Course Curriculum of Third Semester

as per the ICAR - Sixth Deans' Committee Report for the Academic Programmes in

AGRICULTURAL ENGINEERING

- UG-Certificate in Agricultural Engineering
- UG-Diploma in Agricultural Engineering
- UG-Degree: B.Tech. (Agricultural Engineering)

Mahatma Phule Krishi Vidyapeeth, Rahuri

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

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UG Degree Syllabus State Coordinator

with

UG Degree Syllabus Discipline Coordinators &

DICC - UG Degree Syllabus Core Committee

Submitted to the

Directors of Instruction Coordination Committee

~ w.e.f. AY, 2025-26 ~

Course Layout

B.Tech. (Agricultural Engineering)

Semester: III (New) ***w.e.f.*** **Academic Year: 2025-26**

Sr. No.	Course No.	Course Title	Credit Hrs.	Remark
1.	**AEC-234**	Physical Education, First Aid, Yoga Practices and Meditation	2(0+2)	--
2.	**AE-MATH-232**	Engineering Mathematics-I	3(3+0)	--
3.	**PHY-231**	Engineering Physics	3(2+1)	--
4.	**REE-232**	Engineering Chemistry	3(2+1)	--
5.	**FS-231**	Engineering Mechanics	3(2+1)	--
6.	**SWCE-232**	Soil Mechanics	2(1+1)	--
7.	**IDE-231**	Fluid Mechanics and Open Channel Hydraulics	3(2+1)	--
8.	**PFE-231**	Engineering Properties of Agricultural Produce and Food Science	3(2+1)	--
9.	**FMPE-233**	Farm Machinery and Equipment-I	3(2+1)	--
10.	**OC-1/ OC-2/ ...**	Online Course(s)/ MOOCs†	As opted by student	**NG**
		Total Credits Hrs.=	**25(16+9)**	**G**

AEC: Ability Enhancement Course, **OC**: Online Course, **G**: Gradial, **NG**: Non-gradial

†**Note:** It is mandatory for each Student to complete **total 6 credits** (Non-gradial) of **Online Courses** from available resources across III to VIII semesters under the guidance of assigned Faculty/Advisor.

Course-wise Syllabus with Teaching Schedules

Semester : III		
Course No. : AEC-234	**Credit Hrs. : 2(0+2)**	
Course Title : Physical Education, First Aid, Yoga Practices and Meditation		
Gradial Common Course across all UG Degrees		

SYLLABUS

Objectives :
(i) To make the students aware about Physical Education, First Aid and Yoga Practices,
(ii) To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga.

PRACTICAL

Physical Education; Training and Coaching- Meaning and concept; Aerobic and Aerobic exercises; Calisthenics, Weight Training, Circuit Training, Interval Training, Fartlek Training; Effect of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition- Effect of Diet on Performance; Physiological Changes due to ageing and Role of exercise on ageing process; Personality, its dimensions and types, Role of Sports in Personality Development; Motivation and Achievements in Sports; Learning and Theories of Learning; Adolescent Problems and its Management; Posture; Postural Deformities, Exercises for Good Posture.

Yoga: History of Yoga, Types of Yoga, Introduction to Yoga.

- Asanas (Definitions and Importance)- Padmasan, Gaumukhasan, Bhadrasan, Vajrasan Shashakasan, Pashchimothasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan- left & right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Shawasan.
- Suryanamaskar, Pranayama (Definitions and Importance)- Omkar, Suryabhedan, Chandrabhedan, Anulom, Vilom, Shitali, Shitkari, Bhastrika, Bhramari.
- Meditation (Definitions and Importance)- Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh Mudras (Definitions and Importance)- Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Prutvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra.
- Role of Yoga in Sports.
- Teaching of Asanas- Demonstration, Practice, Correction and Practice.

History of Sports and Ancient games, Governance of Sports in India; Important Sporting events-Awards in sports, History, Latest rules, Measurement of playfield, Specifications of equipment, Skill, Technique, Style and Coaching of major games (Cricket, Football, Table tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho and Athletics).

Need and Requirement of First Aid: First Aid techniques, Equipment and Upkeep First Aid techniques; First aid-related with respiratory system; First aid-related with Heart, Blood and Circulation; First Aid-related with wounds and injuries; First Aid-related with Bones, Joints muscles related injuries; First Aid-related with Nervous system and Unconsciousness; First Aid-related with Gastrointestinal Tract, Skin Burns; First Aid-related with Bites and stings, poisoning; First Aid-related with Sense organs; Handling and transport of injured traumatized persons- Sports injuries and their Treatments.

TEACHING SCHEDULE

PRACTICAL [AEC-234]

Exercise No.	Topic	Exercise Title / Sub-topics
1	**Physical Education**	To study the training and coaching- Meaning and concept of Physical Education
2 - 7	**Methods of Training**	To study the method of training - Aerobic and Aerobic exercises
		To study the method of training - Calisthenics
		To study the method of training - Weight Training
		To study the method of training - Circuit Training
		To study the method of training - Interval Training
		To study the method of training - Fartlek Training
8	**Effect of Exercise**	To study the effect of exercise on Muscular, Respiratory, Circulatory and Digestive systems
9	**Balanced Diet and Nutrition**	To study the Balanced Diet and Nutrition- Effect of diet on performance
10	**Physiological Changes**	To study the physiological changes due to ageing and role of exercise on ageing process
11	**Personality Development**	To study the dimensions and types - Role of sports in personality development

Continued…

12	**Motivation and Achievements in Sports**	To study the Motivation and Achievements in Sports
13	**Learning and Theories of Learning**	To study the Learning and Theories of Learning
14	**Adolescent Problems and its Management**	To study the Adolescent Problems and its Management
15	**Posture**	To study the Postural Deformities, Exercises for Good Posture
16 - 22	**Yoga**	To study the Introduction, History and Types of Yoga
		To study the Asanas: Padmasan, Gaumukhasan, Bhadrasan, Vajrasan Shashakasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan- left leg- right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Shawasan
		To study the Suryanamaskar, Pranayama, Omkar, Suryabhedan, Chandrabhedan, Anulom, Vilom, Shitali, Shitkari, Bhastrika, Bhramari
		To study the Meditation, Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
		To study the Mudras: Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Prutvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
		To study the Role of Yoga in Sports
		To study the Demonstration, Practice, Correction and Practice of Asanas
23 - 26	**Sports**	To study the History of Sports and Ancient games
		To study the Governance of Sports in India
		To study the Awards in Sports, History, Latest rules, Measurement of playfield, Specifications of equipment in important sporting events
		To study the Skill, Technique, Style and Coaching of major games (Cricket, Football, Table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho and Athletics)

Continued…

27 - 32	**First Aid**	To study the Need and Requirement of First Aid-First Aid techniques, Equipment and Upkeep
		To study the First aid related with Respiratory system, Heart, Blood and Circulation
		To study the First aid related with Wounds and Injuries, Bones, Joints muscles related injuries
		To study the First aid related with Nervous system Unconsciousness, Sense organs
		To study the First aid related with Gastrointestinal Tract, Skin Burns, Bites and Stings, Poisoning
		To study the Handling and Transport of Injured Traumatized Persons- Sports Injuries and their Treatments

Semester	**:**	**III**		
Course No.	**:**	**AE-MATH-232**	**Credit Hrs.**	**: 3(3+0)**
Course Title	**:**	**Engineering Mathematics - I**		

SYLLABUS

Objectives : To make the students acquainted with the Basic Mathematics applied in Engineering and their applications in solving engineering problems

THEORY

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

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

Differential calculus: Taylor's and Maclaurin's expansions, Maxima and minima for function of one variable, functions of two or more variables, partial derivative and total derivative, homogeneous functions and Euler's theorem.

