DEPARTMENT OF AGRICULTURAL ENGINEERING

COURSE STRUCTURE & SYLLABUS

M.Tech. Agricutural Engineering

(FARM MACHINERY & POWER ENGINEERING)

Programme

(Applicable for batches admitted from 2020-2021)

Jawaharlal Nehru Technological University Kakinada

KAKINADA

Sl.No.	Branch/Discipline	Specialization	Qualifying Degree
1	Agricultural Engineering	Farm Machinery & Power Engineering	BE/B.Tech. (Agri./Mech.)

Semester-wise Scheme for Post Graduate Programme in Farm Machinery & Power Engineering

Details of courses offered for the award of M.Tech. (Agri.) in FMPE

I-Semester

Sl. No.	Code	Course Name		L	T	P	C
1	FMPE 511	Soil Dynamics in Tillage and Traction		3	-	-	3
2	FMPE 512	Design of Farm Machinery		3	-	-	3
3	Program Elective – I FMPE 513	FMPE 5131	Testing and Evaluation of Tractors and Farm Equipment	3	-	-	3
		FMPE 5132	Farm Power and Machinery Management				
		FMPE 5133	Earth Moving Machines				
4	Program Elective – II FMPE 514	FMPE 5141	Higher Mathematics	3	-	-	3
		FMPE 5142	CAD/CAM				
		FMPE 5143	Methods of Numerical Analysis				
5	FMPE 515	Soil Dynamics in Tillage and Traction Lab		-	-	4	2
6	FMPE 516	Farm Machinery Design Lab		-	-	4	2
7	FMPE 517	Research Methodology and IPR		2	-	-	2
8	FMPE 518	Soft Skills		2	-	-	0
			Total				**18**

II-Semester

Sl. No.	Code	Course Name		L	T	P	C
1	FMPE 521	Tractor Design		3	-	-	3
2	FMPE 522	Power Hydraulics		3	-	-	3
3	Program Elective – III FMPE 523	FMPE 5231	Product Manufacturing Technology	3	-	-	3
		FMPE 5232	Ergonomics and Safety in Farm Operations				
		FMPE 5233	Farm Machinery Dynamics, Noise and Vibration				
4	Program Elective – IV FMPE 524	FMPE 5241	Design of Pumps for Irrigation and Drainage	3	-	-	3
		FMPE 5242	Sustainable Energy				
		FMPE 5243	Systems Engineering and Productivity				
5	FMPE 525	Tractor Design Lab		-	-	4	2
6	FMPE 526	Power Hydraulics Lab		-	-	4	2
7	FMPE 527	Mini-Project with Seminar		-	-	4	2
8	FMPE 528	Value Education		2	-	-	0
			Total				**18**

III-Semester

Sl. No.	Code	Course Name		L	T	P	C
1	Program Elective – V FMPE 531	FMPE 5311	Horticulture and Forestry Equipment	3	-	-	3
		FMPE 5312	Applied Instrumentation in Farm Machinery and Stress Analysis				
		FMPE 5313	AI-ML of Farm Machinery				
2	Program Elective – VI FMPE 532	Students are advised to opt for an open elective course of their choice being offered by other department of the Institute (OR) MOOCS/NPTEL certification courses duly approved by the Department		3	-	-	3
3	FMPE 533	Dissertation Phase-I / Industrial Project (To be continued and Evaluated next Semester) *		-	-	20	10
			Total				**16**

* Evaluated and displayed in 4th Semester marks list

IV-Semester

Sl. No.	Code	Course Name	L	T	P	C
1	FMPE 541	Dissertation Phase-II (Continued from III Semester)	-	-	32	16
		Total				**16**

SYLLABUS

FARM MACHINERY AND POWER ENGINEERING

I Year - I Semester	FMPE 511	L	T	P	C
	Soil Dynamics in Tillage and Traction	3	0	0	3

Course Outcome: The student will acquire knowledge regarding mechanics of tillage tools, scouring of soil and importance, determine Kc and Kϕ using plate shrinkage test, wheel slip and its role in traction mechanism, slip measurement and slip control method, rolling resistance and effect of type size inflation pressure and lug height on tractive performance, study of effect of soil compaction by agricultural machinery.

