

Mahakaushal University, Jabalpur (M.P.)



Scheme & Syllabus

For

B.Tech

in

Agriculture Engineering

2021-2022 onwards

Duration of Course: 4 Years

Examination Mode: Semester

Examination System: CBCS

**Mahakaushal University
Village-Aithakheda, Mukunwara Road, Post- Tilwara Jabalpur (M.P.) 482003**

Engineering Mathematics-I

UNIT – I

MATRICES Characteristic equation – Eigen values and Eigen vectors of a real matrix – Properties of Eigen values – Caley – Hamilton theorem – Orthogonal reduction of a symmetric matrix to diagonal form – Orthogonal matrices – Reduction of quadratic form to canonical form by orthogonal transformations.

UNIT – II

DIFFERENTIAL CALCULUS Curvature – Cartesian and polar coordinates – Circle of curvature – Involutives and Evolutives – Envelopes – Properties of envelopes.

UNIT – III

FUNCTIONS OF SEVERAL VARIABLES Function of two variables – Partial derivatives – Total differential – Taylor's expansion – Maxima and Minima – Constrained Maxima and Minima by Lagrangean Multiplier method – Jacobians

UNIT – IV

ORDINARY DIFFERENTIAL EQUATIONS Simultaneous first order linear equations with Constant coefficients – Linear equations of second order with constant and variable coefficients – Homogeneous equation of Euler type – Equations reducible to homogeneous form

UNIT – V

THREE DIMENSIONAL ANALYTICAL GEOMETRY Direction cosines and ratios – Angle between two lines – Equation of a plane – Equation of a straight line – Coplanar lines – Shortest distance between skew lines – Sphere – Tangent plane – Plane section of a sphere – Orthogonal Spheres.

Text Books

1. Grewal B.S, Higher Engg Maths, Khanna Publications, 38th Edition.
2. Dr.V.Ramamurthy & Dr. Sundarammal Kesavan, " Engineering Mathematics" – Vol I & II Anuradha Publications, Revised Edition 2006.

3. Veerajan, T., Engineering Mathematics, Tata McGraw Hill Publishing Co., New Delhi, 2000.

Reference Books

1. Kreyszig, E., "Advanced Engineering Mathematics", 8th edition, John Wiley & Sons. Singapore, 2001.
2. Kandasamy P et al. "Engineering Mathematics", Vol. I (4th revised edition), S.Chand & Co., New Delhi, 2000.
3. Narayanan S., Manicavachagom Pillay T.K., Ramanaiah G., "Advanced Mathematics for Engineering students", Volume I (2nd edition), S.Viswanathan Printers and Publishers, 1992.

Engineering Physics

UNIT – I

WAVE OPTICS-I Interference- definition, types, explanation of interference, Interference by Division of wave front: Fresnel's baptism, fringe width, Interference in thin films
Wedge shaped films, Interference by division of amplitude: Newton's rings, Michelson's Interferometer and its applications.

UNIT – II

WAVE OPTICS-II Diffraction:-Introduction - Differences between Fresnel and Fraunhofer Diffractions Single slit diffraction (Qualitative and quantitative treatment) – Differences between interference and diffraction, resolving power of optical instruments (prism and grating).
Polarization:- Introduction – double refraction –Negative crystals & Positive crystals - Nicol's prism – Quarter wave plate and half wave plate – Production and detection of circularly and elliptically polarized light.

UNIT – III

QUANTUM PHYSICS De Broglie's hypothesis, De Broglie's wave length, Davisson and Germer's experiment, Compton Effect, concept of wave packet & their properties, wave function & probability interpretation, Heisenberg's Uncertainty Principle, its elementary proof and applications, energy and momentum operators, time dependent and time independent Schrödinger Wave equation. Application of time independent Schrödinger wave equation to particle trapped in a one dimensional square potential well.

UNIT – IV

NUCLEAR PHYSICS

General properties of nucleus, Nuclear model (liquid drop model and shell model), accelerator, linear particle accelerator, cyclotron, general Bettertton, Counters and particle detectors Geiger-Muller Counter, nuclear fission, nuclear fusion, nuclear reaction, nuclear reactors.

UNIT – V

LASER AND FIBER OPTICS

Laser: Stimulated and spontaneous processes, main part of laser, laser action population

inversion, pumping, Optical resonators, characteristics of laser beam, Principles and working of Ruby, Nd: YAG, He-Ne & with energy level diagram and Applications of lasers Fiber Optics - Fundamental idea about optical fiber, types of fibers, acceptance angle & cone, numerical aperture, V-number, propagation of light through step index fiber (Ray theory) pulse dispersion, attenuation, losses, various uses, and application of optical fibers.

Text Books

1. Gaur and Gupta "Engineering Physics"
2. Tiwari and Navneet Gupta "Engineering Physics"
3. Vikram Yadav "Engineering Physics"

Reference Books

1. Beiser, "Modern Physics", McGraw-Hill Inc., New Delhi.
2. Avadhanulu and Kshirsagar "Engineering Physics".
3. Jenkins and White: "Optics", McGraw-Hill Book Company.
4. Sanjeev Puri: Modern Physics, Narosa Pub.Co. 2004.
5. Kaplan: Nuclear Physics, Narosa Publishing, 1987.
6. Tyagrajan and Ghatak: Lasers, Macmillan, 2001.

List of Experiments

1. Keiser: G Optical fiber Communication, McGraw-Hill, 2000.
2. Fresnel Biprism,
3. Newton's Rings,
4. Michelsons Interferometer.
5. Resolving Powers –Telescope,
6. Spectrometers-R.I., Wavelength, using prism and grating
7. Optical polarization based experiments: Brewster's angle, polar meter etc.
8. Measurements of wavelength of LASER
9. To study the CRO.
10. Charging and discharging of capacitor
11. Other conceptual experiments related to theory syllabus

Engineering Chemistry

UNIT – I

TECHNOLOGY OF WATER

Source of water, Impurities in water, Analysis of water- Hardness of water, Estimation of Hardness, Alkalinity of water, Determination of alkalinity, Disadvantages of using hard water in boiler- sludge and scale formation, Boiler corrosion, Water softening techniques (Internal and External treatment), treatment of water for domestic purposes.

UNIT – II

CORROSION AND ITS CONTROL

Corrosion: Basic concept- Principles, Mechanism of Dry or Chemical Corrosion and Wet or Electrochemical Corrosion, Pilling Bed worth rule, Types of corrosion- Galvanic corrosion, Concentration cell corrosion, Pitting corrosion, Stress corrosion, Microbiological corrosion, Factors influencing corrosion, Corrosion control.

UNIT – III

A. FUELS

Definition & Classification of fuels, Calorific values, Analysis of coal, Carbonization of coal, Manufacturing of coke & recovery of by-products. Cracking, Knocking, Anti-knocking, Octane & Cetane number, Gaseous fuels.

B. LUBRICANTS

Introduction, functions & classification of lubricants, Mechanism of lubrication, Properties and Testing of lubricants.

UNIT – IV

POLYMERS

Introduction and classification of polymers, Types of polymerization: addition or chain polymerization, condensation polymerization, Mechanism of addition polymerization -Free radical and Ionic polymerization, Ziegler Natta polymerization, Vulcanization of rubbers, Preparation, Properties and Applications of important polymers- Polyethylene, PVC, PMMA, Nylons, Terylene, Glyptal, Bakelite, Urea-formaldehyde, Silicone resin, Neoprene, Buna S, Buna N.