Partial differential equations: Formation of PDE, higher order linear PDE with constant coefficients, solution of non-linear PDE, Charpit's method.

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

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

Suggested Readings [AE-MATH-232]:

1. Grewal B.S., 2015; Higher Engineering Mathematics. Khanna Publishers Delhi. (43rd Edn.)
2. Narayan, S. 2016. A Text Book of Vector. S. Chand and Co. Ltd. New Delhi.
3. Narayan, S. 2016. Differential Calculus. S. Chand and Co. Ltd. New Delhi.
4. Narayan, S. 2016. Integral Calculus. S. Chand and Co. Ltd. New Delhi.

TEACHING SCHEDULE

THEORY [AE-MATH-232]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 10	Differential Equations	First order differential equations	20
		Linear differential equation	
		Bernoulli's differential equation	
		Exact differential equation: Definition, Necessary and sufficient condition for exactness and solution of exact equation	
		Equations reducible to exact form by Integrating factor	
		Equations of the first order and higher degree: Clairaut's form	
11 - 17	Higher Order Differential Equations	Linear differential equations with constant coefficients: Methods / Rules for finding complementary functions	15
		Method / Rules for finding the Particular integral	
		Methods of variation of parameters	
		Cauchy's and Legendre's linear equations	
		Simultaneous linear differential equations with constant coefficients	
18 - 27	Differential Calculus	Maclaurin's and Taylor's Expansion	20
		Maxima and minima	
		Partial Differentiation: functions of two or more variables	
		Partial derivatives	
		Homogeneous function & Euler's Theorem	
		Total derivative	
28 - 32	Partial Differential Equations	Formation of PDE,	10
		Higher order linear PDE with constant coefficient	
		Solution of non-linear PDE	
		Charpit's method	
33 - 38	Integral Calculus	Double integrals,	15
		Change of order of integration	
		Triple integrals,	
		Application of double and triple integrals to find area and volume	
39 - 48	Matrices	Rank of a Matrix	20
		Elementary transformations	
		Gauss-Jordan method to find the inverse of a matrix	
		Solution linear equations	
		Gauss elimination Method	
		Linear transformation,	
		Eigen values and Eigen vectors	
		Cayley Hamilton Theorem - it's use to find inverse of the matrix	
		Diagonalization of matrices	
		Total =	**100**

*[**Note**: In some topics, re-arrangement of points is done for smooth teaching as per the books suggested.]*

Semester	**:**	**III**		
Course No.	**:**	**PHY-231**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Engineering Physics**		

SYLLABUS

Objectives : (i) To make the students acquainted with applications of Physics in engineering and different physical processes in Agricultural Engineering.

(ii) To be skilful in the study of the Magnetism, Quantum Mechanics, Spectroscopy, Solid state Physics, Semiconductors, Superconductivity, LASERS and MASERS, Holography and Optical fibre with emphasis to learn advancements in quantum computing, sensors, resource management and environmental sustainability, that will supportive for learning advanced digital techniques, which are valuable for cutting-edge Agriculture.

THEORY

Magnetism: Dia-, para- and ferro-magnetism- classification; Langevin theory of dia- and para-magnetism, adiabatic demagnetization, Weiss molecular field theory; **Introduction to Quantum Mechanics**: wave particles duality, de Broglie concept uncertainty principle, time dependent and time independent Schrodinger equation. **Spectroscopy**: Qualitative explanation of Zeeman effect, Stark effect and Paschen back effect, Raman spectroscopy; **Solid state Physics**: statement of Bloch function, bands in solids, effective mass, distinction between metals, insulators and semi-conductors. **Semiconductors**: Intrinsic and extrinsic semi-conductors, law of mass action, determination of energy gap in semi-conductors, donors and acceptor levels; **Superconductivity**: super conductivity, critical magnetic field, Meissner effect, isotope effect, Type I and II superconductors, Josephsons effect, DC and AC squids, introduction to high Tc superconductors. **LASERS and MASERS**: Spontaneous and stimulated emission, Einstein A and B coefficients, population inversion, He, Ne and Ruby lasers, Ammonia and Ruby masers; **Holography and optical fiber**: optical fiber- physical structure, basic theory, type of modes, characteristics of optical fiber and applications; **Illumination:** laws of illumination, luminous flux, luminous intensity, candle power, brightness.

PRACTICAL

To verify law of transverse vibrations along a string using electrical tuning fork; To determine e/m of electron using magnetron valve method; Determine dielectric constant of material using De-Sauty's bridge; Study the variation of magnetic field with distance along the axis of a current carrying circular coil and to determine the radius of the coil; Determine the energy band gap in a semi-conductor using a p-n junction diode; Study the LCR circuit; Find the wave length of light by using prism and spectrometer; Determine the low resistance using Carey Foster bridge without calibrating the bridge wire.

TEACHING SCHEDULE

THEORY [PHY-231]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 4	Magnetism	Introduction, Properties of magnetic materials, Classification of Magnetism, Dia-, para- and ferro-magnetism; Langevin theory of dia- and para-magnetism, adiabatic demagnetization, Weiss molecular field theory	10
5 - 8	Quantum Mechanics	Introduction to Quantum Mechanics: Wave particles duality, De-Broglie concept Uncertainty principle, Time-dependent and Time-independent Schrodinger equation.	10
9 - 12	Spectroscopy	Qualitative explanation of Zeeman effect, Stark effect and Paschen-Back effect, Raman spectroscopy and its applications.	15
13 - 16	Solid State Physics	Introduction to Bravais Lattice, Band structure of solids, Effective mass, Distinction between (ICAR) Classification of Solids on the basis of band structure-Metals, insulators and semi-conductors. Statement of Bloch function.	10
17 - 20	Semiconductors	Definition of Intrinsic and Extrinsic semi-conductors, Law of mass action, Determination of energy gap in semi-conductors, donors and acceptor levels.	15
21 - 24	Superconductors	Superconductivity, Critical magnetic field, Meissner effect, Isotope effect, Type I and II superconductors, Josephsons effect, DC and AC squids, Introduction to high Tc superconductors.	15
25 - 28	Lasers and Masers	LASERS and MASERS: Spontaneous and Stimulated emission, Einstein A and B coefficients, Population inversion, He-Ne and Ruby lasers, Ammonia and Ruby masers.	10
29 - 32	Holography, Optical Fiber and Illumination	Introduction and Principle of Holography, Recording of the Hologram, Reconstruction of the image. Applications of Holography. Optical Fibre – Physical Structure, Basic theory, Types of modes, Characteristics of optical fibre and applications; Laws of Illumination, Luminous flux, Luminous intensity, Candle power, Brightness.	15
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [PHY-231]