Theory

Unit I

Mechanics of tillage tools: Introduction, inclined, vertical, wide blades, cutting of soil. Scouring of soil and its importance, soil compaction by agricultural machines and tractors. Remedies for soil compaction. Techniques for measuring terrain values and load sinkage relationship. Determination of Kc and Kφ using plate sinkage test. Shear stress, displacement relationship in sinkage and horizontal deformation, slip, sinkage and vertical load.

Unit-II

Motion resistance of a rigid wheel and a track. Tractive efforts developed by a wheel and a track. Wheel slip and its role in traction mechanics. Slip measurement and slip control method. Mobility number and effect of mobility number on tractive effort. Rolling resistance and effect of tyre size inflation pressure and lug height on tractive performance. Matching of power, weight, speed and slip to obtain optimum power transmission.

Unit-III

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: Directs hear box, torsion shear apparatus, tri-axial apparatus. Soil behavior considerations: Soil water pressure and movement. Critical state soil mechanics: Soil stress-strain behavior, shear rate effects. 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-IV

Extension of theory to three dimensions: 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. Complex tool shapes: Curved tools- shankand 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-V

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.

Suggested Readings

1. Gill, W.R. and Vanden Berg, Soil Dynamics in Tillage, Handbook No. 316, US Department of Agriculture,1968.
2. Bekker, M.G. Theory of Land Locomotion, University of Michigan Press, USA,1956.
3. Bekker, M.G., Off-Road Locomotion, University of Michigan Press USA,1969.
4. Bekker, M.G., Introduction of Terrain Vehicle System, Michigan, USA,1969.
5. Karafaith, L.L., and A.A, Nowatzki, Soil Mechanics for Off–Road Engineering,Tran Tech. Pub., Switzerland,1978.
6. Wong, J.Y., Theory of Ground Vehicle, John Willey & Sons, New York,1978.
7. Mohesin N.N. 1970. Physical properties of plant and animal materials "Gorden & Breach Science Publishers, NewYork.
8. McKyes E 2016. Soil Cutting and Tillage: Vol 7. Developments in Agricultural Engineering Elsevier R Science Publisher SBV.
9. Koolen, A J and Kuipers H 1983. Agricultural Soil Mechanics. Springer-Verlag ISBN 3:978-3-642-69012-9.
10. Gill W R and Van den Berg G E 1968. Soil Dynamics in Tillage and Traction. Handbook 316, Agricultural Research Service, US Department of Agriculture, Washington DC, 1968
11. 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.
12. McKYES E 1989, Agricultural Engineering Soil Mechanics, Elsevier science publishers B. V., P.O. Box 211, 1000 AE Amsterdam, the Netherlands.

I Year - I Semester	FMPE 512	L	T	P	C
	Design of Farm Machinery	3	0	0	3

Course Outcome: The student will be able to learn about farm machinery design principles, design of working components of M. B. plough, secondary tillage equipment, types of metering devices and their working, design of thresher cylinder and safety devices for tractor and farm implements.

Theory

Unit I

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. Farm machinery design principles. Working process of mould board plough, determination of basic parameters. Design of working components of a M.B. Plough: share. Forces acting on the M.B. Plough. Design of coulters, shares, mould boards. Constructing of mould board working surface. Design of landside, frog, jointer. Forcesacting on plough bottom and their effect on plough balance: Trailed, semi mounted and mounted plough. Draft on ploughs, resistance during ploughing.

Unit II

Design of working component of a disc plough: Concave disk working tools, forces acting on disc. 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. Rotary machines: Trajectory of motion of rotary tiller tynes, forces acting, power requirement. Machines with working tools executing an oscillatory motion.

Unit III

Methods of sowing and planting: Machines, agronomic specifications. Sowing inter- tilled crop. Grain hoppers: Seed metering mechanism, furrow openers and seed tubes. Procedure of design of fluted roller, horizontal plate type metering devices and seed and fertilizer boxes. Machines for fertilizer application: Discs type broadcasters. Organic fertilizer application: Properties of organic manure, spreading machines. Liquid fertilizer distributors. Planting and transplanting: Paddy trans-planters, potato planters.

Unit IV

Pesticide calculation examples. Multidisciplinary nature of pesticide application. Overview of chemical control integrated pest management. Targets for pesticide deposition. Formulation of pesticides. Spray droplets. Hydraulic nozzles. Power operated hydraulic sprayer design principles. Air assisted hydraulic sprayer design principles. Controlled droplet application. Electrostatic ally charged sprayers. Spray drift and its mitigation. Aerial spraying systems. Use of drones for spraying: Design of spray generation and application issues.

