H	H	H	M
CO5	H	H	H	H	H	M
CO6	H	M	M	M	M	M

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Introduction to industrial automation and control: Architecture of industrial automation systems, review of sensors and measurement systems. Introduction to process control: PID control, controller tuning, implementation of PID controllers, special control structures, feed forward and ratio control, predictive control, control of systems with inverse response, cascade control, overriding control, selective control and split range control	
UNIT – 2	Introduction to sequence control: PLCs and relay ladder logic, sequence control, scan cycle, RLL syntax, sequence control structured design approach, advanced RLL programming, the hardware environment, Introduction to CNC machines.	
UNIT – 3	Control of machine tools: Analysis of a control loop, introduction to actuators. Flow control valves, hydraulic actuator systems, principles, components and symbols, pumps and motors. Proportional and servo valves. Pneumatic control systems, system components, controllers and integrated control.	
UNIT – 4	Control systems: Electric drives, introduction, energy saving with adjustable speed drives stepper motors, principles, construction and drives. DC motor drives: Introduction to DC-DC converters, adjustable speed drives. Induction motor drives: Introduction, characteristics, adjustable speed drives. Synchronous motor drive-motor principles, adjustable speed and servo drives.	
UNIT – 5	Networking of sensors, actuators and controllers, the fieldbus, the fieldbus communication protocol, introduction to production control systems	
	Total	

References:

1. https://nptel.ac.in/downloads/108105063/
2. Manesis S and Nikolakopoulos G 2018. Introduction to Industrial Automation. 1st Edition,
   CRC Press. Textbook - ISBN 9781498705400 - CAT# K24766

I Semester	SOIL DYNAMICS IN TILLAGE AND TRACTION LAB	L	T	P	C
		0	1	2	2

PRACTICES:

1. To study the effect of soil compaction by agricultural machines
2. Determination of soil movement on M.B. Plough
3. Measurement of terrain parameters required for tractive performance for prediction of off-road vehicles
4. Determination of pull-slip curve for a tar-macadam and field condition
5. Determination of pull-slip curves for a farm tractor on different terrains
6. Study of rolling resistance and tractive efficiency of rigid, pneumatic and track types vehicles.
7. Measurements of soil shear strength by in-situ shear box apparatus and soil friction by friction plate
8. Measuring cone penetrometer resistance and working out tractive coefficients for tyres
9. Measurement of in-situ shear strength of soil by torsional vane shear apparatus

I Semester	FARM MACHINERY DESIGN LAB	L	T	P	C
		0	1	2	2

PRACTICES:

1. Statement and formulation of design problems.
2. Design of mould board: mould board plough working surface, jointer, coulter, frog, share, trailed, semi mounted and mounted ploughs
3. Design of disc plough, disk harrow, peg tooth harrow
4. Design of cultivators, sweep, rotary tiller
5. Design of traction and transport devices
6. Design of seed metering mechanism, hopper, furrow openers
7. Design of fertilizer spreaders, liquid fertilizer applicators and sub systems
8. Design of cylinder for a multi-cropthresher.
9. Design of paddy transplanters, potato planters
10. Measurement of spray characteristics of different nozzles
11. Design of sprayers – manual, power operated, special purpose (orchard, tall tree)
12. Design of harvesting machines, threshing drum, cleaning and grading systems

I Semester	SEMINAR-I	L	T	P	C
		0	0	2	1

II Semester	DESIGN OF TRACTOR SYSTEMS	L	T	P	C
		3	1	0	4

Pre-requisite: Students should have prior knowledge of Engineering Mechanics, Strength of Materials, Theory of Machines, Thermodynamics, and Basics of Farm Machinery and Power. Familiarity with material properties, stress–strain behavior, IC engine fundamentals, and kinematics of machine elements is essential for understanding tractor system design.

Course Objectives:

1. To provide fundamental knowledge of tractor systems including engine, transmission, steering, brakes, hydraulics, and chassis components.
2. To develop analytical and design skills for evaluating the performance, strength, and reliability of tractor subsystems.
3. To integrate engineering principles for optimizing tractor design in terms of efficiency, safety, ergonomics, and field performance.
4. To expose students to modern design tools, standards, and practices for sustainable and innovative tractor system development.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Explain the functional requirements and working principles of major tractor systems.	2
3CO2	Analyze the stresses, loads, and performance parameters of tractor engine, transmission, and chassis components.	4
CO3	Apply design principles and standards for the selection and sizing of tractor subsystems.	3
CO4	Evaluate the efficiency, safety, ergonomics, and field performance of tractors under varying conditions.	5
CO5	Design and optimize tractor subsystems using engineering tools, CAD/CAE software, and simulation techniques.	6
CO6	Demonstrate problem-solving, teamwork, and technical communication skills in tractor system design projects.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	L	L	--	--
CO2	H	H	M	M	M	--
CO3	H	M	H	M	M	--
CO4	M	H	H	H	M	M
CO5	M	M	H	H	H	--

CO6	L	L	M	L	M	L

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Design and types, research, development, design procedure, technical specifications of tractors, modern trends in tractor design and development.	
UNIT – 2	Special design features of tractors in relation to Indian agriculture. Engine related terminology. Selection of stroke-bore ratio.	
UNIT – 3	Design of engine components: Piston, connecting rod, cylinder, cylinder head, crank shaft etc. Design of tractor systems like clutch, gearbox, steering, steering geometry, turning force,	
UNIT – 4	Design of tractor systems like hydraulic system & hitching, chassis, operator's seat, work-place area and controls. Tire selection, aspect ratio etc.	
UNIT – 5	Mechanics of tractor stability. Computer aided design and its application in farm tractors.	
	Total	

Text Books:

1. Sharma P C and Agarwal D K 2000. Machine Design. S K Kataria and Sons, Delhi.
2. Barger E L Liljedahl J B and McKibben E C 1967. Tractors and their Power Units. Wiley Eastern Pvt. Ltd.