UNIT – V

INSTRUMENTATIONAL METHODS OF CHEMICAL ANALYSIS

Introduction to Spectroscopy, Electromagnetic spectrum, Introduction, Principle, Instrumentation and Application of IR, UV- Visible, NMR, Basic Principle and Instrumentation of Potentiometry, Flame photometry and Chromatography.

Text Books

1. Jain.P.C and Monika Jain, Engineering Chemistry, Dan pat Raj publishing company (P) Ltd, New Delhi – 2002.
2. Dara.S.S, Text book of Engineering Chemistry, S. Chand & Company Ltd, New Delhi
3. Sharma B.K., "Instrumental methods of chemical analysis" 24th Edition Krishna Prakashan Media Pvt. Ltd, Meerut, 2005.

Reference Books

1. Kuriacose J.C. And Rajaram J. Chemistry in Engineering and Technology, Volume II, Tata McGraw Hill p.b. Co., 1988.
2. Jeyalakshmi.R & Ramar. P, Engineering Chemistry, 1st Edition, Devi Publications, Chennai

2006.

3. Rattan S., Text book of Engineering Chemistry, S.K. Kataria and Sons, Publication, 1st Edition, New Delhi, 2012

List of Experiments

1. Preparation of standard solutions.
2. Conductometric titration-determination of strength of an acid.
3. Determination of alkalinity, hydroxyl, carbonate and bicarbonate in water.
4. Determination of total hardness in water using EDTA titrations.
5. Estimation of iron by potentiometer.
6. Estimation of Copper in Ore
8. Determination of viscosity of lubricating oil with change of temperature by
 - a. Red Wood Viscometer Number 1
 - b. Red Wood Viscometer Number 2
9. Determination of Flash and Fire point of liquid fuel and lubricants by
 - a. Cleveland's Open Cup Method
 - b. Abel's Flash Point Apparatus
 - c. Pensky Martin's Flash Point Apparatus.
10. Determination of Cloud and Pour point of lubricants by Cloud and Pour point Apparatus.
11. Determination of carbon residue of lubricants by Conradson's Apparatus.

REFERENCE BOOKS FOR PRACTICAL

1. Chemistry department manual, Edition, 2008.
2. Chawla S., Theory and Practical's of Engineering Chemistry, Dhanpat Rai & Co. (Pvt.) Ltd. 6th Edition, New Delhi –2011.

Workshop Practice & Technology

PURPOSE

To provide the students with hands on experience on different trades of engineering like fitting, carpentry, smithy, welding and sheet metal.

INSTRUCTIONAL OBJECTIVES

to familiarize with

1. The basics of tools and equipments used in fitting, carpentry, sheet metal, welding and smithy.
2. The production of simple models in the above trades.

Text Books

1. Gopal, T.V., Kumar, T., and Murali, G., A first course on workshop practice – Theory, practice And work book, Suma Publications, 2005.

Reference Books

1. Kannaiah, P. & Narayanan, K.C. Manual on Workshop Practice, Scitech Publications, Chennai, 1999.
2. Venkatachalapathy, V.S. , First year Engineering Workshop Practice, Ramalinga Publications, Madurai, 1999.

List of Experiments

1. EMPHASIS TO BE LAID ON REAL LIFE APPLICATIONS WHEN FRAMING THE EXERCISES.

2. FITTING

Tools & Equipments – Practice in Filing and Drilling.

Making Vee Joints, Square, dovetail joints, Key Making.

3. CARPENTARY

Tools and Equipments- Planning practice. Making Half Lap, dovetail, Mortise & Tenon joints, a mini model of a single door window frame.

4. SHEET METAL

Tools and equipments - Fabrication of a small cabinet, Rectangular Hopper, etc.

5. WELDING

Tools and equipments - Arc welding of butt joint, Lap Joint, Tee Fillet.

Demonstration of Gas welding, TIG & MIG.

6. SMITHY

Tools and Equipments –Making simple parts like hexagonal headed bolt, chisel.

Surveying and Leveling

UNIT-I

Modern equipments for surveying : Digital levels and theodolites, Electronic Distance measurement (EDM), Total Station and Global Positioning Systems (GPS), Digital Planimeter .

UNIT-II

Surveying Astronomy: Definitions of astronomical terms, coordinate systems for locating heavenly bodies, geographic, geodetic, geocentric, Cartesian, local and projected coordinates for earth resources mapping, convergence of meridian, parallel of latitude, shortest distance between two points on the earth, determination of latitude and longitude.

UNIT-III

GPS Surveying: Introduction & components of GPS, Space segment, control segment and user segment, Elements of Satellite based surveys-Map datum's, GPS receivers, GPS observation methods and their advantages over conventional methods.
Digital Terrain Model (DTM) : Topographic representation of the terrain and generation of DTM on computers using spot heights and contour maps.

UNIT-IV

Photogrammetric : Principle, definitions and classifications of terrestrial and aerial photogrammetric, flight planning for aerial photography, scale and relief displacements of vertical aerial photographs, stereoscopic vision on vertical photographs, computation of position, length and elevations of objects using photographs and photo mosaic.

UNIT-V

Remote Sensing: Principle, components, classification, remote sensing data acquisition process, different types of remote sensing satellite imagery with special relevance to Indian Remote Sensing Satellites (IRS) and applications. Geographic Information Systems (GIS) : Definition, components and advantages.
Surveying Project- Student will go for one week Surveying Camp to carry out Project Work.

SUGGESTED TEXT BOOKS AND REFERENCES :

1. Surveying and Leveling-Part-I & II by T.P. Kanetkar and S.V. Kulkarni, Pune Vidyarthi Griha Prakashan, Pune
2. Engineering Surveying : Theory and Examination Problems for Students by W . Schofield, Butterworth, Heinemann, Oxford.
3. Surveying: Problems Solving with theory and objective type questions by A.M. Chandra, New Age International Publishers N. Delhi.
4. Advance Surveying by A.M. Chandra, New Age International Publishers N. Delhi.
5. Surveying Vol. II by S.K. Duggal, Tata McGraw Hill Publishing Company Ltd. New Delhi.
6. Remote Sensing and image interpretation by Lilesand T.M. and Kiefer R.W

List of Experiments

1. **Introduction to Digital Level and Theodolite** (Modern Equipment Handling)
2. **Linear and Angular Measurement using Total Station/EDM**
3. **Area Determination using Digital Planimeter**
4. **GPS Observation and Data Collection** for farm boundary mapping (Static/Kinematic)
5. **Coordinate Conversion and Understanding Map Datums**
6. **Digital Terrain Model (DTM) Generation** and Contour Mapping from field data.
7. **Determination of Latitude and Longitude** using GPS.
8. **Calculation of Scale and Relief Displacement** on Aerial Photographs.
9. **Stereoscopic Vision** and interpretation using a pocket stereoscope.
10. **Remote Sensing Image Classification** and interpretation of agricultural land cover (using IRS imagery if possible).
11. **Introduction to Geographic Information Systems (GIS)** components and creation of basic spatial data layers.

Environmental Science

UNIT-I

The Multidisciplinary Nature of Environmental Studies and Ecosystems

Definition, scope and importance of Environmental Studies. Need for public awareness. Natural Resources: Renewable and non-renewable resources, natural resources and associated problems (forest, water, mineral, food, energy, land). Ecosystems: Concept, structure and function of an ecosystem, producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of forest, grassland, desert, and aquatic ecosystems.