Unit V

Introduction to combine harvesters: Construction, equipment subsystems, power sub systems. Crop harvesting: Plant properties, physical and mechanical properties of plant stem, plant bending modeling. Properties of plant grain: Physical, mechanical, grain damage. Properties of MOG: Mechanical and aerodynamic. 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. Cornear detachment: Stalk cutting and chopping. Forces acting on a cutter bar of a reaper, design of threshing cylinder. Safety devices for tractors and farm implements. Reliability criteria in design of farm machinery. Cereal threshing and separation: Design of tangential and axial threshing units. Performance indices of threshing units. Modeling 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.

Suggested Readings

1. Liljedahl, B.J., Turnquist, P.K, Smith, W.D. and HokiVaketo. Tractor and Their Power units, Fourth Edition, Avi Publications, New York, 1989.
2. Ralph Alcock. Tractor Implement System. AVI Pub.1986.
3. Bernacki, H., Kanafozski, O and T. Karvowski. Agriculture machines: Theory and Construction. Vol. I and II, translated and published by US Deptt. of Agriculture,1976.
4. Bosoi, E.S., Vermiaev, OV, Smirnov, I.I. and Sulta –Shakh, E.G. theory, construction and calculation of agriculture machines, A.A Balkema Pub., Rotterdam, 1988.
5. Gyachev, L.V., Theory of surfaces of plow bottoms, A.A Balkema Pub., Rotterdam, 1987.
6. Kepner, R.A., Bainer, Ray and E.L. Barger. Principle of Farm Machinery, AVI Pub., 1978.
7. Nartov, P.S. Disc Soil Working implements, A.A. Balkema Pub. Rotterdam, 1986.
8. Kurtz. G., Thompson, L. and P. Claar. Design of Agricultural Machines, John Willey and sons, 1984.
9. Sharma, D.N. and Mukesh S. Farm Machinery Design: Principles and problems. Jain Brothers, East Park Road, New Delhi.

I Year - I Semester	FMPE 5131	L	T	P	C
	Testing and Evaluation of Tractors and Farm Equipment	3	0	0	3

Course Outcome: Gaining knowledge about testing of agricultural machines and testing of farm tractor, tractor test code BIS: ISO: OECD and Nebraska

Theory

Unit I

Importance and significance of testing and types of tests. Testing of agricultural machines: M.B. Plough, disc plough. Test procedures and various test codes: National and International.

Unit II

Testing of agricultural machines: Sub - soiler, laser land leveler, Rotavator, Cultivator, Disc Harrow, Seed cum fertilizer drill and planters.

Unit III

Testing of agricultural machines: Manual and power operated weeders, reaper, thresher and chaff cutter.

Unit IV

Testing of agricultural machines: Combine harvesters. Plant protection machines. 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.

Unit V

Testing of farm tractor – Tractor test codes: BIS, ISO, OECD and Nebraska.

Suggested Readings

1. BIS test codes for farm machines and tractors
2. ISO test code for farm machines and tractor
3. Nebraska tractor test code
4. OECD tractor test code
5. RNAM test codes for farm machines
6. Testing manual, CIAE, Bhopal.

I Year - I Semester	FMPE 5132	L	T	P	C
	Farm Power and Machinery Management	3	0	0	3

Course Outcome: After completing this course student will be acquainted with importance and objectives of farm mechanization in Indian agriculture, estimation of operating cost of tractor and farm machinery, tractor power performance terms, selection of farm machinery, selection of proper power and related problem, reliability of agricultural machinery, replacement of farm machinery and inventory control, spare parts, system approach to farm machinery management and application.

Theory

Unit I

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.

Unit II

Management and performance of power, operator, labour, 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 III

Power requirement problems to PTO, DBHP. Selection of farm machinery, size selection, timeliness of operation, optimum width and problem related to its power selection; selecting proper power level and problem related to it.

Unit IV

Reliability of agricultural machinery. Replacement of farm machinery and inventory control of spare parts.

Unit V

Systems approach to farm machinery management and application of programming techniques to farm machinery selection and scheduling. Network Analysis: Transportation, CPM and PERT, dynamic programming, Markov chain.