Reference Books:

1. Macmillan R H 2002. The Mechanics of Tractor – Implement Performance and Worked Example. University of Melbourne, Australia.

II Semester	DESIGN OF FARM MACHINERY-II	L	T	P	C
		3	1	0	4

Pre-requisite: Students should have basic knowledge of Engineering Mechanics, Strength of Materials, Farm Machinery-I, Theory of Machines, and Agricultural Production Practices**.** Familiarity with tillage implements, seeding and planting equipment, material properties, kinematics of linkages, and basic design standards is essential for understanding advanced concepts in farm machinery design.

Course Objectives:

1. To provide advanced knowledge of design principles and functional requirements of farm machinery used for tillage, seeding, planting, intercultural operations, plant protection, and harvesting.
2. To develop analytical and problem-solving skills for evaluating the performance, strength, and efficiency of farm machinery components.
3. To integrate engineering principles with ergonomic, safety, and sustainability considerations in the design of modern farm machinery.
4. To expose students to modern design methodologies, standards, and software tools for developing innovative, cost-effective, and efficient farm equipment.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Explain the functional requirements and principles of advanced farm machinery for seeding, planting, intercultural, plant protection, and harvesting operations	2
3CO2	Analyze forces, stresses, and power requirements of various farm machinery components.	4
CO3	Apply engineering principles and design standards in sizing and selecting suitable farm machinery elements.	3
CO4	Evaluate the performance, efficiency, safety, and ergonomics of farm equipment under field conditions.	5
CO5	Design and optimize farm machinery systems using CAD/CAE tools and modern computational techniques.	6
CO6	Demonstrate teamwork, professional ethics, and effective communication skills in farm machinery design projects.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	L	L	--	--
CO2	H	H	M	M	M	--
CO3	H	M	H	M	M	--
CO4	M	H	H	H	M	M
CO5	M	M	H	H	H	--
CO6	L	L	M	L	M	L

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Pesticide calculation examples. Multidisciplinary nature of pesticide application. Overview of chemical control integrated pest management. Targets for pesticide deposition. Formulation of pesticides.	
UNIT – 2	Spray droplets. Hydraulic nozzles. Power operated hydraulic sprayer design principles. Air assisted hydraulic sprayer design principles. Controlled droplet application. Electrostatically charged sprayers. Spray drift and its mitigation. Aerial spraying systems. Use of drones for spraying: Design of spray generation and application issues.	
UNIT – 3	Introduction to combine harvesters: Construction, equipment subsystems, power sub systems. Crop harvesting: Plant properties, physical and mechanical properties of plant stem, plant bending modelling. Properties of plant grain: Physical, mechanical, grain damage. Properties of MOG: Mechanical and aerodynamic	
UNIT – 4	Design of grain header: Orienting and supporting reel. Plant cutting cutter bar: Working process, cutter bar drive. Knife cutting speed pattern area. Design of auger for plant collection. Corn header: Working elements, snapping roll design, stalk grasping and drawing process. Corn ear detachment: Stalk cutting and chopping.	
UNIT – 5	Cereal threshing and separation: Design of tangential and axial threshing units. Performance indices of threshing units. Modelling material kinematics in different threshing units. Factors influencing the threshing process and power requirement. Separation process and design of straw walker. Cleaning Unit process and operation. Grain pan: Chaffer and bottom sieve. Blower design and flow orientation. Design of conveying system for grain. Straw choppers and shredders.	
	Total	

Text Books:

1. Thornhill E W and Matthews G A 1995. Pesticide Application Equipment for Use in Agriculture Vol II. Mechanically powered equipment FAO Rome.
2. Miu P 2016. Combine Harvesters Modeling and Design. CRC Press, Boca Raton, USA ISBN 13:978-1-4822-8237-5

Reference Books:

1. Bosoi E S, Verniaev O V, Smirnov II and Sultan-Shakh E G 1987. Construction and Calculations of Agricultural Machinery - Vol.II. Oxonian Press Pvt. Ltd. New Delhi.
2. Bernacki C, Haman J and Kanafajski Cz 1972. Agricultural Machines Theory and Construction. Vol-I. U.S. Department of Commerce, National Technical Information Service, Springfield, Virginia22151.
3. Bindra, O S and Singh H 1971. Pesticides Application Equipments. Oxford & IBH Publishing Co., New Delhi.

II Semester	ERGONOMICS AND SAFETY IN FARM OPERATIONS	L	T	P	C
		3	1	0	4

Pre-requisite: Students should have basic knowledge of Human Anatomy & Physiology, Agricultural Machinery and Equipment, Farm Operations, and Work Environment Factors**.** Familiarity with engineering mechanics, occupational health principles, safety standards, and fundamental ergonomics concepts is essential to understand human–machine–environment interactions in farm operations.