Exercise No.	Exercise Title
1 - 2	To verify law of transverse vibrations along a string using electrical tuning fork
3 - 4	To determine e/m of electron using magnetron valve method
5 - 6	To determine dielectric constant of material using De-Sauty's bridge
7 - 8	To study the variation of magnetic field with distance along the axis of a current carrying circular coil and to determine the radius of the coil
9	To estimate the energy band gap in a semiconductor using a p-n junction diode
10 - 11	To study the LCR circuit
12 - 13	To study the frequency response of the parallel resonance circuits
14 - 15	To determine the Wavelength of laser light using prism and spectrometer
16	To determine the low resistance using Carey Foster bridge without calibrating the bridge wire

Suggested Readings [PHY-231]:

1. Avadhanulu, M.N. 2013. An Introduction to Lasers Theory and Applications. S. Chand Publication.
2. Chattopadhyay, D. and Rakshit, P.C. 2011. Electricity and Magnetism. S. Chand Publication.
3. Ghatak, A.K. and Lokanathan, S. 2022. Quantum Mechanics, Theory and Application. Trinity Press.
4. Griffiths, D.J. and Schroeter. 2018. Introduction to Quantum Mechanics. Cambridge University Press.
5. Khandelwal, D.P. 1985. A Laboratory Manual of Physics. Vani Publications.
6. Kittel, C. 2005. Introduction to Solid State Physics. Wiley Eastern Pvt. Ltd.
7. Laud, B.B. 2011. Lasers and Non-linear Optics. New Age International Publishers.
8. Mani, H.S. and Mehta, G.K. 2022. Modern Physics. Affiliated East-West Press.
9. Omar, M.A. 2002. Elementary Solid-State Physics. Pearson.
10. Prakash, S. 2011. Optics. Pragati Prakashan, Meerut.
11. Saraf, B. and Khandelwal, D.P. 1982. Physics through Experiments. Vol. I & II. Vikas Publication, New Delhi.
12. Subramanyam, N., Lal, B. and Avadhanulu, M.N. 2012. A Textbook of Optics. S. Chand Publ.
13. White, H.E. 2019. Introduction to Atomic Spectra. Mc-Graw Hill Publication.
14. Worsnop, B.L. and Flint, H.C. 1951. Advanced Practical Physics. Littlehampton Book Services Ltd.
15. Mehta, V.K. 1980. Principles of Electronics, S. Chand Publication.

Semester	**:**	**III**	
Course No.	**:**	**REE-232**	**Credit Hrs. : 3(2+1)**
Course Title	**:**	**Engineering Chemistry**	

SYLLABUS

Objectives : (i) To make the students acquainted with applications of Chemistry in Engineering,
(ii) To study different chemical processes in Agricultural and Food Engineering.

THEORY

Phase rule: Phase, component, degree of freedom, Application to one component system, viz. Water system, Sulphur system, Two component system, viz. Pb-Ag system, Desilverisation of Pb; **Colloids:** Classification, Properties like Optical activity- Tyndall effect, Brownian movement, Electrical properties-electrophoresis, Causes, Types and Methods of prevention- Proper designing. **Corrosion:** Cathodic protection using pure metal and metal alloys, Use of inhibitors. **Water:** Temporary and permanent hardness, Disadvantages of hard water, Scale and sludge formation of boilers, Boiler corrosion, Basic idea on thermo-gravimetric analysis, Polarographic analysis, Nuclear radiation, Detectors and Analytical applications of radio-active materials, Discovery of isotopes and new elements, release of atomic energy, radio-active tracer, and carbon dating; **Fuels:** Classifications, Calorific value and its determination by bomb calorimeter. **Principles of Food Chemistry:** Lipids, Proteins, Carbohydrates and their Classifications, Vitamins and their Importance. Enzymes and Co-enzymes Importance in Food processing and storage, their use in manufacturing of ethanol and acetic acid by fermentation method; Introduction to food preservatives, definition, Types: Natural and Artificial preservative and its use, Colouring and flavoring reagents of foods. **Lubricants:** Classifications, Properties- Viscosity, flash point and fire point mechanism, thick film, thin film and extreme pressure, neutralization point, saponification number and mechanical stability. Type of Polymerization with Examples (addition, free radical); Different Properties of Polymers- Chemical resistance, Crystallinity. **Polymers:** Effect of heat on polymers, General use, Basic principles of determination of molecular weight by viscosity methods, Basic principles of determination of molecular weight by light scattering methods. **Introduction to IR spectroscopy:** Basic principles of Spectroscopy, Beer-Lambart's law, Types of vibration, symmetric, asymmetric vibration, Absorbances of different functional group in IR.

PRACTICAL

To determine temporary and permanent hardness of water by EDTA method; To estimate chloride in water sample; To estimate dissolved oxygen in water sample; To study the different types of fuels and compare their characteristics; To study different types of foods and their ingredients; To study the different types of food preservatives and their active principles; To study the different properties of lubricants; To determine λmax and verification of Beer-Lambert law.

TEACHING SCHEDULE

THEORY [REE-232]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 3	Phase Rule	• Definition - • Explanation of Terms Phase Rule- • Component & Degree of freedom- • Application to: - One component system viz; Water system and Sulphur System - Two component System viz; Lead-Silver System (Pb-Ag) • Desilverisation of Pb-	15
4 - 5	Colloids	• Classification- • Optical properties- Optical activity, Tyndall effect, Brownian movement • Electrical properties- Electrophoresis, Causes, Types, and Methods of prevention- Proper designing	15
6	Corrosion	• Cathodic protection using pure metal and metal alloys, • Use of inhibitors.	
7 - 8	Water	• Hardness of water; Temporary and Permanent hardness; Disadvantages of hard water • Scale and sludge formation in boilers; Boiler corrosion	20
9 - 10	Thermo-gravimetric & Polarographic Analysis	• Basic idea on thermo-gravimetric analysis and Polarographic analysis	
11 - 13	Nuclear Chemistry	• Nuclear radiation, Detectors and Analytical applications of radio-active materials • Discovery of isotopes and new elements, Release of atomic energy, Radio-active tracer and Carbon dating	
14 - 15	Fuels	• Classifications of Fuels • Calorific value and its Determination by Bomb calorimeter	20
16 - 18	Principles of Food Chemistry	• Lipids, Proteins, Carbohydrates and their Classifications, Vitamins and their importance	
19 - 20	Enzymes and Co-enzymes	• Important in Food processing and storage, • Use in manufacturing of ethanol and acetic acid by fermentation method	
21 - 22	Food Preservatives	• Introduction of Food Preservatives- • Definition, Types- • Natural and Artificial preservatives and its use, Colouring and flavoring regents of foods.	