Suggested Readings

1. Culpin, C, Profitable farm mechanization, Lock Wood & Sons, London, 1996.
2. Hunt, D, Farm Power and Machinery Management, Iowa State University Press, USA, 1979.
3. Singh, S. and Verma, S.R. Farm Machinery Maintenance and Management. DIPA, ICAR, KAB-I, New Delhi.
4. Carveille, L.A. (1980). Selecting farm machinery. Louisiana Cooperative Extn. Services publication.
5. Watters, W.K. (1980) Farm Machinery Management guide. Pennsylvania Agri. Extn. Services Spl. Circular No 192.
6. FAO (1980). Agricultural Engineering in develop: selection of mechanization inputs, FAO, Agri serviceBulletin.

I Year - I Semester	FMPE 5133	L	T	P	C
	Earth Moving Machines	3	0	0	3

Course Outcome: Students will be able to study the land leveling: Criteria and methods; Plane, profile & plan inspection; Earth work calculations; types, construction, capacity and working of the machines like Bulldozer; Scraper; Grader; Shovel; Dragline, calm shell, trenching machine and compactors, Drilling and drilling tools; basting and types of explosive & stemming; Transportation and handling of explosive; Application of CPM; Safety engineering for construction.

Theory

Unit I

Land leveling: Criteria and methods; Plane profile and plan inspection; Contour adjustment, Earth work calculations;

Unit II

Types, construction, capacity and working of the following machines: Bulldozer; Scraper; Grader; Shovel; Dragline, calm shell, trenching machine and compactors,

Unit III

Drilling and blasting: Air operated drilling tools; Jack hammer; Drifter; Wagon drill selection of drilling equipment,

Unit IV

Types of explosive & stemming, Blasting caps and storage; Transportation and handling of explosive; Job planning and management;

Unit V

Application of CPM; Safety engineering for construction

Suggested Readings

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

I Year - I Semester	FMPE 5141	L	T	P	C
	Higher Mathematics	3	0	0	3

Course Outcome: It consists of four main topics: 1.Discrete Mathematics 2.Graph theory 3.Linear programming problems 4.Queuingtheory.

Theory

Unit I

Representation of statements, Duality, Tautologies and Contradictions, Quantifiers, Predicates and validity of arguments. Propositional Logics, Languages and Grammer, Finite state machines and their transitional table diagrams, Lattices, Partially ordered sets-I

Unit II

Partially ordered sets-II, Duality and Lattices as algebraic system, Sub lattice -I & II, Boolean Algebra Switching Algebra, Boolean Functions, Different representation of Boole an functions, table diagrams, Lattices, Partially ordered sets-I

Unit III

Circuit minimization and simplification-II, Karnaugh Map-I &II, Various types of Graphs- Eulerian and Hamiltion Graphs, Travelling salesman problem, Vertex and edge connectivity, Matrix representation of graph, Incidence and adjacency matrices of graphs

Unit IV

Planar graphs, Kuratowski's Theorem, Detection of planarity, Euler's formula, Dula of a Planar graph Coloring of Graphs, Chromatics numbers, Four color theorem, Graphical method-I & II, Simplex method

Unit V

Two phase method-II, Dual Simplex method, Application of Dual Simplex method, Sensitivity Analysis-I, Queuing System. Distribution of arrivals and service times, Analysis of M/M/1:FIFO,Application of M/M/1 FIFO , Analysis of M/M/S FIFO, Application of M/M/S FIFO

Suggested Readings

1. Higher Engineering Mathematics by Erwin kreyszig

I Year - I Semester	FMPE 5142	L	T	P	C
	CAD/CAM	3	0	0	3

Course Outcome: The student will be able to conceptualize spatial concepts and design components and assemblies of Farm machinery and make graphic models using commercial CAD software like Solid Works, Catia and AutoCAD.

Theory

Unit I

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 II

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. 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 III

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.

Unit IV

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 V

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.

Suggested Readings

1. Jankowski G and Doyle R 2007. Solid Works® 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

I Year - I Semester	FMPE 5143	L	T	P	C
	Methods of Numerical Analysis	3	0	0	3

Course Outcome: At the end of the course, the student will be able to Understand the fundamentals of the theory of elasticity, Implement the principles and techniques of photo elastic measurement, Obtain the principles and techniques of strain gage measurement, Adopt the principles and techniques of moiré analysis, Apply the principles and techniques of holographic interferometer, and Apply the principles and techniques of brittle coating analysis Understand the fundamentals of the theory of elasticity.