Course Objectives:

1. To impart knowledge of ergonomic principles and their application in designing farm tools, machinery, and work environments for enhanced operator comfort and efficiency.
2. To create awareness about occupational health and safety hazards in farm operations and develop preventive strategies.
3. To develop analytical skills for assessing physiological, biomechanical, and environmental factors affecting farm workers' performance.
4. To promote safe, sustainable, and operator-friendly design solutions that minimize drudgery, accidents, and health risks in agriculture.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Explain the principles of ergonomics and their relevance in farm operations.	2
3CO2	Identify occupational health hazards, risks, and safety issues in agricultural workplaces.	1
CO3	Analyze physiological, biomechanical, and environmental factors influencing farm workers' performance.	4
CO4	Apply ergonomic standards and guidelines to design safe and operator-friendly farm tools, machinery, and work environments.	3
CO5	Evaluate the effectiveness of safety measures and ergonomic interventions in reducing drudgery, accidents, and health risks.	5
CO6	Demonstrate teamwork, professional ethics, and communication skills while proposing solutions for ergonomics and safety challenges in agriculture.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	M	L	--	M
CO2	M	H	M	M	--	H
CO3	H	H	M	H	M	M
CO4	M	M	H	M	M	M
CO5	M	H	H	H	M	H
CO6	L	L	M	L	L	M

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Description of human-machine systems. Ergonomics and its areas of application in the work system. History of ergonomics. Modern ergonomics.	
UNIT – 2	Anthropometry: Its role in daily life, principles in workspace and equipment design, design of manual handling tasks and application in equipment design. Human postures: Postural stress and its role in design of farm machinery	
UNIT – 3	Human factors in tractor seat design: Entry system, controls, shape, colour coding, dial and indicators. Modern technology for comfort in driving places	
UNIT – 4	Physiological parameters: Psychological and mental stresses and their measurement techniques. Human energy expenditure: Calibration of subjects, human workload and its assessment.	
UNIT – 5	Safety considerations and operators protective gadgets in farm operations. Standards/codes for tractors and agricultural machinery safety	
	Total	

Text Books:

1. Bridger R S 2009. Introduction to Ergonomics. CRC Press, Boca Rotan, USA
2. Sanders M S and McCormick E J 2000. Human Factors in Engineering and Design. McGraw Hill. 7th edition

Reference Books:

1. Astrand P, Rodahl K, Dahl H A and Stromme S B 2003. Textbook of Work Physiology - Physiological Basis of Exercise. McGraw Hill.
2. Gite L P 2009. Anthropometric and Strength Data of Indian Agricultural Workers for Farm Equipment Design. Central Institute of Agricultural Engineering, Bhopal.
3. Gite L P, Agrawal K N, Mehta C R, Potdar R R and Narwariya B S. 2019. Handbook of Ergonomical Design of Agricultural Tools, Equipment and work Places. Jain Brothers, New Delhi.

II Semester	PRINCIPLES OF HYDRAULIC AND PNEUMATIC SYSTEMS	L	T	P	C
		3	0	0	3

Pre-requisite: Students should have prior knowledge of Fluid Mechanics, Engineering Mechanics, and Strength of Materials**.** Familiarity with basic thermodynamics, properties of fluids, machine elements, and fundamental concepts of pressure, flow, and energy transmission is essential to understand hydraulic and pneumatic systems used in agricultural machinery and automation.

Course Objectives:

1. To impart fundamental knowledge of hydraulic and pneumatic principles, components, and their applications in power transmission and control.
2. To develop analytical skills for evaluating pressure, flow, force, and efficiency in hydraulic and pneumatic circuits.
3. To enable students to design and integrate fluid power systems for agricultural, industrial, and automation applications.
4. To promote awareness of safety, reliability, and maintenance practices in the operation of hydraulic and pneumatic systems.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Explain the basic principles of fluid power, properties of fluids, and working of hydraulic and pneumatic components.	2
3CO2	Identify and describe the functions of pumps, motors, valves, actuators, and accessories used in hydraulic and pneumatic systems.	2
CO3	Analyze pressure, flow rate, force transmission, and efficiency in hydraulic and pneumatic circuits.	4
CO4	Apply design principles to develop and optimize hydraulic and pneumatic circuits for agricultural and industrial applications.	3
CO5	Evaluate the performance, safety, and reliability of fluid power systems under different working conditions.	5
CO6	Demonstrate problem-solving, teamwork, and communication skills while working on hydraulic and pneumatic system projects.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	L	L	--	--
CO2	H	M	M	L	--	--
CO3	H	H	M	M	M	--
CO4	M	M	H	M	M	--
CO5	M	H	H	H	M	M
CO6	L	L	M	L	M	L

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Hydraulic power, its advantages, applications, properties of hydraulic fluids, viscosity, bulk modulus, density. Concepts of energy of hydraulic systems, laws of fluid flow.	
UNIT – 2	Hydraulic pump and motors, principle, capacity, classifications, working, performance. Design of various types of pumps and motors.	
UNIT – 3	Actuators, types, design of linear actuator and rotary actuators. Hydraulic rams, gear motors, piston motors and their performance characteristics. Hose, filters, reservoirs, types of circuits, intensifier, accumulator, valves. Valve types: Direction control, deceleration, flow, pressure control, check valve and their working etc.	
UNIT – 4	Hydraulic circuit design. Applications in farm power and machinery: Tractor, combine, farm machinery systems, hydrostatic system etc.	
UNIT – 5	Power pack, pneumatic circuits, properties of air. Compressors, types. Design of pneumatic circuits.	
	Total	

Text Books:

1. Majumdar S R 2003. Oil Hydraulics Systems: Principles and Maintenance. Tata McGraw Hill Co.
2. Anthony E 2003. Fluid Power with Applications. Pearsons Education (Singapore) Pvt. Ltd.