Continued…

23 - 25	Lubricants	• Function • Mechanism of lubrication- fluid film or thick film, boundary lubrication of thin -film and extreme pressure lubrication. • Classification • Properties of lubricating oils viz., Viscosity, flash point and fire point mechanism, thick film, thin film and extreme pressure neutralization point, saponification number and mechanical stability	15
26 - 27	Polymerization	• Type of Polymerization with Examples (Addition, Free radical); • Different properties of Polymers- Chemical resistance, Crystallinity	15
28 - 30	Polymers	• Effect of heat on polymers, General use, • Basic principles of determination of molecular weight by viscosity methods, • Basic principles of determination of molecular weight by light scattering methods	
31 - 32	IR Spectroscopy	• Introduction to IR spectroscopy • Basic principles of spectroscopy, Beer-Lambart's law, • Types of vibration: Symmetric, Asymmetric vibration, • Absorbances of different functional group in IR.	
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [REE-232]

Exercise No.	Exercise Title
1 - 2	To determine the temporary and permanent hardness of water by EDTA method
3	To estimate chloride in water sample.
4	To estimate dissolved oxygen in water sample.
5 - 6	To study the different types of fuels and compare their characteristics.
7 - 8	To study of Proximate and Ultimate analysis of selected biomass.
9 - 10	To study of calorific value of solid and gaseous fuel.
11	To study the different types of food preservatives and their active principles.
12	To study different types of foods and their ingredients.
13 - 14	To study the different properties of lubricants.
15 - 16	To determine λ_{max} and verification of Beer-Lambert's Law.

Suggested Readings [REE-232]:

1. Jain P.C. and Jain Monika. 2016. *Engineering Chemistry*. Dhanpat Rai Publication.
2. Jain P.C. and Jain Monika.1994. *Engineering Chemistry*. Dhanpat Rai publishing company Pvt. Ltd., Delhi.
3. Bahl B.S., Bahl A. and Tuli B.D. 2007. *Essentials of Physical Chemistry*. S. Chand and Co. Ltd., New Delhi.
4. Finar I.L. 2002. *Organic Chemistry*, *Vol I and II*. Pearson.
5. Glasstone S. *Elements of Physical Chemistry*. The Macmillan Company of India Limited.
6. Morrison R.T., Boyd R.N. and Bhattacharjee S.K. 2010. *Organic Chemistry*. Pearson.
7. Sharam Y.R. 2013. *Elementary Organic Spectroscopy*. S. Chand Publishing.

Semester	**:**	**III**		
Course No.	**:**	**FS-231**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Engineering Mechanics**		

SYLLABUS

Objectives : (i) To make the students acquainted with the Principles of Engineering Mechanics.
(ii) To make the students acquainted with the calculation of different stresses to be helpful for design of engineering structures.

THEORY

Basic concepts of Engineering Mechanics, Statics, Dynamics, Kinetics, Scalar quantities, Vector quantities, Systems of units; Composition and resolution of forces, Analytical method, Graphical method; Laws of Forces, Moments and their Application, Levers, Parallel forces and Couples; Equilibrium of Forces, Free body diagrams. Centre of gravity (CG) of simple geometrical figures, CG by moments, plane figures, Axis of references, CG of symmetric sections, Unsymmetrical sections, Solid bodies and Cut sections; Moment of inertia: methods of finding out M.I., Methods of integration, M.I. of different sections, Theorem of perpendicular axes, parallel axes, M.I. of composite sections and cut sections, Frictional forces, Static friction, Dynamic friction, Limiting friction, Normal reaction, Angle of friction, Coefficient of friction, Laws of friction, Equilibrium of a body lying in horizontal and inclined planes, Ladder friction; Wedge friction, Screw friction, Screw jack; Analysis of simple framed structures, Methods of sections, Force table, Methods of joints, Hinged joints, Roller support, Vertical and Inclined loads; Simple stresses and strain, Hooke's Law, Poisson's ratio, Modulus of elasticity, Strain related problems. Shear force and bending moment, Fundamentals of shear force and bending moment, SFD and BMD of cantilever and simply supported and overhanging beams, Point of contra-flexture; Torsion of circular shaft, Torsional effect, Hoop stress, Power transmitted by a shaft; Principal stresses and strain, Analysis of plane and complex stress, Principal planes and Principal stresses, Mohr's circle, Finding out principal stresses, Different analysis.

PRACTICAL

Problems on composition and resolution of forces; Study the moments of a force; Problems related to resultant of a concurrent- coplanar force system; Problems related to non-concurrent coplanar force system; Systems of couples in space; Problems related to centroids of composite areas; Problems on Moment of Inertia, radius of gyration of composite areas; Analysis of equilibrium of concurrent coplanar and non-concurrent coplanar force system; Problems involved with frictions; Analysis of simple trusses by methods of joints and methods of sections; Analysis of simple trusses by graphical method; Problems on simple stress and strains; Problems on shear and bending moment diagrams. Problems on stresses on beams. Problems on torsion of the shafts; Analysis of plane and complex stresses.

TEACHING SCHEDULE

THEORY [FS-231]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	Introduction	Basic concepts of Engineering Mechanics, Static, dynamic, kinetic, scalar quantities, Vector quantities, Systems of unit	25
2 - 3	Composition and Resolution of Forces	Composition and resolution of forces, Analytical method, Graphical method	
4 - 7	Moments, Equilibrium of Forces, Parallel Forces and Couples	Laws of forces, Moments and their application, levers, Parallel forces and couples; Equilibrium of forces, Free body diagrams	
8 - 11	Centre of Gravity	Centre of gravity (CG) of Simple geometrical figures, CG by moments, plane figures, axis of references, CG of symmetric sections, Unsymmetrical sections, Solid bodies and Cut sections	25
12 - 14	Moment of Inertia	Methods of finding out M.I., Methods of integration, M.I. of different sections, Theorem of perpendicular axes, parallel axes, M.I. of composite sections and cut sections	
15 - 18	Friction	Frictional forces, static friction, dynamic friction, limiting friction, normal reaction, angle of friction, coefficient of friction, laws of friction, equilibrium of a body lying in horizontal and inclined planes, ladder friction; wedge friction, screw friction, screw jack	25
19 - 21	Analysis of Perfect Frames	Analysis of simple framed structures, Methods of sections, force table, methods of joints, hinged joints, roller support, vertical and inclined loads	
22 - 25	Simple Stresses and Strain	Simple Stresses and Strain, Hooke's Law, Poisson's ratio, Modulus of elasticity, Strain related problems	25
26 - 28	Shear Force and Bending Moment	Shear force and Bending moment, Fundamentals of shear force and Bending moment, SFD and BMD of cantilever and simply supported and overhanging beams, Point of contra-flexture	
29 - 30	Torsion	Torsion of circular shaft, torsional effect, hoop stress, power transmitted by a shaft	
31 - 32	Principal Stresses and Strain	Principal stresses and strain, Analysis of plane and complex stress, Principal planes and Principal stresses, Mohr's circle, Finding out Principal stresses, Different analysis	
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FS-231]