Theory

UNITI

Transform Methods- Laplace transform methods for one-dimensional wave equation - Displacements in a long string - Longitudinal vibration of an elastic bar - Fourier transforms methods for one-dimensional heat conduction problems in infinite and semi-infinite rod

UNITII

Elliptic Equations-Laplace equation - Properties of harmonic functions - Fourier transform methods for Laplace equation

Calculus of Variations- Variation and its properties - Euler's equation - Functionals dependent on first and higher order derivatives - Functionals dependent on functions of several independent variables - Some applications - Direct methods - Ritz and Kantorovich methods

UNITIII

Integral Equations- Fredholm and Volterra integral equations - Relation between differential and integral equations - Green's function -Fredholm equation with separable kernel - Iterative method for solving equations of second kind

UNITIV

Finite Difference and their Applications: Introduction- Differentiation formulas by Inter polating parabolas – Backward and forward and central differences- Derivation of Differentiation formulasusing Taylor series- Boundary conditions- Beam deflection – Solution of characteristic value problems- Richardson’s extrapolation - Use of unevenly spaced pivotal points- Integration formulae by interpolating parabolas- Numerical solution to spatial differential equations – Application to Simply Supported Beams, Columns & rectangular Plates.

UNITV

Numerical Differentiation: Difference methods based on undetermined coefficients-optimum choice of step length– Partial differentiation. Numerical Integration: Method based on interpolation-method based on undetermined coefficient – Gauss – Lagrange interpolation method- Radaua integration method- composite integration method – Double integration using Trapezoidal and Simpson’s method– New Marks Method and Application to Beams – Calculations of Slopes & Deflections.

Suggested Readings

1. Introduction to Partial Differential Equations, Sankara Rao. K, PHI, New Delhi, 1995

2. Numerical Methods for Scientific and Engineering Computations. M. K. Jain- S. R. K. Iyengar – R. K. Jain, New Age International (p) Ltd., Publishers

3. Differential Equations and Calculus of Variations Elsgolts. L, Mir Publishers, Moscow, 1966

4. Fundamentals of Mathematical Statistics Gupta. S.C, & Kapoor. V.K, Sultan Chand & Sons,

Reprint 1999.

5. Higher Engineering Maths for Engg. And Sciences Venkataraman. M. K, National Publishing

Company, Chennai

6. Numerical Methods for Engineering Problems N. Krishna Raju, K.U. Muthu Macmillan

Publishers

5. Elements of Partial Differential Equations, Sneddon. I.N, Mc Graw Hill, 1986

6. Computer based numerical analysis by Dr. M. Shanta Kumar, Khanna Book publishers New Delhi

I Year - I Semester	FMPE 515	L	T	P	C
	Soil Dynamics in Tillage and Traction Lab	**0**	**0**	**4**	**2**

Practical

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 Year - I Semester	FMPE 516	L	T	P	C
	Farm Machinery Design Lab	**0**	**0**	**4**	**2**

Practical

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 Year - I Semester	FMPE 517	L	T	P	C
	Research Methodology and IPR	2	0	0	2

Theory
UNIT I

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 II

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 III

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 IV

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT V

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.

Suggested Readings

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science &engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5.Mayall, "Industrial Design", McGraw Hill, 1992.
6.Niebel, "Product Design", McGraw Hill, 1974.
7. Asimov, "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

I Year - I Semester	FMPE 518	L	T	P	C
	Soft Skills	2	0	0	0

COURSE OUTCOME: The Students will be able to understand that how to improve your soft skills and level of readability, learn about what to write in each section and understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission.

Theory

UNIT-I

Planning and Preparation, Word Order, Breaking up long sentences. Structuring Paragraphs and Sentences, Being concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT-II

Clarifying Who Did What, Highlighting your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT-III

Review of the Literature, Methods, Results, Discussion, Conclusions, the Final Check.

UNIT-IV

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, useful phrases, how to ensure paper is as good as it could possibly be the first-time submission.

UNIT-V

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, and skills are needed when writing the Conclusions.

REFERNCES:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM Highman's book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011