Reference Books:

1. Krutz G 1984. Design of Agricultural Machines. John Wiley and Sons.
2. Merritt H E 1991. Hydraulic Control System. John Wiley and Sons Inc

II Semester	MACHINERY FOR PRECISION AGRICULTURE	L	T	P	C
		3	0	0	3

Pre-requisite: Students should have prior knowledge of Farm Machinery and Power, Soil Science, Crop Production Practices, and Basics of Sensors & Electronics**.** Familiarity with GPS/GIS concepts, automation principles, hydraulics & control systems, and fundamentals of data acquisition in agricultural operations is essential to understand the design and application of precision agriculture machinery.

Course Objectives:

1. To impart knowledge of principles and concepts of precision agriculture, including the role of sensors, GPS/GIS, variable rate technology, and automation in farm operations.
2. To develop analytical skills for assessing the performance and suitability of precision agriculture machinery and technologies in different farming conditions.
3. To enable students to design, integrate, and apply advanced machinery for site-specific crop management, resource optimization, and sustainability.
4. To promote awareness of modern technologies, safety, and economic considerations in the adoption and implementation of precision agriculture machinery.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Explain the principles of precision agriculture and the role of sensors, GPS, GIS, and automation in modern farming.	2
CO2	Identify and describe the components, machinery, and technologies used for variable rate application, sensing, and data acquisition.	2
CO3	Analyze site-specific data to assess machinery performance and optimize input use.	4
CO4	Apply engineering principles to design and integrate machinery for precision agriculture practices.	3
CO5	Evaluate the efficiency, sustainability, and economic viability of precision agriculture machinery under field conditions.	5
CO6	Demonstrate problem-solving, teamwork, and communication skills in projects related to precision agriculture technologies.	3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	L	L	--	--
CO2	H	M	M	L	M	--
CO3	H	H	M	H	H	--
CO4	M	M	H	M	H	--
CO5	M	H	H	H	M	M
CO6	L	L	M	L	M	L

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Importance of precision agriculture. Mapping in farming for decision making. Geographical concepts of PA. Understanding and identifying variability	
UNIT – 2	Geographical Position System (GPS) Basics (Space Segment, Receiver Segment, Control Segment), Error and correction, Function and usage of GPS. Introduction to Geographic Information system (GIS), function of GIS, use of GIS for decisions. IDI devices usage in Precision Agriculture Yield monitor, variable rate applicator for fertilizers, seed, chemicals etc. Remote sensing Aerial and satellite imagery. Above ground (non-contact) sensors.	
UNIT – 3	Data analysis, concepts of data analysis, resolution, Surface analysis. Analysis application interpretive products (map, charts, application map etc).	
UNIT – 4	Electronics and Control Systems for Variable rate applications, Precision Variable Equipment, Tractor-Implement interface technology, Environmental Implications of Precision Agriculture.	
UNIT – 5	Goals based on end results of Precision Agriculture, Recordkeeping, Spatial Analysis, Variable Rate Application, reducing of negative environmental impact, Crop/technology cost optimization. Economic of precision agriculture and determining equipment and software, review of Cost/Benefit of Precision Agriculture, System vs. Parcels. Making a selection.	
	Total	

Text Books:

1. Shannon D K, Clay D E and Kitchen N R (editors) 2018. Precision Agriculture Basics American Society of Agronomy, Crop Science Society and Soil Science Society of America, 5585Gulford Rd, Madison, WI 53711
2. Clay S A, Clay D E, and Bruggeman S A 2017. Practical Mathematics for Precision Farming American Society of Agronomy, Crop Science Society and Soil Science Society of America, 5585Gulford Rd, Madison, WI 53711

Reference Books:

1. Henten E J V, Goense D and Lokhorst C 2009. Precision Agriculture. Wageningen Academic Publishers
2. Singh A K and Chopra U K 2007. Geoinformatics Applications in Agriculture. New India Publishing Agency, PritamPura, New Delhi
3. Ram T, Lohan S K, Singh R and Singh P 2014. Precision Farming: A New Approach. Astral International Pvt. Ltd., New Delhi., ISBN: ISBN 978-81-7035-827-5 (Hardbound) ISBN 978-93-5130-258-2 (International Edition)
4. Shannon D K, Clay D E and Kitchen N R (editors) 2018. Precision Agriculture Basics American Society of Agronomy, Crop Science Society and Soil Science Society of America, 5585Gulford Rd, Madison, WI 53711.

II Semester	ENGINEERING PROPERTIES OF BIOLOGICAL MATERIALS	L	T	P	C
		3	0	0	3

Pre-requisite: Students should have prior knowledge of Physics, Chemistry, Biology, and Basic Agricultural Engineering**.** Familiarity with mechanics of materials, thermodynamics, fluid mechanics, and material science is essential. Understanding of basic crop structure, composition, and post-harvest handling will help in studying physical, thermal, rheological, and aerodynamic properties of biological materials.