Exercise No.	Exercise Title
1	Problems on composition and resolution of forces
2	Study the moments of a force
3	Problems related to resultant of a concurrent-coplanar force system
4	Problems related to resultant of a non-concurrent coplanar force system
5	Problems on systems of couples in space
6	Problems related to centroids of composite areas
7	Problems on Moment of Inertia, radius of gyration of composite areas
8	Analysis of equilibrium of concurrent coplanar and non-concurrent coplanar force system
9	Problems involved with frictions
10	Analysis of simple trusses by methods of joints and methods of sections
11	Analysis of simple trusses by graphical method
12	Problems on simple stresses and strains
13	Problems on shear and bending moment diagrams
14	Problems on stresses on beams
15	Problems on torsion of the shafts
16	Analysis of plane and complex stresses.

Suggested Readings [FS-231]:

1. Bansal R.K. 2005. A Text Book of Engineering Mechanics. Laxmi Publishers, New Delhi.
2. Khurmi R.S. 2006. Strength of Materials. S. Chand Publishing.
3. Khurmi R.S. 2018. A Text Book of Engineering Mechanics. S. Chand Publishing.
4. Prasad I.B. 2004. Applied Mechanics and Strength of Materials. Khanna Publishers, New Delhi.
5. Prasad I.B. 2004. Applied Mechanics. Khanna Publishers, New Delhi.
6. Sundarajan V. 2002. Engineering Mechanics and Dynamics. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
7. Timoshenko S. and Young D.H. 2003. Engineering Mechanics. McGraw Hill Book Co., New Delhi.

Semester	**:**	**III**			
Course No.	**:**	**SWCE-232**	**Credit Hrs.**	**:**	**2(1+1)**
Course Title	**:**	**Soil Mechanics**			

SYLLABUS

Objectives : To make the students acquainted with the Principles of Soil Mechanics and the calculation of different stresses in soil, which will be helpful in designing the retaining walls and other engineering structures.

THEORY

Introduction to Soil Mechanics, Field and scope of Soil Mechanics; Phase diagram, Physical and index properties of soil, Particle size distribution, Grain size distribution curve, Soil indices; Plastic limit, liquid limit, shrinkage limit; Classification of soils, Effective and neutral stress, Boussinesq and Wester-guard's analysis, New-mark's influence chart, Stress distribution and diagrams; Shear stress, Mohr's circle, Direct shear stress, Triaxial test and Vane shear test; Mohr coulomb failure theory, Effective stress principle, Determination of shear parameters by direct shear test, Triangle test and vane shear test. Numerical Exercise based on various types of tests Compaction of soils, Standard and modified protector test, Abbot's compaction and Jodhpur mini compaction test, Field compaction method and Control; Consolidation of soils, Terzaghi's theory of one-dimensional consolidation, Spring analogy, Laboratory consolidation test, Calculation of void ratio and coefficient of volume change, Taylor's and Casagrande's method. Earth pressure: Plastic equilibrium in soils, Active and passive states, Rankine's theory of earth pressure, Active and passive earth pressure for cohesive soils, Simple numerical exercises; Stability of slopes: Introduction to stability analysis of infinite and finite slopes friction circle method, Taylor's stability number, Friction circle method.

PRACTICAL

Determination of moisture content of soil sample; Determination of specific gravity of soil sample; Study of field density by core cutter; Study of bulk density, dry density by sand replacement method; Determination of grain size distribution of coarse grained soil by sieving; Determination of grain size by hydrometer method; Determination of liquid limit by Casagrande apparatus; Determination of liquid limit by cone penetrometer; Determination of plastic limit of soil specimen; Determination of shrinkage limit of soil; Determination of optimum moisture content of saturated soil by Abbot's compaction test; Determination of optimum moisture content of saturated soil by Proctor's mould; Consolidation characteristics of soil; Shear strength of soil by direct shear test; Shear strength of soil by tri-axial shear test.

TEACHING SCHEDULE

THEORY [SWCE-232]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	Soil Mechanics	Introduction to Soil Mechanics, Field and Scope of Soil Mechanics	5
2	Soil Properties	Soil as a three-phase system or diagram, Physical properties of soil (void ratio, porosity and degree of saturation, functional relationships and numerical)	5
3		Index properties of soil: Water content, Specific gravity, Particle size distribution, Consistency limits, *In-situ* density and Density index.	5
4		Particle size distribution, Grain size distribution curve, soil indices; Plastic limit, Liquid limit, Shrinkage limit	5
5		Classification of soils: Particle size classification, Textural classification Highway Research Board classification and Unified Classification	5
6	Soil Stresses	Effective and natural stress: Modes of water, capillarity and stress condition in soil	5
7		Boussinesq and Wester-guard's analysis, New-mark's influence chart	5
8 - 9		Mohr's circle, direct shear stress, triaxial test and vane shear test; Mohr coulomb failure theory, Effective stress principle, Determination of shear parameters by direct shear test, triangle test and vane shear test	10
10 - 11	Compaction of Soils	Standard Proctor Test, Modified Proctor Test, Abbot Compaction Test, Jodhpur Mini Compaction test, Field compaction methods and Field compaction control	15
12 - 13	Consolidation of Soil	One-dimensional consolidation, Spring analogy, Tergazi's theory of one-dimensional consolidation, Laboratory consolidation test, Calculation of voids ratio and coefficient of volume change, Taylor's and Casagrande's method.	15
14 - 15	Earth Pressure	Plastic equilibrium in soils, Active and passive states, Rankine's theory of earth pressure, Active earth pressure for cohesive soils, Passive earth pressure for cohesive soils. Simple Numerical Exercises.	15
16	Stability of Slopes	Introduction to Stability analysis of infinite slopes, Finite slope. Friction circle methos, Taylor's stability number, Friction circle method.	10
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [SWCE-232]

Exercise No.	Exercise Title
1	Determination of moisture content of soil sample.
2	Determination of specific gravity of soil sample.
3	Study of field density by core cutter.
4	Study of bulk density, dry density by sand replacement method.
5	Determination of grain size distribution of coarse-grained soil by sieving.
6	Determination of grain size by hydrometer method.
7	Determination of liquid limit by Cassagrande apparatus.
8	Determination of liquid limit by cone penetrometer.
9	Determination of plastic limit of soil specimen.
10	Determination of shrinkage limit of soil.
11	Determination of optimum moisture content of saturated soil by Abbot's compaction test.
12	Determination of optimum moisture content of saturated soil by Proctor's mould.
13	To study the Consolidation characteristics of soil.
14	Determination of hydraulic conductivity of soil by constant head methods.
15	Shear strength of soil by direct shear test.
16	Shear strength of soil by tri-axial shear test.