UNIT-II

Biodiversity and Its Conservation

Biodiversity: Introduction, genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Global, National and Local level biodiversity. India as a mega-diversity nation. Hotspots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT-III

Environmental Pollution

Definition, causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, and Nuclear hazards. Solid waste management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies (e.g., Bhopal Gas Tragedy, Chernobyl). Disaster management: Floods, earthquake, cyclone and landslides.

UNIT-IV

Social Issues and the Environment

From unsustainable to sustainable development. Urban problems related to energy. Water conservation, rainwater harvesting, and watershed management. Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion. Wasteland reclamation. Consumerism and waste products. Environmental Protection Act (1986), Air (Prevention and Control of Pollution) Act (1981), Water (Prevention and Control of Pollution) Act (1974), Wildlife Protection Act, Forest Conservation Act.

UNIT-V

Human Population and Environment & Field Work

Population growth, variation among nations. Population explosion – Family Welfare Programme. Environment and human health: Human Rights. Value Education. HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and Human Health. Agriculture and Environmental Impact: Impact of modern agricultural practices (fertilizers, pesticides, irrigation) on the environment. Agro-Ecology and sustainable agriculture.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Textbook of Environmental Studies** for Undergraduate Courses by Erach Bharucha, Universities Press.
2. **Environmental Science: Working With the Earth** by G. Tyler Miller Jr., Scott E. Spoolman, Brooks Cole.
3. **Ecology and Environment** by P. D. Sharma, Rastogi Publications.
4. **Environmental Biology** by K. C. Aggarwal, Naim & Sons.
5. **Environmental Studies** by Benny Joseph, Tata McGraw-Hill.
6. **Principles of Environmental Science** by Cunningham, W.P. and Saigo, B.W., Tata McGraw Hill.
7. **Perspectives in Environmental Studies** by A. Kaushik and C. P. Kaushik, New Age International Publishers.

Agriculture for Engineers

UNIT-I

Introduction to Agriculture and Soil Science

Definition, scope, and importance of Agriculture in the national economy. General characteristics of a good soil. Soil components: Mineral matter, organic matter, soil air, and soil water. Physical properties of soil: Texture, structure, density, porosity, and consistency; their importance in tillage and crop growth. Soil classification and major soil types of India (Alluvial, Black, Red, Laterite). Soil fertility vs. Soil productivity. Basic knowledge of essential plant nutrients and their deficiency symptoms.

UNIT-II

Agronomy and Crop Production

Agronomy: Definition, scope, and principles. Classification of crops based on season (Kharif, Rabi, Zaid) and economic use (Cereals, Pulses, Oilseeds, Fibers). Tillage and Tillage Implements: Objectives of tillage, primary and secondary tillage, different types of plows, cultivators, and harrows. Seed and Sowing: Good quality seed characteristics, seed treatment, and methods of sowing (broadcasting, drilling, dibbling, transplanting). Water Management: Basics of water requirement of crops, methods of irrigation (surface, sprinkler, drip). Weed Management: Definition of weed, types, and methods of weed control (mechanical, chemical, cultural).

UNIT-III

Farm Machinery and Farm Power

Farm Power: Sources of farm power (human, animal, mechanical, electrical, renewable). Internal Combustion (IC) Engines: Working principle of 2-stroke and 4-stroke engines (Diesel and Petrol); basic components and terminology (Bore, Stroke, Compression Ratio). Tractors: Classification, main components, and power transmission system (Clutch, Gearbox, Differential). Tillage Machinery: Study of Mould Board (MB) plow and Disc plow (construction and adjustment). Sowing and Intercultural Machinery: Seed-cum-fertilizer drills and cultivators.

UNIT-IV

Horticulture and Post-Harvest Technology

Horticulture: Definition, scope, and branches (Pomology, Olericulture, Floriculture). Propagation Methods: Importance and types (cutting, layering, grafting, budding). Planting Systems in orchards. Post-Harvest Technology: Importance of post-harvest management. Drying and Storage: Principles of drying, moisture content, storage structures for grains and perishables (e.g., cold storage). Processing: Introduction to basic operations like cleaning, grading, milling, and extraction.

UNIT-V

Agricultural Structures and Renewable Energy

Farm Structures: Types of farm buildings (barns, granaries, cold storage, greenhouses). Greenhouse Technology: Classification of greenhouses, materials, and environmental control (temperature, humidity, ventilation). Renewable Energy in Agriculture: Solar energy applications (solar dryers, pumps), Biogas Technology (principle and plant types), Wind energy applications. Precision Agriculture: Introduction to GPS, GIS, and Remote Sensing in agriculture for site-specific farming.

List of Experiments

1. **Soil Texture Analysis:** Determination of soil texture by **Hydrometer method** (or Feel method) and plotting on the Textural Triangle.
2. **Soil Moisture Content:** Determination of **Moisture Content** in a given soil sample using the oven-dry method.
3. **Tractor Engine Study:** Study of the main components of a **Diesel/Petrol IC Engine** (cut-section model) and understanding the working cycle.
4. **Farm Implement Study (Tillage):** Study and sketching of the main components of a **Mould Board (MB) plow** and a **Disc plow**, including measurement of plow size.
5. **Farm Implement Study (Sowing):** Study of a **Seed-cum-Fertilizer Drill**, identification of metering mechanisms (fluted roller, cup feed), and principle of calibration.
6. **Irrigation Measurement:** Measurement of water flow rate using a **Rectangular Weir** or **V-notch** in a laboratory flume.
7. **Irrigation System Study:** Demonstration and study of the components of **Drip** and **Sprinkler** irrigation systems.
8. **Drying Experiment:** Determination of the **drying rate** of a given agricultural commodity (e.g., maize, paddy) using a laboratory dryer.
9. **Biogas Plant Study:** Detailed study of the components and working of a **Biogas Plant** model (e.g., Fixed dome or Floating drum type).
10. **Horticulture Technique:** Demonstration of different **plant propagation techniques** like cutting, layering, and grafting.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Agronomy: Principles and Practices** by S.R. Reddy, Kalyani Publishers.
2. **Principles of Agricultural Engineering (Vol. I)** by T.P. Ojha and A.M. Michael, Jain Brothers.
3. **Elements of Agricultural Engineering** by Jagdishwar Sahay, Standard Publishers Distributors.
4. **A Textbook of Soil Science** by D.K. Das, Kalyani Publishers.
5. **Farm Power and Machinery** by B.P.N. Singh and T. P. Ojha, Kalyani Publishers.
6. **Fundamentals of Renewable Energy** by G. D. Rai, Khanna Publishers.

English Language-I

UNIT-I

Basic Grammar and Vocabulary

Articles, Prepositions, Tenses (Simple, Continuous, Perfect), and Parts of Speech. Subject-Verb Agreement and Common Errors in English. Vocabulary Building techniques: Root words, Prefixes, and Suffixes. Technical Vocabulary relevant to engineering and science. Use of Synonyms and Antonyms. Homophones and Homonyms. One-Word Substitutions. Introduction to the use of a Thesaurus and Dictionary.

UNIT-II

Reading Comprehension and Critical Reading

Techniques for effective reading: Skimming and Scanning. Reading Comprehension exercises based on technical and non-technical passages. Identifying the main idea and supporting details. Inferencing and drawing conclusions. Critical Reading: Evaluating arguments, distinguishing fact from opinion, and recognizing author's tone and purpose. Exercises on reading various texts, including essays, reports, and articles.