Course Objectives:

1. To provide fundamental knowledge of physical, thermal, mechanical, rheological, and aerodynamic properties of biological materials.
2. To develop skills in measuring and analyzing engineering properties relevant to design and processing of agricultural produce.
3. To apply engineering concepts for solving problems in handling, storage, transportation, and processing of biological materials.
4. To create awareness about the role of engineering properties in quality evaluation, product development, and equipment design for agricultural products.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Explain the importance and scope of engineering properties of biological materials in agricultural engineering.	2
CO2	Identify and describe physical, thermal, rheological, and aerodynamic properties of different agricultural products.	2
CO3	Analyze experimental data related to engineering properties and interpret their significance in processing and storage.	4
CO4	Apply engineering principles to evaluate material behavior under mechanical and thermal stresses.	3
CO5	Evaluate the influence of engineering properties on design, performance, and efficiency of post-harvest equipment.	5
CO6	Demonstrate practical skills, teamwork, and communication in experiments and projects involving biological materials.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	L	L	--	M
CO2	H	M	M	M	--	--
CO3	H	H	M	H	M	--
CO4	M	M	H	M	M	--
CO5	M	H	H	H	M	M
CO6	L	L	M	L	M	L

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Importance and brief description of mechanical; thermal; electrical and optical properties; Physical characteristics - shape; size; charted standards; roundness; sphericity; axial dimensions and projected area.; volume and density - platform scale; specific gravity balance; pycnometer method; porosity and surface areas – leaf and stalk surface area; fruit surface area.	
UNIT – 2	Basic concepts of rheology, physical states of material; rheological models and Rheological equations, Maxwell, Kelvin, 4-element model, generalized Maxwell and Generalized Kelvin models; viscoelastic characterization of materials - stress; strain behavior; creep, stress relaxation and dynamic tests.	
UNIT – 3	Textural and structural mechanics of food materials, effect of age, water content and temperature on texture of foods, introduction to rheological characteristics of agricultural, dairy and food products.	
UNIT – 4	Mechanical damage – economic importance; causes; detection and evaluation of mechanical damage. Impact damage and its mechanics; vibration damage and stress cracking; Maximum allowable load for agricultural products.	
UNIT – 5	Aero- and hydro-dynamic characteristics - Drag coefficient; terminal velocity; separation of foreign materials; pneumatic transport and handing; effect of moisture on frictional properties, angle of internal friction; angle of repose, application of frictional properties in design of handling and processing machines such as screw conveyors and oscillating conveyors.	
	Total	

Text Books:

1. Bourne, M. 2002. Food Texture and Viscosity–Concept and Measurement. Academic Press.
2. Mohesenin N N. 2000. Physical Properties of Plant and Animal Materials. Gordon & Breach Science Publ.

Reference Books:

1. Peleg M & Bagelay E B. 1983. Physical Properties of Foods. AVI Publ. Co.
2. Rao M A & Rizvi S S H. (Eds). Engineering Properties of Foods. Marcel Dekker.
3. Rao M A, Rizvi S S H & Datta A D K. 2005. Engineering Properties of Food. Francis and Taylor, C R C press.
4. Sahin S & Sumnu S G. 2006. Physical Properties of Food. Springer.
5. Singhal O P & Samuel D V K. 2003. Engineering Properties of Biological Materials.

II Semester	MECHATRONICS AND ROBOTICS IN AGRICULTURE	L	T	P	C
		3	0	0	3

Pre-requisite: Students should have prior knowledge of Engineering Mechanics, Basics of Electronics and Electrical Engineering, Sensors and Instrumentation, Farm Machinery, and Principles of Automation and Control**.** Familiarity with hydraulics and pneumatics, programming logic, CAD/CAE tools, and fundamentals of robotics will help in understanding the design and application of mechatronic and robotic systems in agriculture.

Course Objectives:

1. To provide knowledge of mechatronic systems, sensors, actuators, and control principles relevant to agricultural applications.
2. To develop analytical skills for integrating mechanical, electrical, and electronic components in agricultural machinery and automation.
3. To enable students to design and apply robotic systems for precision farming, crop management, and resource optimization.
4. To promote awareness of emerging technologies, safety, sustainability, and economic aspects of mechatronics and robotics in agriculture.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Explain the principles of mechatronics, sensors, actuators, and control systems used in agriculture.	2
CO2	Identify and describe robotic systems and automation technologies applicable to precision farming and crop management.	1
CO3	Analyze the performance of mechatronic and robotic components in agricultural machinery.	4
CO4	Apply engineering principles to design and integrate robotic systems for site-specific agricultural operations.	3
CO5	Evaluate the efficiency, safety, sustainability, and economic aspects of mechatronic and robotic applications in agriculture.	5
CO6	Demonstrate problem-solving, teamwork, and communication skills in projects involving agricultural robotics and automation.	3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	L	L	M	--
CO2	H	M	M	L	M	--
CO3	H	H	L	H	H	--
CO4	M	M	H	M	H	--
CO5	M	H	H	H	M	M
CO6	L	L	M	L	M	L

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Introduction to mechatronics: Basic definitions, key elements of mechatronics, historical perspective, the development of the automobile as a mechatronic system. Mechatronic design approach, functions of mechatronic systems, ways of integration, information processing systems, concurrent design procedure for mechatronic systems.	
UNIT – 2	System interfacing, instrumentation, and control systems. Input/output signals of a mechatronic system, signal conditioning, microprocessor control, microprocessor numerical control, microprocessor input/output control.	
UNIT – 3	Microprocessor based controllers and microelectronics: Introduction to microelectronics, digital logic, overview of control computers, microprocessors and microcontrollers, programmable logic controllers, digital communications.	
UNIT – 4	Technologies of robot: Sub systems, transmission system (Mechanics), power generation and storage system, sensors, electronics, algorithms and software. Servo motor drives types and applications. Stepper motor and its concept. Industrial robots: Classification and sub systems. Defining work space area.	
UNIT – 5	Application of robots in agriculture: Harvesting and picking, weed control, autonomous mowing, pruning, seeding, spraying and thinning, phenotyping, sorting and packing. Utility platforms. Use of different agrobots in agriculture.	
	Total	

Text Books:

1. Shakhatreh and Fareed 2011. The Basics of Robotics. Lahti University of Applied Sciences Machine and production technology.
2. Robert H B 2002. Mechatronic Hand Book. CRC Press.