Suggested Readings [SWCE-232]:

1. Punmia B.C., Jain A.K. and Jain A.K. 2005. Soil Mechanics and Foundations. Laxmi Publications (P) Ltd., New Delhi.
2. Ranjan G. and Rao A. S. R. 1993. Basic and Applied Soil Mechanics. Welley Easters Ltd., New Delhi.
3. Singh A. 1994. Soil Engineering. Vol. I. CBS Publishers and Distributions, New Delhi.

Semester	**:**	**III**		
Course No.	**:**	**IDE-231**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Fluid Mechanics and Open Channel Hydraulics**		

SYLLABUS

Objectives : To make the students acquainted with the behaviour of fluids at rest and in motion and to enable them to apply the principles to design simple fluid mechanical systems in engineering

THEORY

Properties of fluids: Ideal and real fluid units; Pressure and its measurement, Pascal's law, pressure forces on plane and curved surfaces, center of pressure, pressure diagram, application of hydrostatics in engineering structures; Buoyancy, Archimedes' principle, metacenter and meta- centric height, condition of floatation and stability of submerged and floating bodies.

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

Flow through orifices (Measurement of Discharge, Measurement of Time), Flow through Mouthpieces, Flow over Notches, Flow over weirs, end contraction of rectangular weir, ventilation of weirs, various types of nappes.

Laminar and turbulent flow in pipes, General equation for head loss Darcy equation, Moody's diagram, minor and major hydraulic losses through pipes and fittings, Flow through network of pipes, Hydraulic gradient and energy gradient, Chezy's formula for loss of head in pipes, Flow through simple and compound pipes, Transmission of power through pipes.

Open channel design and hydraulics: Chezy's formula, Bazin's formula, Kutter's Manning's formula, Best hydraulic section, Velocity and Pressure profiles in open channels, Hydraulic jump, Discharge measurement in open channel: Current meter;

Dimensional analysis and similitude: Rayleigh's method and Buckingham's `Pi' theorem, Types of similarities, Dimensionless numbers. Introduction to fluid machinery.

PRACTICAL

Study of manometers and pressure gauges; Study of transmissibility of liquid pressure; Study of various types of flow such as laminar flow, uniform flow, steady flow, vertex flow rotational flow; Determination of meta centric height; Verification of Bernoulli's theorem; Determination of coefficient of discharge of venturimeter and orifice meter; Determination of coefficient of friction in pipeline; Determination of coefficient of discharge for rectangular notch and triangular notch.; Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice; Determination of coefficient of discharge for mouth piece.; Determination of efficiency of hydraulic ram; Measurement of velocity by current meter.; Study of open channel flow.; Velocity distribution in open channels and determination of Manning's coefficient of Rugosity and Chezy's roughness coefficient; Study of various types of models and prototypes: geometrical, kinematic and dynamic similarities; Study on non-dimensional constants such as Froud's number and Reynold's number; Study of various types of pumps and its components.

TEACHING SCHEDULE

THEORY [IDE-231]

Lecture No.	Topic	Sub- topics/ Key Points	Weightage, (%)
1	Properties of Fluids	Introduction, Properties of fluid, Types of fluids: Ideal and Real fluid.	15
2 -7	Pressure and its Measurement	Fluid pressure at point, Pascal's law, Absolute, Gauge, Atmospheric and Vacuum pressure. Piezometer, U-tube manometer, Single column manometer, U-tube differential manometers, Inverted U-tube differential manometer, Mechanical gauges.	
8 - 10	Pressure Forces on Plane and Curved Surfaces	Total pressure and center of pressure, Pressure diagram, Vertical plane surface submerged in liquid, Horizontal plane surface submerged in liquid, Inclined plane surface submerged in liquid, Curved surface sub-merged in liquid. Application of hydrostatics in engineering structures.	15
11 - 13	Buoyancy and Floatation	Archimedes's Principle, Introduction, Buoyancy, Center of buoyancy, Meta-centre, Metacentric height, Analytical method for metacentric height.	
		Conditions of floatation and stability of submerged and Floating bodies.	

Continued…

14 - 15	Kinematics of Fluid Flow	Lagrangian and Eulerian description of fluid motion.	10
16	Description of the Flow Pattern	Path lines, streak lines and stream lines, stream tube, Types of fluid flow, Translation, Rotation, Circulation and Vorticity, Vortex motion. Velocity potential function and Stream function, Vorticity, Flow net.	
17 - 18	Dynamics of Fluid Flow	Venturimeter, Bernoulli's equations; Orifice meter, Nozzle (Pitot-tube), Siphon.	
19 - 21	Flow through Orifices and Mouth Pieces; Flow through Notches, Weirs	Introduction, Classifications of orifices, Classifications of mouthpieces, Measurement of discharge, measurement of time. Classification of notches and weirs, Discharge over a rectangular notch or weir, Ventilation of weirs, Various types of nappe.	10
22 - 24	Laminar and Turbulent Flow in Pipes	General equation for head loss, Darcy equation, Moody's diagram; Major and minor hydraulic losses through pipes and fittings. Chezy's formula for loss of head in pipes. Flow through simple and compound pipe. Flow through network of pipes, Power transmission through pipes. Hydraulic gradient and energy gradient.	10
25 - 28	Open Channel Design and Hydraulics	Chezy's formula and Manning's formula, Bazin's formula, Ganguillet-Kutter's formula, Best hydraulic section, velocity and pressure profiles in open channels, Hydraulic jump, Discharge measurement in open channels; Current meter.	30
29 - 31	Dimensional Analysis and Similitude	Rayleigh's method, Buckingham's π – theorem, Types of similarities (Similitude), Dimensionless numbers.	10
32	Introduction of Fluid Machinery	Fluid machinery; Hydraulic ram.	
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [IDE-231]

Exercise No.	Exercise Title
1	Study of manometers and pressure gauges.
2	Study of transmissibility of liquid pressure.
3	Study of various types of flow such as laminar flow, uniform flow, steady flow, vertex flow, rotational flow.
4	Determination of meta centric height.
5	Verification of Bernoulli's theorem.
6	Determination of coefficient of discharge of venturimeter.
7	Determination of coefficient of discharge of orifice meter.
8	Determination of coefficient of friction in pipeline.
9	Determination of coefficient of discharge for rectangular notch and triangular notch.
10	Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice.
11	Determination of coefficient of discharge for mouth piece.
12	Determination of efficiency of hydraulic ram.
13	Study of open channel flow and measurement of velocity by current meter.
14	Velocity distribution in open channels and determination of Manning's coefficient of Rugosity and Chezy's roughness coefficient.
15	Study of various types of models and prototypes: geometrical, kinematic and dynamic similarities.
16	Study on non-dimensional constants such as Froude's number and Reynold's number and Study of various types of pumps and its components.