UNIT-III

Written Communication: Mechanics and Paragraph Writing

Punctuation, Capitalization, and Spelling. Sentence Structure: Simple, compound, and complex sentences. Avoiding run-on sentences and sentence fragments. Paragraph Writing: Elements of a good paragraph (Unity, Coherence, and Development). Developing paragraphs using various methods (e.g., definition, classification, comparison-contrast, cause-effect). Writing short descriptive and narrative paragraphs.

UNIT-IV

Written Communication: Formal Letters and Memos

Formal Letter Writing: Essential components of a formal letter. Types of letters: Letter of Enquiry, Letter of Complaint, Letter of Order, and Official Correspondence. Memo Writing: Structure and purpose of a Memo (Inter-office communication). Writing Circulars and Notices. Note Making: Techniques for making effective notes from lectures or lengthy texts. Summarizing and precis writing.

UNIT-V

Oral Communication and Soft Skills

Introduction to Phonetics and Basic English Pronunciation. Effective Listening skills. Public Speaking: Overcoming nervousness and structuring a short presentation. Introducing oneself and others formally. Group Discussions (GDs): Rules and effective participation strategies. Interview Skills: Basic etiquette, preparing for common interview questions, and professional body language. Telephone Etiquette.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **High School English Grammar & Composition** by Wren and Martin, S. Chand & Company.
2. **Effective English Communication** by Krishnaswamy N., Tata McGraw Hill.
3. **Communication Skills** by V. K. Jain and O. P. Bakhshi, S. Chand & Sons.
4. **Basic Communication Skills for Technology** by Andrea J. Rutherford, Pearson Education.
5. **A Communicative Grammar of English** by Geoffrey Leech and Jan Svartvik, Longman.
6. **Word Power Made Easy** by Norman Lewis, Goyal Publishers & Distributors.

Engineering Drawing Lab

1. **Drafting Fundamentals:** Practice on **Lettering** (single-stroke and double-stroke) and **Dimensioning** (unidirectional and aligned systems) as per IS codes.
2. **Scales:** Construction of **Plain Scale** and **Diagonal Scale**.
3. **Orthographic Projections:** Drawing the **Orthographic Views** (Front, Top, and Side views) of simple machine parts or objects from their pictorial views.
4. **Projections of Lines:** Determination of **True Length** and **True Inclination** of a straight line inclined to both the HP and VP.
5. **Projections of Solids:** Drawing the projections of a **Solid** (e.g., Pyramid or Prism) when its axis is inclined to one reference plane.
6. **Sections and Development:** Drawing the **Sectional View** and the **True Shape of the Section** of a simple solid (e.g., a cylinder).
7. **Isometric Projection:** Drawing the **Isometric View** of a simple object or combination of solids from its given orthographic views.
8. **CAD Basic Commands:** Familiarization with the CAD software interface; using basic **Drawing** (Line, Circle) and **Modify** (Trim, Extend, Offset) commands.
9. **CAD Dimensioning & Layers:** Using CAD to draw a 2D engineering part, applying proper **Dimensioning** and managing different **Layers**.
10. **CAD Application:** Creating a simple 2D drawing of a **Mechanical component** or a basic **Farm Layout/Structure** in CAD.

Engineering Mathematics-II

UNIT – I

Laplace Transform: Introduction of Laplace Transform, Laplace Transform of elementary functions, properties of Laplace Transform, Change of scale property, second shifting property, Laplace transform of the derivative, Inverse Laplace transform & its properties, Convolution theorem, Applications of L.T. to solve the ordinary differential equations

UNIT – II

Fourier Series: Introduction of Fourier series , Fourier series for Discontinuous functions, Fourier series for even and odd function, Half range series Fourier Transform: Definition and properties of Fourier transform.

UNIT – III

Second Order linear differential equation with variable coefficients : Methods one integral is known, removal of first derivative, changing of independent variable and variation of parameter, Solution by Series Method.

UNIT – IV

Linear and Non Linear partial differential equation of first order: Formulation of partial differential equations, solution of equation by direct integration, Lagrange's Linear equation, charpit's method. Linear partial differential equation of second and higher order: Linear homogeneous and non homogeneous partial diff. equation. Separation of variable method for the solution of wave and heat equations.

UNIT – V

Vector Calculus: Differentiation of vectors, scalar and vector point function, geometrical meaning of Gradient, unit normal vector and directional derivative, physical interpretation of divergence and Curl. Line integral, surface integral and volume integral, Green's, Stoke's and Gauss divergence theorem.

Text Books

1. Grewal B.S, Higher Engg Maths, Khanna Publications, 38th Edition. Veerajan, T., Engineering

Reference Books

1. Advanced Engineering Mathematics by Erwin Kreyszig, Wiley India
2. Higher Engineering Mathematics by BS Grewal, Khanna Publication
3. Advance Engineering Mathematics by D.G.Guffy

Computers Programming and Data Structures

UNIT-I

Introduction to Programming and C Fundamentals

Computer Basics: Hardware, software, compilers, interpreters. Problem-Solving Techniques: Algorithms, flowcharts, and pseudo-code. Introduction to C: Structure of a C program, compilation, and execution. Data Types, Variables, Constants. Operators (Arithmetic, Relational, Logical, Bitwise) and Expressions. Input/Output Operations (printf(), scanf()). Control Structures: Decision making (if, if-else, switch) and Looping (while, do-while, for, break, continue).

UNIT-II

Functions, Arrays, and Strings

Functions: Need for functions, definition, declaration, and calling. Scope Rules and storage classes. Recursion (Factorial, Fibonacci series). Arrays: One-dimensional, two-dimensional, and multi-dimensional arrays. Initialization and accessing elements. Pointers (introduction only). Strings: Declaration, initialization, reading, writing, and standard string functions (strlen, strcpy, strcat, strcmp).

UNIT-III

Pointers, Structures, and File Handling

Pointers: Pointer variables, pointer arithmetic, pointers and arrays, array of pointers, and function pointers. Structures and Unions: Defining and initializing structures, accessing members, array of structures. Self-Referential Structures (introduction). File Handling: Working with files (text and binary files). File operations (fopen, fprintf, fscanf, getc, putc, fclose). Application: Simple data logging and retrieval (relevant to agricultural sensors/data).

UNIT-IV

Introduction to Data Structures and Linear Structures

Data Structures: Definition, classification (primitive, non-primitive, linear, non-linear). Abstract Data Types (ADT). Arrays as an ADT. Stack ADT: Operations (Push, Pop, Peek) and applications (Expression evaluation, function calls). Queue ADT: Operations (Enqueue, Dequeue) and types (Circular Queue, Linked Lists). Linked Lists: Singly linked list (creation, insertion, deletion, display).

UNIT-V

Non-Linear Data Structures and Sorting/Searching

Trees: Definition, terminology (root, node, height, depth), and Binary Trees. Binary Search Tree (BST): Creation and basic operations (search, insertion). Graphs: Terminology (vertex, edge, weighted graph), introduction to representation (Adjacency Matrix). Sorting Techniques: Elementary sorting algorithms: Bubble Sort, Selection Sort, and Insertion Sort. Searching: Linear Search and Binary Search.