Reference Books:

1. Alciatore, D G and Histand M.B. 2002.Introduction to Mechatronics and Measurement System. Mcgraw Hill Pvt Limited, New Delhi

II Semester	DATA ANALYSIS USING STATISTICAL PACKAGES	L	T	P	C
		3	0	0	3

Pre-requisite: Students should have basic knowledge of Statistics, Probability, and Experimental Designs**.** Familiarity with mathematics, data collection methods, hypothesis testing, regression, and analysis of variance (ANOVA) is essential. Prior exposure to computers, spreadsheets, and introductory programming concepts will help in effectively using statistical packages such as R, SPSS, SAS, or Python for data analysis in agricultural and engineering applications.

Course Objectives:

1. To provide knowledge of statistical concepts and their applications in analyzing experimental and survey data.
2. To familiarize students with statistical software packages (such as R, SPSS, SAS, or Python) for data handling and analysis.
3. To develop skills in applying appropriate statistical tests, regression, and multivariate techniques for research problems.
4. To enable students to interpret, visualize, and communicate results effectively for decision-making in agriculture and allied fields.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Explain fundamental statistical concepts and their role in data analysis.	2
CO2	Demonstrate proficiency in using statistical software packages for data entry, management, and processing.	3
CO3	Apply appropriate statistical tests (t-test, chi-square, ANOVA, regression, etc.) to analyze experimental and survey data.	3
CO4	Analyze datasets using advanced techniques such as correlation, multivariate analysis, and time series methods.	4
CO5	Interpret and critically evaluate statistical outputs to draw valid conclusions for agricultural and research applications.	5
CO6	Interpret and critically evaluate statistical outputs to draw valid conclusions for agricultural and research applications.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	L	M	L	--
CO2	M	M	L	M	H	--
CO3	H	H	M	H	M	L

CO4	H	H	M	H	H	L
CO5	M	H	M	H	M	M
CO6	L	M	M	M	M	--

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Introduction to various statistical packages: Excel, R, SAS, SPSS. Data Preparation; Descriptive statistics; Graphical representation of data, Exploratory data analysis.	
UNIT – 2	Test for normality; Testing of hypothesis using chi-square, t and F statistics and Z-test.	
UNIT – 3	Data preparation for ANOVA and ANCOVA, Factorial Experiments, contrast analysis, multiple comparisons, Analyzing crossed and nested classified designs.	
UNIT – 4	Analysis of mixed models; Estimation of variance components; Correlation and regression analysis, Probit, Logit and Tobit Models.	
UNIT – 5	Discriminant function; Factor analysis; Principal component analysis; Analysis of time series data, Fitting of non-linear models; Neural networks	
	Total	

Text Books:

1. Anderson C.W. and Loynes R.M. 1987. The Teaching of Practical Statistics. John Wiley.
2. Atkinson A.C. 1985. Plots Transformations and Regression. Oxford University Press.

Reference Books:

1. Chambers J.M., Cleveland W.S., Kleiner B and Tukey P.A. 1983. Graphical Methods for Data Analysis. Wadsworth, Belmount, California.
2. Chatfield C. 1983. Statistics for Technology. 3rd Ed. Chapman & Hall. Chatfield C. 1995. Problem Solving: A Statistician's Guide. Chapman & Hall.
3. Cleveland W.S. 1985. The Elements of Graphing Data. Wadsworth, Belmont, California.
4. Ehrenberg ASC. 1982. A Primer in Data Reduction. John Wiley

II Semester	BIOMASS ENERGY CONVERSION TECHNOLOGIES	L	T	P	C
		3	0	0	3

Pre-requisite: Students should have fundamental knowledge of physics, chemistry, and basic thermodynamics**.** Understanding of renewable energy concepts, crop residues, and agricultural by-products is essential. Prior exposure to heat transfer, combustion principles, and mechanical/electrical energy conversion systems will help in comprehending biomass utilization. Familiarity with environmental science and sustainability concepts is also desirable.

Course Objectives:

1. To provide knowledge of biomass resources, their characteristics, and potential for energy generation.
2. To understand the principles and technologies involved in biomass conversion processes such as combustion, gasification, pyrolysis, and anaerobic digestion.
3. To develop the ability to evaluate the performance, efficiency, and environmental impact of biomass energy systems.
4. To enable students to apply biomass conversion technologies for sustainable energy solutions in agriculture and rural development.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Explain the sources, properties, and classification of biomass for energy applications.	2
CO2	Describe the principles and working of biomass conversion processes such as combustion, gasification, pyrolysis, and anaerobic digestion.	2
CO3	Apply engineering concepts to design and analyze biomass energy systems for agricultural and rural applications.	3
CO4	Analyze the efficiency, economics, and environmental aspects of different biomass conversion technologies.	4
CO5	Evaluate the feasibility and sustainability of biomass-based energy projects.	5
CO6	Demonstrate problem-solving and project skills in applying biomass energy technologies for renewable energy development.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	L	M	L	--
CO2	H	M	M	M	M	--
CO3	H	H	H	M	H	L
CO4	H	H	M	H	M	M
CO5	M	H	M	H	M	M