Suggested Readings [IDE-231]:

1. Bansal R.K. A Text Book of Fluid Mechanics and Hydraulic Mechanics (10th edition). Laxmi Publications (P) Ltd., New Delhi.
2. Modi P.N and Seth S.M. 2017. Hydraulics and Fluid Mechanics (including Hydraulic Machines) (16th Edition). Standard Book House, Delhi-6.
3. Garg S.K. Irrigation Engineering and Hydraulic Structures. Khanna Publisher, New Delhi.
4. Jagdish Lal. Fluid Mechanics. Metropolitan Books CI. Pvt. Ltd. New Delhi.
5. Ramanuthan S. 2011. Hydraulics, Fluid Mechanics and Hydraulic Machines. Dhanpat Rai and Sons, New Delhi.
6. Khurmi R.S. and Khurmi N.S. 1987. Hydraulics, Fluid Mechanics and Hydraulic Machines. S. Chand & Co. Ltd., New Delhi.

Semester	**:**	**III**		
Course No.	**:**	**PFE-231**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Engineering Properties of Agricultural Produce and Food Science**		

SYLLABUS

Objectives : To make the students acquainted with the different engineering properties of agricultural produce and to help them to understand the importance of these properties in handling, processing and storage.

THEORY

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

Thermal properties viz., heat capacity, specific heat, thermal conductivity, thermal diffusivity, heat of respiration, co-efficient of thermal expansion; Electrical and dielectric properties as resistance, capacitance, dielectric loss factor, loss tangent and dielectric constant; Frictional properties, viz. static friction, kinetic friction, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials; Aero-dynamic characteristics such as drag coefficient, terminal velocity.

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

Introduction to Food Science and Food Technology; Biochemical reactions involved in food processing and storage; Food spoilage agents, general methods for food preservation (physical, chemical and biological methods); Food microbiology: Classification of microorganisms, Multiplication of bacteria, Different beneficial and harmful microorganisms in relation to food preservation and spoilage, Industrial Bacteriology and Food fermentation.

PRACTICAL

Determination of the size of grains, fruits and vegetables using measuring instruments and using projection system; Determination of the shape (sphericity and roundness); Determination of the bulk and particle volume, bulk and particle density, specific gravity and porosity of grains; Determination of the volume, density and specific gravity of large individual objects (F and V); Determination of the surface area of the F and V; Determination of angle of repose, co-efficient of friction of different grains on different surfaces and angle of internal friction; To study the terminal velocity of grains and separating behavior of grains in a vertical wind tunnel; Determination of specific heat and thermal conductivity of some food grains; Determination of electrical properties of food materials; Determination of hardness of food materials; Determination of viscosity of food; Study and comparison of colour of food materials; Determination of carbohydrates; Determination of total nitrogen; Determination of oil content; Determination of ash content; Study of different types of microorganisms and microbiological examination of food products.

TEACHING SCHEDULE

THEORY [PFE-231]

Lecture No.	Topic	Sub-topics/ Key points	Weightage (%)
1	Engineering Properties	Different Engineering properties of food and their importance	10
2	Application of Engineering Properties	Application of Engineering properties in handling, processing and storage	
3 - 6	Physical Properties	viz., Shape, Size, Roundness, Sphericity, Surface area, Volume, Density, Porosity, Specific gravity	15
7	Colour Properties	CIE colour model	15
8 - 10	Thermal Properties	Heat capacity, Specific heat, Thermal conductivity, Thermal diffusivity, Heat of respiration, Coefficient of thermal expansion	
11 - 12	Electrical and Dielectric Properties	Resistance, Capacitance, Dielectric loss factor, Loss tangent and Dielectric constant	
13 - 14	Frictional Properties	Static friction, Kinetic friction, Rolling resistance, Angle of internal friction, Angle of repose, Flow of bulk granular materials	10
15	Aero-dynamic Characteristics	Drag coefficient, Terminal velocity	
16 - 18	Rheological Characteristics of Food	Elastic, plastic and viscous behaviour, Visco-elasticity, Rheological models to explain food characteristics	15
19 - 21		Fluid behaviour as Newtonian, Non-Newtonian, Pseudo-plastic, Dilatant, Thixotropic, Rheopectic and Bingham plastic; Textural characteristics of foods	
22 - 24	Non-destructive Methods of Quality Determination of Foods	Principles of machine vision systems and its application, Spectroscopy, Hyperspectral imaging and Acoustic techniques	15

Continued…

25	Introduction to Food Science and Food Technology	Introduction to Food Science and Food Technology	10
26	Biochemical Reactions	Biochemical reactions involved in food processing and storage	
27	Food Spoilage Agents	Food spoilage agents	
28	General Methods for Food Preservation	Physical, chemical and biological	
29	Food Microbiology	Classification of microorganisms, Multiplication of bacteria	
30 - 31	Different Microorganisms	Different beneficial and harmful microorganisms in relation to food preservation and spoilage	10
32	Industrial Bacteriology and Food Fermentation	Industrial Bacteriology and Food fermentation	
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [PFE-231]

Exercise No.	Exercise Title
1	Determination of the size of grains, fruits and vegetables using measuring instruments and using projection system.
2	Determination of the shape, sphericity and roundness.
3	Determination of the bulk and particle volume, bulk and particle density, specific gravity and porosity of large individual objects (Fruits, Vegetables and Grains)
4	Determination of the surface area of F & V.
5	Determination of angle of repose, co-efficient of friction of different grains on different surfaces and angle of internal friction.
6	To study the terminal velocity of grains and separating behavior of grain in a vertical wind tunnel.
7	Determination of specific heat and thermal conductivity of some food grains.
8	Determination of electrical properties of food materials.
9	Determination of hardness of food materials.
10	Determination of viscosity of food.
11	Study and comparison of colour of food materials.
12	Determination of carbohydrates.
13	Determination of total nitrogen.
14	Determination of oil content.
15	Determination of ash content
16	Study of different types of microorganisms and microbiological examination of food products.