List of Experiments

1. **C Basics:** Implement programs using basic I/O, operators, and different **Control Structures** (e.g., calculating simple and compound interest, solving quadratic equation roots).
2. **Logic and Iteration:** Write programs to generate series (e.g., Fibonacci, Prime numbers) and check properties of numbers using nested loops.
3. **Functions and Recursion:** Implement functions for tasks like calculating **Factorial** using **recursion** and determining the Greatest Common Divisor (GCD).
4. **Arrays:** Implement programs for matrix operations (**addition/multiplication**) and statistical calculations (mean, standard deviation) on a list of experimental data.
5. **Strings:** Write programs to perform operations on strings (e.g., check for palindrome, reverse a string) and count words/characters in a given text.
6. **Structures and Pointers:** Implement a program using **Structures** to store and manipulate a list of agricultural records (e.g., crop yield data, weather data) and sort them using **Pointers**.
7. **File Handling:** Implement a program to **read and write data** (e.g., sensor readings like temperature, moisture) to a text file and retrieve/display the data.
8. **Linear Data Structures (Stack):** Implement **Stack** operations (Push, Pop) using an array and apply it to check for **parenthesis balancing**.
9. **Linear Data Structures (Queue):** Implement **Queue** operations (Enqueue, Dequeue) using an array or a linked list, applicable for simulating task scheduling.
10. **Searching and Sorting:** Implement and compare the performance of **Linear Search** and **Binary Search**. Implement a simple **Sorting Algorithm** (e.g., Selection or Bubble Sort) to sort crop data.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Programming in ANSI C** by E. Balagurusamy, Tata McGraw Hill Education.
2. **Data Structures through C in Depth** by S. K. Srivastava and Deepali Srivastava, BPB Publications.
3. **The C Programming Language** by Brian W. Kernighan and Dennis M. Ritchie, Prentice Hall.
4. **Data Structures using C** by Reema Thareja, Oxford University Press.
5. **Introduction to Algorithms** by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, MIT Press.

Applied Electronics and Instrumentation

UNIT-I

Semiconductor Devices and Basic Circuits

Semiconductor Theory: Intrinsic and extrinsic semiconductors, p-n junction diode characteristics. Rectifiers: Half-wave, Full-wave (Centre-tap and Bridge) rectifiers; calculation of ripple factor and efficiency. Filters: Introduction to capacitor and L-C filters. Zener Diode: Operation and application as a Voltage Regulator. Bipolar Junction Transistors (BJT): Basic structure, configurations (C-B, C-E, C-C), and C-E characteristics.

UNIT-II

Amplifiers and Operational Amplifiers (Op-Amps)

Amplifiers: Introduction, types of coupling (R-C coupled), and basic C-E amplifier circuit. Feedback: Concepts of positive and negative feedback; its effect on gain and bandwidth. Operational Amplifier (Op-Amp): Ideal characteristics, concept of virtual ground. Basic Op-Amp Circuits: Inverting, Non-inverting, Adder, Subtractor, Integrator, and Differentiator. Comparator and its application in signal conditioning.

UNIT-III

Digital Electronics and Logic Gates

Number Systems: Binary, Octal, Decimal, and Hexadecimal conversion. Binary Codes: B-C-D and Gray codes. Boolean Algebra: Basic theorems and postulates. Logic Gates: AND, OR, NOT, NAND, NOR, XOR, and XNOR. Realization of logic functions using universal gates (NAND/NOR). Combinational Circuits: Half Adder, Full Adder, Multiplexer (MUX), and Demultiplexer (DEMUX). Flip-Flops: Introduction to S-R, J-K and D Flip-Flops.

UNIT-IV

Transducers and Sensors for Agriculture

Instrumentation System: Functional elements (transducer, signal conditioner, display). Transducers: Classification, selection criteria. Resistive Transducers: Potentiometers (for displacement), Strain Gauges (for force/weight). Capacitive and Inductive Transducers. Sensors for Agriculture: Measurement of Soil Moisture (TDR, Tensiometer), Temperature (R-T-D, Thermistor), Light Intensity (Photodiode), and p-H value. Introduction to Biosensors for quality analysis.

UNIT-V

Measuring Instruments and Data Acquisition

Analog Meters: Working principle of P-M-M-C type instruments (Ammeter and Voltmeter). Bridge Circuits: Wheatstone Bridge and Maxwell Bridge for resistance and inductance measurement. Oscilloscope (C-R-O): Functional block diagram and application for voltage, frequency, and phase measurement. Digital Instruments: Introduction to Digital Voltmeter (DVM). Data Acquisition Systems (D-A-S): Basic components, A-D and D-A converters, and their necessity in Precision Agriculture.

List of Experiments

1. Semiconductor Characteristics: Plot the V-I characteristics of a p-n Junction Diode and determine its static and dynamic resistance.
2. Voltage Regulation: Study and verify the performance of a Zener Diode as a voltage regulator.
3. Rectifier Circuit: Assemble and test a Bridge Rectifier circuit, calculate its ripple factor with and without a capacitor filter.
4. Transistor Amplifier: Plot the input and output characteristics of a B-J-T in C-E configuration and determine the current gain (β).
5. Op-Amp Applications: Implement and verify the output of Op-Amp based circuits: Inverting Amplifier and Non-Inverting Amplifier (for signal gain).
6. Logic Gates: Verify the truth tables of basic Logic Gates (A-N-D, O-R, N-O-T) and Universal Gates (N-A-N-D, N-O-R).
7. Combinational Logic: Design and test a Half-Adder or Full-Adder circuit.
8. Strain Gauge Application: Assemble and balance a W-h-e-a-t-s-t-o-n-e B-r-i-dg-e and demonstrate its use with a Strain Gauge for measuring physical change (e.g., small weight or deflection).
9. Temperature Sensing: Calibrate a Thermistor or R-T-D and use a D-M-M (Digital Multimeter) to measure temperature.
10. C-R-O Measurement: Use a C-R-O to measure voltage, frequency, and phase difference of A-C signals.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. Electronic Devices and Circuit Theory by Robert L. Boylestad and Louis Nashelsky, Pearson Education.
2. Digital Logic and Computer Design by M. Morris Mano, Pearson Education.
3. Electronic Instrumentation by H. S. Kalsi, Tata McGraw Hill Education.
4. Electrical and Electronic Measurements and Instrumentation by A. K. Sawhney, Dhanpat Rai & Sons.
5. Op-Amps and Linear Integrated Circuits by Ramakant A. Gayakwad, Prentice Hall,

Electrical Circuits

UNIT-I

DC Circuit Fundamentals and Network Theorems

Basic Definitions: Voltage, current, power, energy, resistance, inductance, and capacitance. Ohm's Law. Kirchhoff's Laws (K-V-L and K-C-L). Series and Parallel combinations of resistors. Nodal and Mesh Analysis for simple DC circuits. Network Theorems (DC): Statement and application of Superposition Theorem, Thevenin's Theorem, and Norton's Theorem. Maximum Power Transfer Theorem.

UNIT-II

Steady-State AC Circuits

Alternating Current (AC) Fundamentals: Generation of AC voltage, instantaneous, peak, R-M-S and average values, and form factor. Phasor representation of sinusoidal quantities. Impedance and Admittance. AC Circuit Analysis: Behavior of R, L, and C in AC circuits. Series R-L, R-C, and R-L-C circuits: Impedance calculation, phasor diagrams, and power (P, Q, S). Parallel R-L-C circuits.