CO6	M	M	H	H	H	L

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Biomass characterization: Types and resources, sustainability issues, assessment tools and methodologies, biomass fuel characterization, Biomass supply chain concept. Direct use of biomass: Size reduction, baling, pelletization, briquetting technologies.	
UNIT – 2	Biochemical conversion of biomass: Feedstock, process design, operation, optimized process parameters and utilization for biogas and bioethanol production.	
UNIT – 3	Biomass combustion: Stoichiometric air requirement, chemistry of combustion, design of combustion system, combustion zones, flame structure, stability, emissions. Co-firing of biomass.	
UNIT – 4	Thermo-chemical conversion of biomass: Feedstock, chemistry, reactor design, operation, optimized process parameters and utilization for gasification, carbonization, torrefaction and pyrolysis.	
UNIT – 5	Cogeneration technologies: Cycles, topping, bottoming, selection, problems, applications. Waste heat recovery: Estimation, systems, design and application.	
	Total	

Text Books:

1. Vimal O P 1984. Energy from Biomass.Agrcole Publishing Academy, New Delhi.
2. Twidell J W and Weir A D 2006. Renewable Energy Sources. E & F N Spon ltd., New York.

Reference Books:

1. Chaturvedi P 1995. Bio Energy Resources: Planning, Production and Utilization. Concept Pub. Co., New Delhi.
2. Chakravorty A 1985. Biogas Technology & other Alternative Technologies. Oxford & IBH Publication Ltd., Delhi.
3. Goswami D Y 1986. Alternative Energy in Agriculture.Vol. II (Ed), CRC, Press Inc. Florida, USA.
4. Stout B A 1984. Biomass Energy Profiles. FAO Agril. Services Bulletin No.54., Elsevier Science Publishers ltd., England

II Semester	FARM MACHINERY DYNAMICS, NOISE AND VIBRATION	L	T	P	C
		3	0	0	3

Pre-requisite: Students should have prior knowledge of Engineering Mechanics, Strength of Materials, Theory of Machines, and Vibrations. Familiarity with farm machinery components, dynamics of moving parts, and power transmission systems is essential. Basic understanding of applied mathematics, differential equations, and mechanical measurements will help in analyzing vibration, noise, and dynamic behavior of agricultural machinery.

Course Objectives:

1. To provide fundamental knowledge of dynamics of farm machinery and its components.
2. To understand the sources, measurement, and effects of noise and vibration in agricultural machinery.
3. To develop analytical skills for evaluating machine performance, stability, and operator comfort.
4. To enable students to apply vibration and noise control techniques for improving the efficiency, durability, and safety of farm equipment.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Explain the principles of dynamics related to farm machinery and equipment.	2
CO2	Identify sources and characteristics of noise and vibration in agricultural machinery.	2
CO3	Apply analytical methods to evaluate vibration, stability, and dynamic response of farm machines.	3
CO4	Analyze the effects of noise and vibration on machine performance, operator health, and safety.	4
CO5	Evaluate methods and technologies for vibration isolation, damping, and noise control in farm machinery.	5
CO6	Design and recommend practical solutions to minimize noise and vibration for efficient and safe operation of agricultural equipment.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	M	M	L	--
CO2	H	M	L	M	M	--
CO3	H	H	M	H	H	L
CO4	H	H	M	H	M	M
CO5	M	H	M	H	M	M
CO6	H	H	H	H	H	M

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Principles of soil working tools: shares, discs and shovels and blades, vibrating tillage tools and impact of vibration in saving of energy.	
UNIT – 2	Metering of seeds and granular fertilizers with various mechanisms, effect of various parameters on distribution of seed and fertilizer in seed-cum-fertilizer drills and planters.	
UNIT – 3	Electrostatic spraying and dusting, spray distribution patterns, kinematics of reapers, parameters affecting performance of threshers.	
UNIT – 4	Noise and vibration theory – definitions, units and parameters of measurements and their importance. Types of vibrations–free and forced vibrations.	
UNIT – 5	Balancing of single rotating weight in same plane, balancing of reciprocating parts of engine.	
	Total	

Text Books:

1. Kepner, R. A. Bainer, R, and Barger E. L. Principles of Farm Machinery, A VI Pub.,
2. Grover G K. Mechanical Vibrations. New Chand and Broths. Roorkee, 2007

Reference Books:

1. MeirovitchL. Elementsof vibrationanalysis. IIEdition. McgrawHill, 2007
2. Bosoi, E. S. Vermiaev, O V, Smirnov, I-I and Sultan Shakh, E. G. Theory, Construction and Calculation of Agricultural Machines, A. A. Balkema Poub. Rot terdam, 2009
3. Kanafozski, O and T. Karwowski Agricultural Machines: Theory and Construction. Vol.I & II, Translated and published by US Deptt. Of Agriculture, 2008

II Semester	ARTIFICIAL INTELLIGENCE	L	T	P	C
		3	0	0	3

Pre-requisite: The student pursuing Artificial Intelligence should have a fundamental understanding of mathematics, programming, algorithms, statistics, and logical reasoning, as these areas form the essential foundation for learning and applying advanced AI concepts effectively.