Suggested Readings [PFE-231]:

1. Mohesin N.N. 1980. *Physical Properties of Plants & Animals*. Gordon & Breach Science Publishers, New York.
2. Singhal O.P. and Samuel D.V.K. 2003. *Engineering Properties of Biological Materials*. Saroj Prakasan, New Delhi.
3. Rao M.A. and Rizvi S.H. 1995. *Engineering Properties of Foods*. Marcel Dekker Inc. New York.
4. Jha. S.N. 2010. Non-destructive evaluation of food quality theory and practice. Springer -Verlag Berlin Heidelberg,
5. Ana Maria Jimenez-carvelo, Alejandra Arroyo-Carvelo & Luis Cuadros-Rodriguez. 2024. Non-invasive and Non-destructive methods for food integrity. Springer Nature Switzerland AG, Gewerbestrasse 11,6330, Cham Switzerland.
6. Notes of IGNOU, The people's university. Indira Gandhi National Open University of school of continuing education.
7. Vijaya Khader. 2001. Textbook of food science & Technology. Directorate of knowledge management in agriculture, (ICAR), Pusa, New Delhi.
8. William C. Frazier, Dennies C Westhoff. 2014. Food microbiology. McGraw hill education Pvt. Ltd. Chenni, India
9. Vijaya Khader. 2017. Preservation and processing of fruit and vegetables. Kalyani publication, New Delhi, India.
10. R.P.Shiratsava & Sanjeev Kumar. 2002. Fruit and vegetable preservation principle and practices. CBS publisher & distributor Pvt. Ltd. New Delhi, India
11. Fundamental of food microbiology, Chapter 1. Introduction to food microbiology, (Notes of IGNOU, The people's university. Indira Gandhi National Open University of School of Continuing Education).
12. L.E. Casida. 1968. Industrial Microbiology.
13. Serpil S. and Servet G S. 2005. *Physical Properties of Foods*. Springer Science + Business Media, LLC, 233 Spring Street, New York.

Semester	**:**	**III**		
Course No.	**:**	**FMPE-233**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Farm Machinery and Equipment-I**		

SYLLABUS

Objectives : To make the students acquainted with the basic construction and operational features of different farm machineries used in operations such as seed-bed preparation, sowing, planting and transplanting, etc. and their economics of operation.

THEORY

Introduction to Farm Mechanization; Classification of farm machines; Unit operations in crop production; Identification and selection of machines for various operations on the farm.

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

Seed-bed preparation and its classification; Land reclamation and earth moving equipment; Machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage, viz., mould-board plough, disc plough, chisel plough, sub-soiler, harrows, puddler, cultivators, identification of their major functional components; Attachments with tillage machinery; Hitching systems and controls.

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

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

PRACTICAL

Familiarization with different farm implements and tools; Study of hitching systems; Study on draft measurement; Study of different problems on machinery management.; Study of primary tillage machinery- types, construction, operation, adjustments and calculations of power and draft requirements; Study of secondary tillage machinery- types, construction, operation, adjustments and calculations of power and draft requirements; Study of different types of puddlers and determination of puddling index in the field; Study of sowing and planting equipment- construction, types, calculation for calibration and adjustments; Study of seed drill and its calibration; Study of different types of metering mechanisms used in seed drills and planters; Study of paddy transplanters; Study of various pre-germinated paddy seeder; Study of vegetable transplanters; Identification of materials of construction in agricultural machinery and study of material properties; Testing and Evaluation of tillage and sowing equipment; Visit to a site to observe field operations of paddy transplanters; Visit to an implement manufacturing unit.

TEACHING SCHEDULE

THEORY [FMPE-233]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 3	Farm Mechanization and Selection of Farm Machinery	Introduction to Farm Mechanization; Classification of farm machines; Unit operations in crop production; Identification and selection of machines for various operations on the farm.	10
4 - 7	Construction of Farm Machinery	Materials used in construction of farm machines; Heat treatment processes and their use in farm machines; Properties of materials used for critical and functional components of agricultural machines; Different types of steels and alloys for agricultural applications; Identification of heat treatment processes specially for the agricultural machinery components.	10
8 - 9	Seed-bed Preparation	Seed-bed preparation and its Classification; Land reclamation and earth moving equipment;	10
10 - 14	Tillage Equipment	Machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage viz., mould-board plough, disc plough, chisel plough, sub-soiler, harrows, puddler, cultivators, Identification of their major functional components.	15
15 - 16	Hitching System	Attachments with Tillage machinery; Hitching systems and controls.	5
17 - 20	Performance Parameters and Cost Economics	Calculation of field capacities and field efficiency; Draft of tillage tools and calculations for power requirement for the tillage machines; Calculation for economics of machinery usage; Comparison of ownership with hiring of machines.	10
21 - 25	Sowing and Planting Equipment	Sowing and Planting Equipments viz., Seed drills, no-till drills, strip-till drills, different types of planters, bed-planters; Planting equipment for crops like sugarcane, potato; Furrow openers and metering systems in drills and planters.	20

Continued…

26	Calibration of Seed-drills	Calibration of seed-drills/ planters; Adjustments during operation.	5
27 - 28	Transplanting Equipment	Paddy, vegetables and other transplanters.	5
29 - 32	Testing and Evaluation of Agricultural Equipment	Testing and Evaluation of tillage and sowing equipment and their test codes.	10
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [FMPE-233]

Exercise No.	Exercise Title
1	Study of hitching systems
2	Study of draft measurement of agricultural machinery
3	Study of different problems on machinery management
4 - 5	Study of primary tillage machinery- Types, construction, operation, adjustments and calculations of power and draft requirements
6 - 7	Study of secondary tillage machinery- Types, construction, operation, adjustments and calculations of power and draft requirements
8	Study of different types of puddlers and determination of puddling index in the field.
9	Study of Sowing and planting equipments: Construction, metering mechanism and adjustments
10	Study of calibration of seed drills and planters
11	Study of paddy transplanters and various pre-germinated paddy seeder
12	Study of vegetable transplanters
13	Identification of materials of construction in agricultural machinery and study of material properties
14	Testing and Evaluation of tillage and sowing equipment
15	Visit to a site to observe field operations of transplanters
16	Visit to an Implement Manufacturing Unit

Suggested Readings [FMPE-233]:

1. Jain, S.C. and Phillips, G. 2003. Farm Machinery - An Approach. Standard Publishers and Distributors.
2. Kepner, R. A., Bainer, R. and Barger, E. L. 2005. Principles of Farm Machinery. CBS Publishers and Distributors.
3. Lal Radhey and Datta, A.C. 1978. Agricultural Engineering through Worked Out Examples. Saroj Prakashan, Allahabad.
4. Nakra, C.P. 2003. Farm Machines and Equipment. Dhanpat Rai and Publishing Co.
5. Smith, H.P. and Wilkes, L.H. 2011. Farm Machinery and Equipment. McGraw Hill Publication, New York.
6. Srivastav, A.K., Goering, C.E. and Rohrbach, R.P. 2005. Engineering Principles of Agricultural Machines. ASAE. St. Joseph, Mich.
7. Srivastava, A.C. 1991. Elements of Farm Machinery. Oxford and IBH Publication.
8. Srivastava, T.K. 2007. A Work Book on Practical Farm Machinery. Vol. I and II. Saroj Prakashan, Allahabad
9. Suresh, R. and Kumar, S. 2018. Farm Power and Machinery Engineering. Standard Publishers.