UNIT-III

Resonance and Coupled Circuits

Series Resonance: Resonance frequency, impedance and current at resonance, Q-factor, and bandwidth. Parallel Resonance: Resonance frequency and its characteristics. Magnetically Coupled Circuits: Concept of mutual inductance and coefficient of coupling, Dot Convention. Analysis of simple coupled circuits.

UNIT-IV

Three-Phase AC Systems

Generation of Three-Phase E-M-Fs. Phase Sequence. Three-Phase Connections: Star (Y) and Delta (Δ) configurations; relationship between line and phase voltages and currents in balanced systems. Power Measurement: Measurement of three-phase power using the Two-Wattmeter Method for balanced loads. Concept of Power Factor in three-phase systems.

UNIT-V

Transients and Circuit Instruments

Transient Response: Introduction to transient behavior in R-L and R-C circuits (DC excitation). Time Constant concept. Laplace Transform method for solving simple transient circuits (conceptual introduction). Measuring Instruments: Introduction to P-M-M-C and Electrodynamometer type instruments. Construction and working principles of Ammeter, Voltmeter, and Wattmeter.

List of Experiments

1. **Ohm's Law Verification:** Verify Ohm's Law and study the **series and parallel combination** of resistors.
 2. **Kirchhoff's Laws Verification:** Experimentally verify **Kirchhoff's Current Law** and **Kirchhoff's Voltage Law** in a simple DC circuit.
 3. **Superposition Theorem:** Verify the **Superposition Theorem** for voltage or current in a linear DC circuit with two sources.
 4. **Thevenin's and Norton's Theorems:** Verify **Thevenin's Theorem** and **Norton's Theorem** and find the equivalent circuit for a given DC network.
 5. **Maximum Power Transfer:** Determine the condition for **Maximum Power Transfer** in a DC circuit by varying the load resistance.
 6. **Series Circuit:** Study the behavior of a **Series Circuit** under AC excitation, measure the impedance and power factor.
 7. **Series Resonance:** Study the characteristics of a **Series Resonant Circuit**, determine the resonant frequency and factor.
 8. **Three-Phase Power Measurement:** Measure the **Three-Phase Power** and **Power Factor** for a balanced connected or connected load using the **Two-Wattmeter Method**.
 9. **Wattmeter and Energy Meter:** Study the connection and functional use of a **Single-Phase Wattmeter** and a **Single-Phase Energy Meter**.
 10. **Application:** Use a (Cathode Ray Oscilloscope) to measure the **Phase Difference** between the voltage and current in an or circuit.
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SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Electrical Technology (Vol. I)** by B. L. Theraja and A. K. Theraja, S. Chand & Company.
2. **Electric Circuit Analysis** by Abhijit Chakrabarti, Dhanpat Rai & Co.
3. **Engineering Circuit Analysis** by W. H. Hayt, J. E. Kemmerly, and S. M. Durbin, McGraw Hill Education.
4. **Circuits and Networks: Analysis and Synthesis** by A. Sudhakar and S. P. Shyammoan, Tata McGraw Hill Education.
5. **Fundamentals of Electric Circuits** by Charles K. Alexander and Matthew N. O. Sadiku, McGraw Hill Education.

Thermodynamics and Heat Engines

UNIT-I

Basic Concepts of Thermodynamics and the First Law

Fundamental Concepts: Definition of Thermodynamic System (open, closed, isolated), State, Path, and Process. Properties of a System (intensive and extensive). Thermodynamic Equilibrium. Pure Substance and Phase Rule. Zeroth Law of Thermodynamics and concept of temperature. Work and Heat interactions. First Law of Thermodynamics for a closed system, application to non-flow and steady-flow processes. Internal Energy and Enthalpy.

UNIT-II

The Second Law and Entropy

Second Law of Thermodynamics: Limitations of the First Law. Heat Engine, Refrigerator, and Heat Pump. Statements of the Second Law (Clausius and Kelvin-Planck). Reversibility and Irreversibility. Carnot Cycle and Carnot Theorem. Thermodynamic Temperature Scale. Entropy: Concept, Clausius inequality, calculation of entropy change for various processes. T-S Diagram.

UNIT-III

Properties of Steam and Steam Cycles

Formation of Steam: Saturated steam, wet steam, superheated steam. P-V and T-S diagrams for water and steam. Use of Steam Tables and Mollier Charts (H-S diagram) for property determination. Vapour Power Cycles: Rankine Cycle (simple, ideal cycle). Factors affecting the efficiency of the Rankine Cycle. Introduction to Steam Boilers (types and components).

UNIT-IV

Internal Combustion (IC) Engines and Gas Cycles

Classification of IC Engines: 2-Stroke and 4-Stroke, Spark Ignition (S-I) and Compression Ignition (C-I) engines. Air Standard Cycles: Derivation of efficiency for Otto Cycle and Diesel Cycle. Comparison of Cycles. Engine Performance Parameters: Indicated Power (I-P), Brake Power (B-P), Mechanical Efficiency, and Specific Fuel Consumption (S-F-C). Engine Systems: Ignition, Lubrication, ~~Cooling~~ and Fuel Feed systems (overview).

UNIT-V

Heat Transfer and Refrigeration

Modes of Heat Transfer: Introduction to Conduction (Fourier's Law), Convection (Newton's Law of Cooling), and Radiation (Stefan-Boltzmann Law). Simple numerical problems on heat transfer. Refrigeration: Principles of refrigeration. Vapour Compression Refrigeration Cycle (Simple P-H diagram). Refrigerants (types and properties). Introduction to the use of refrigeration and cold storage in agriculture.

List of Experiments

1. **Engine Familiarization:** Study and identify the main parts and systems of a **4-Stroke Diesel or Petrol Engine** (using cut-section models or actual engine).
2. **Valve Timing Diagram:** Draw the **Valve Timing Diagram** for a 4-Stroke - or - Engine and understand the function of valve overlap.
3. **Engine Performance Test (Diesel):** Conduct a load test on a **4-Stroke Diesel Engine** and determine **Brake Power , Brake Specific Fuel Consumption, and Brake Thermal Efficiency.**
4. **Engine Performance Test (Petrol):** Conduct a load test on a **4-Stroke Petrol Engine** and determine its performance parameters
5. **Heat Balance Sheet:** Determine the **Heat Balance Sheet** for an -Engine (Diesel or Petrol) at a constant load.
6. **Bomb Calorimeter:** Determine the **Higher Calorific Value** of a solid or liquid fuel using a Bomb Calorimeter.
7. **Separating and Throttling Calorimeter:** Determine the **Dryness Fraction** of wet steam using a **Separating and Throttling Calorimeter.**
8. **Vapour Compression System:** Study the working and components of a simple **Vapour Compression Refrigeration Test Rig** and plot the cycle on a -diagram.
9. **Temperature Measurement:** Calibration of various **Temperature Measuring Instruments** (e.g., Thermocouple).
10. **Thermal Conductivity:** Determine the **Thermal Conductivity** of a given metal rod or insulating material.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **A Textbook of Thermal Engineering** by R. S. Khurmi and J. K. Gupta, S. Chand & Co.
2. **Engineering Thermodynamics** by P. K. Nag, Tata McGraw Hill Education.
3. **Fundamentals of Classical Thermodynamics** by Gordon J. Van Wylen and Richard E. Sonntag, John Wiley & Sons.
4. **Heat and Mass Transfer** by D. S. Kumar, S. K. Kataria & Sons.
5. **IC Engines** by V. Ganesan, Tata McGraw Hill Education.