Course Objectives:

1. To provide students with fundamental knowledge of Artificial Intelligence concepts, techniques, and applications.
2. To develop problem-solving skills using AI approaches such as search strategies, knowledge representation, and reasoning.
3. To enable students to design and implement intelligent systems using programming tools and algorithms.
4. To cultivate the ability to apply AI methods in real-world domains for decision-making and automation.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Understand the fundamental principles and techniques of Artificial Intelligence	2
CO2	Apply AI problem-solving strategies such as search algorithms and reasoning techniques	3
CO3	Analyze knowledge representation methods and inference mechanisms for intelligent systems	4
CO4	Design and develop AI-based applications using suitable programming tools	6
CO5	Evaluate the performance of different AI models and techniques for specific problems	5
CO6	Demonstrate the ability to apply AI concepts to real-world domains such as agriculture, healthcare, and robotics	3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	L	L	L	--
CO2	M	H	M	M	M	--
CO3	M	M	H	M	M	--
CO4	L	M	H	H	H	M
CO5	M	M	H	H	M	M
CO6	M	H	H	H	H	M

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Definitions of intelligence and artificial intelligence. What is involved in intelligence? Disciplines important to AI. History of development of AI. Different types of AI. Acting humanly, Turing test. AI systems in everyday life. Applications of AI.	
UNIT – 2	Classical AI, concept of expert system, conflict resolution, multiple rules, forward chaining, backward chaining. Advantages and disadvantages of expert system. Fuzzy logic and fuzzy rules. Fuzzy expert systems.	
UNIT – 3	Problem solving using AI, search techniques, breadth first search, depth first search, depth limited search, bidirectional search, heuristic search, problems and examples. Knowledge representation, frames, methods and demons, correlations, decision trees, fuzzy trees.	
UNIT – 4	Philosophy of AI, Penrose's pitfall, weak AI, strong AI, rational AI, brain prosthesis experiment, the Chinese room problem, emergence of consciousness, technological singularity, Turing test.	
UNIT – 5	Modern AI, biological brain, basic neuron model, perceptrons and learning, self-organizing neural network, N-tuple network, evolutionary computing, genetic algorithms, agent methods, agents for problem solving, software agents, multi agents, hardware agents	
	Total	

Text Books:

1. Warwick K 2012.Artificial Intelligence: The Basics ISBN: 978-0-415-56482-3 (hbk).
2. Ivan Bratko, Prolog Programming for Artificial Intelligence.

Reference Books:

1. GNU PROLOG A Native Prolog Compiler with Constraint Solving over Finite Domains Edition 1.44, for GNU Prolog version 1.4.5 July 14, 2018.

II Semester	TRACTOR SYSTEMS LAB	L	T	P	C
		0	1	2	2

PRACTICES:

1. Design of various IC engine components.
2. Experimental determination of Centre of gravity.
3. Performance evaluation of response time of automatic: depth control.
4. Performance evaluation of response time of automatic: position control
5. Automatic draft control on a farm tractor.
6. Study of various hydraulic components in relation to design of hydraulic system of a
7. farm tractor.
8. Study of performance evaluation of different transmission system.
9. Problems showing utilisation of hydraulics in farm machines.
10. Engine design calculations,
11. Transmission component design calculations.
12. Extensive practices on the computer aided design packages

II Semester	ERGONOMICS AND SAFETY IN FARM OPERATIONS LAB	L	T	P	C
		0	1	2	2

PRACTICES:

1. Identifying role of ergonomics in our daily life.
2. Measurement of anthropometric dimensions of agricultural workers and establishing relationship between them.
3. Determination of human requirements for field operation with manually operated equipment.
4. Assessment of psychological/general load for specific agricultural operations.
5. Calibration of human subject on bicycle ergometer and/ or treadmill for its energy output
6. calibration of physiological parameters like heart rate, oxygen consumption rate under laboratory conditions.
7. Case studies of agricultural accidents and safety measure.
8. Determination of muscular fatigue for selected agricultural tasks.
9. Study of noise levels for engine/tractor.
10. Study of vibrations in farm tractors and agricultural machines.
11. Study of standard time for selected farm operations

II Semester	SEMINAR – II	L	T	P	C
		0	0	2	1

III Semester	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		3	0	0	3

Pre-requisite: The student pursuing Research Methodology and IPR should have a basic understanding of statistics, technical writing, logical reasoning, and fundamentals of innovation, along with awareness of intellectual property concepts, which provide the foundation for conducting systematic research and protecting research outcomes.

Course Objectives:

1. To enable students to understand the fundamentals of research, its types, and methodologies.
2. To develop the ability to design research problems, collect data, and analyze results systematically.
3. To create awareness about intellectual property rights, patents, copyrights, and trademarks.
4. To cultivate skills for writing quality research reports, theses, and publications with ethical practices.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Explain the fundamentals of research, its process, and significance in scientific inquiry	2
CO2	Identify and formulate research problems, hypotheses, and suitable methodologies	3
CO3	Analyze data collection methods, statistical tools, and interpretation techniques	4
CO4	Evaluate the quality, reliability, and ethics of research outputs	5
CO5	demonstrate knowledge of intellectual property rights including patents, copyrights, and trademarks	3
CO6	Develop the ability to prepare research proposals, reports, and publications in an ethical manner	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	L	L	--	--
CO2	M	H	M	M	M	--
CO3	M	M	H	M	M	--
CO4	L	M	M	H	M	H
CO5	M	M	M	M	H	M
CO6	M	H	H	H	M	M

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations	
UNIT – 2	Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee	
UNIT – 3	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	
UNIT – 4	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications	
UNIT – 5	New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	
	Total	

Text Books:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science
   &engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

Reference Books:

1. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974