Engineering Mechanics

UNIT-I

Statics of Particles and Rigid Bodies

Introduction: Concepts of rigid bodies, deformable bodies, and fluid. Forces: Characteristics, unit, and classification. System of Forces (Collinear, Coplanar, Spatial). Principle of Transmissibility. Resolution and Composition of Forces. Resultant of a system of forces. Equilibrium of a Particle: Conditions for equilibrium, Lami's Theorem. Free Body Diagram (FBD). Equilibrium of Rigid Bodies: Moments, couples, and their properties. Varignon's Theorem.

UNIT-II

Friction and Analysis of Structures

Friction: Types of friction (static and kinetic). Laws of Dry Friction. Coefficient of friction. Angle of Friction and Angle of Repose. Applications of Friction: Wedge friction, block on an inclined plane. Analysis of Structures: Definition of a Truss, types of trusses. Assumptions made in truss analysis. Methods of Analysis: Method of Joints (for simple trusses) and Method of Sections.

UNIT-III

Centroid, Moment of Inertia, and Simple Machines

Centroid and Centre of Gravity (C.G.): Definitions. Locating C.G. of simple plane areas (rectangle, triangle, circle). Moment of Inertia (M.I.): Definition, Radius of Gyration. Parallel Axis Theorem and Perpendicular Axis Theorem. Calculating M.I. of simple and composite laminae. Simple Machines: Definitions of Lift, Effort, Mechanical Advantage (M.A.), Velocity Ratio (V.R.), and Efficiency. Simple lifting machine, Law of Machine.

UNIT-IV

Kinematics of Particles

Basic Concepts: Displacement, velocity, and acceleration. Motion under Constant Acceleration (rectilinear motion). Curvilinear Motion: Projectile motion. Relative Motion. D'Alembert's Principle. Kinematics of Rotation: Angular displacement, velocity, and acceleration. Relationship between linear and angular parameters.

UNIT-V

Kinetics of Particles

Newton's Laws of Motion and their application. Work, Power, and Energy: Work-Energy Principle. Conservation of Energy. Impulse and Momentum: Principle of Conservation of Momentum. Impact of Bodies (elastic and inelastic collisions, coefficient of restitution). Circular Motion: Centripetal and centrifugal forces.

List of Experiments

1. **Verification of Polygon Law of Forces:** Verify the **Polygon Law of Forces** for a coplanar, concurrent force system using a force table.
2. **Verification of Lami's Theorem:** Determine the unknown force in a three-force system by applying and verifying **Lami's Theorem**.
3. **Beam Reactions:** Determine the **reactions at the supports** for a simply supported beam under various loading conditions (concentrated and uniformly distributed loads).
4. **Verification of Equilibrium of a Rigid Body:** Determine the position of the **Centre of Gravity (C.G.)** of an irregular plane lamina.
5. **Coefficient of Friction:** Determine the **coefficient of static and kinetic friction** for different pairs of surfaces (e.g., wood on wood, metal on metal).
6. **Inclined Plane:** Determine the **force required to move a body** up and down a rough inclined plane, and verify the effect of the **Angle of Repose**.
7. **Simple Lifting Machine:** Study a **Simple Screw Jack** (or Worm and Worm Wheel) to determine its **Mechanical Advantage, Velocity Ratio, and Efficiency**, and plot the **Law of the Machine**.
8. **Conservation of Energy:** Study and verify the principle of **Conservation of Energy** using a '**Compound Pendulum**' or a similar setup.
9. **Moment of Inertia:** Determine the **Moment of Inertia** of a given flywheel or disc.
10. **Truss Analysis Demonstration:** Use a simple truss model and load it to observe the nature of forces (tension/compression) in different members.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Engineering Mechanics (Statics and Dynamics)** by A. K. Tayal, Umesh Publications.
2. **Engineering Mechanics** by S. Timoshenko, D. H. Young, and J. V. Rao, McGraw Hill Education.
3. **A Textbook of Engineering Mechanics** by R. K. Bansal, Laxmi Publications.
4. **Vector Mechanics for Engineers: Statics and Dynamics** by F. P. Beer and E. R. Johnston Jr., McGraw Hill Education.
5. **Engineering Mechanics: Statics** by J. L. Meriam and L. G. Kraige, John Wiley & Sons.

English Language-II

UNIT-I

Technical Communication Essentials

Nature and Scope of Technical Communication and its importance in the professional world. Forms of Technical Communication (reports, proposals, specifications). Style in Technical Writing: Clarity, precision, objectivity, and brevity. Effective Sentence and Paragraph Structure for technical content. Definition and Description: Writing formal definitions, describing objects and processes.

UNIT-II

Technical Report Writing

Types of Reports: Informational and Analytical Reports. Structure of a Formal Report: Title page, Abstract/Summary, Table of Contents, Introduction, Body (Discussion), Conclusions, Recommendations, and Appendices. Memos and Circulars: Writing effective inter-office communications. Minutes of Meeting (MoM): Drafting and finalizing minutes.

UNIT-III

Business and Professional Writing

Job Application and Resume Writing: Writing effective Cover Letters and different formats of Curriculum Vitae (CV)/Resume (chronological, functional). Email Etiquette: Writing professional and formal emails for various purposes. Drafting Proposals: Introduction to the structure and components of a technical/business proposal. Tender Notices and Quotations (basic formats).

UNIT-IV

Oral Communication and Presentation Skills

Techniques of Public Speaking: Organizing content, managing audience, and using visual aids effectively. Presentation Skills: Designing and delivering technical presentations (slides, content, delivery). Group Discussions (GDs): Objectives, strategies for effective participation, and evaluation criteria. Interview Techniques: Types of interviews, body language, and preparation for H-R and technical rounds.

UNIT-V

Advanced Grammar and Soft Skills

Error Analysis: Advanced common errors in grammar and usage. Active and Passive Voice (use in technical writing). Direct and Indirect Speech. Punctuation and Mechanics (advanced use of semi colons, colons, and hyphens). Soft Skills: Understanding and developing Interpersonal Skills, Leadership, Teamwork, Time Management, and Emotional Intelligence.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Technical Communication: Principles and Practice** by Meenakshi Raman and Sangeeta Sharma, Oxford University Press.
2. **Effective Technical Communication** by Barun K. Mitra, Oxford University Press.
3. **Basic Communication Skills for Technology** by Andrea J. Rutherford, Pearson Education.
4. **Business Communication** by Rayudu, H. P., Himalaya Publishing House.
5. **Soft Skills for Everyone** by Jeff Butterfield, Cengage Learning.

Operation & Maintenance of Tractor and Farm Machinery Lab

1. **Tractor Familiarization:** Study and identify the main parts, controls, and instrument panel of a standard **Agricultural Tractor**.
2. **Engine Maintenance:** Perform the procedure for checking and replenishing engine oil, cooling system fluid, and identifying various filters (air, fuel, oil).
3. **Tractor Pre-Operational Check:** Perform the complete list of daily and weekly **Pre-Operational Checks** on a tractor.
4. **Tractor Clutch and Brake Adjustment:** Practice the procedure for checking and adjusting the free play in the **Clutch Pedal** and the **Brake Pedals**.
5. **Tyre Inflation and Ballasting:** Measure the inflation pressure of tractor tyres and understand the concept and methods of **Water Ballasting** for traction improvement.
6. **Plow Adjustment:** Study and adjust the operational settings of a **Mould Board (MB) Plow** or **Disc Plow** for proper depth, width of cut, and leveling.
7. **Tillage Implement Field Operation:** Operate the tractor with a primary tillage implement (e.g., cultivator or disc harrow) to practice **straight-line driving and headland turning**.
8. **Seed Drill Calibration:** Calibrate a **Seed-cum-Fertilizer Drill** or a **Planter** to deliver a predetermined rate of seed or fertilizer application per unit area.
9. **Sprayer Calibration:** Calibrate a **Field Sprayer** (e.g., boom sprayer) to achieve a required application rate by adjusting pressure and nozzle output.
10. **Hitch System Adjustment:** Practice connecting and disconnecting an implement (e.g., trailer, rotavator) using the **Three-Point Hitch System**, focusing on leveling and proper pin connection.
11. **Troubleshooting Basics:** Practice identifying and troubleshooting common minor faults in a tractor or implement (e.g., engine overheating, hydraulic pressure drop, blocked seed tube).
12. **Field Capacity Measurement:** Conduct a trial run with an implement (e.g., cultivator) in the field to measure the **Effective Field Capacity** and **Field Efficiency**.

Engineering Mathematics-III

Unit I

Functions of complex variables : Analytic functions, Harmonic Conjugate, Cauchy-Riemann Equations, Line Integral, Cauchy's Theorem, Cauchy's Integral Formula, Singular Points, Poles & Residues, Residue Theorem , Application of Residues theorem for evaluation of real integrals

Unit II

Errors & Approximations, Solution of Algebraic & Trancedental Equations (Regula Falsi , Newton-Raphson, Iterative, Secant Method), Solution of simultaneous linear equatins by Gauss Elimination, Gauss Jordan, Crout's methods , Jacobi's and Gauss-Siedel Iterative methods

Unit III

Difference Operators, Interpolation (Newton Forward & Backward Formulae, Central Interpolation Formulae, Lagrange's and divided difference formulae), Numerical Differentiation and Numerical Integration.

Unit IV

Solution of Ordinary Differential Equations(Taylor's Series, Picard's Method, Modified Euler's Method, Runge-Kutta Method, Milne's Predictor & Corrector method), Regression, Curve Fitting (Method of Least Square).

Unit V

Correlation and

Concept of Probability : Probability Mass function, Probability density function. Discrete Distribution: Binomial, Poisson's, Continuous Distribution: Normal Distribution, Exponential Distribution ,Gamma Distribution ,Beta Distribution ,Testing of Hypothesis |:Students t-test, Fisher's z-test, Chi-Square Method

Reference:

1. Numerical Methods using Matlab by J.H.Mathews and K.D.Fink, P.H.I.
2. Numerical Methods for Scientific and Engg. Computation by MKJain, Iyengar and RK Jain, New Age International Publication
3. Mathematical Methods by KV Suryanarayan Rao, SCITECH Publuication
4. Numerical Methods using Matlab by Yang,Wiley India
5. Pobability and Statistics by Ravichandran ,Wiley India
6. Mathematical Statistics by George R., Springer

Soil Mechanics

UNIT-I

Introduction and Index Properties of Soil

Soil Formation: Geological cycle, transportation, and deposition. Definition of Soil Mechanics. Phase Diagram: Three-phase system (solid, water, air). Definitions and Interrelationships: Void ratio (e), Porosity (n), Water content (w), Degree of saturation (S_r), Unit weight (γ), Submerged unit weight (γ'), and Specific gravity (G). Determination of Index Properties in the laboratory.

UNIT-II

Soil Classification and Permeability

Atterberg's Limits: Liquid Limit (WL), Plastic Limit (WP), and Shrinkage Limit (WS). Plasticity Index (IP) and Liquidity Index (IL). Soil Classification Systems: Indian Standard Soil Classification System (ISCS) and Unified Soil Classification System (USCS). Soil Structure (Single-grained, Flocculated, Dispersed). Permeability: Darcy's Law, coefficient of permeability (k), factors affecting k . Laboratory Determination: Constant Head and Falling Head Permeameter tests.

UNIT-III

Compaction and Consolidation

Soil Compaction: Definition, mechanism, and objectives. Compaction Curve: Optimum Moisture Content (O-M-C) and Maximum Dry Density (M-D-D). Standard and Modified Proctor Tests. Compaction Control in the field. Consolidation: Definition, mechanism, and distinction from compaction. Terzaghi's One-Dimensional Consolidation Theory (basic concepts). Coefficient of Volume Compressibility (m_v) and Coefficient of Consolidation (c_v).

UNIT-IV

Shear Strength of Soil

Concept of Shear Strength: Components of shear strength (cohesion and friction). Coulomb's Law of Shear Strength ($\tau=c+\sigma\tan\phi$). Mohr-Coulomb Failure Theory. Shear Strength Tests: Direct Shear Test and Triaxial Compression Test (types and principles: U-U, C-U, C-D). Vane Shear Test for cohesive soils.

UNIT-V

Stress Distribution and Earth Pressure

Stress Distribution: Boussinesq's Theory for point loads (basic concept). Westergaard's Theory (introduction). Pressure Bulb. Newmark's Chart (principle only). Earth Pressure: Introduction to Retaining Walls. Active and Passive Earth Pressure (concept only). Rankine's Theory for cohesionless soils (simple cases).

List of Experiments

1. **Water Content Determination:** Determine the natural **Water Content** of a given soil sample using the **Oven Drying Method**.
2. **Specific Gravity:** Determine the **Specific Gravity (G)** of soil solids using a **Pycnometer** or **Density Bottle**.
3. **Grain Size Analysis (Sieve Analysis):** Perform **Sieve Analysis** for a coarse-grained soil sample and plot the **Particle Size Distribution Curve**.
4. **Grain Size Analysis (Hydrometer):** Perform **Hydrometer Analysis** for a fine-grained soil sample.

5. **Liquid Limit:** Determine the **Liquid Limit** of a soil sample using the **Casagrande's Apparatus** or Cone Penetrometer method.
6. **Plastic and Shrinkage Limits:** Determine the **Plastic Limit** and the **Shrinkage Limit** of a soil sample and calculate the Plasticity Index .
7. **Compaction Test:** Determine the **Optimum Moisture Content** and **Maximum Dry Density** of a soil sample using the **Standard Proctor Compaction Test**.
8. **Permeability (Constant Head):** Determine the **Coefficient of Permeability** of a coarse-grained soil sample using the **Constant Head Permeameter**.
9. **Direct Shear Test:** Determine the **Shear Strength Parameters** of a cohesionless soil (sand) using the **Direct Shear Test**.
10. **Unconfined Compression Test:** Determine the **Unconfined Compressive Strength** of a cohesive soil specimen and calculate the undrained cohesion .

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Soil Mechanics and Foundation Engineering** by B. C. Punmia, Ashok Kumar Jain, and Arun Kumar Jain, Lakshmi Publications.
2. **Geotechnical Engineering** by C. Venkatramaiah, New Age International Publishers.
3. **Soil Mechanics in Engineering Practice** by Karl Terzaghi and Ralph B. Peck, John Wiley & Sons.
4. **Basic and Applied Soil Mechanics** by Gopal Ranjan and A. S. R. Rao, New Age International Publishers.
5. **IS Codes** relevant to soil testing (e.g., IS 2720 series).

Strength of Materials

UNIT-I

Simple Stresses and Strains

Introduction: Concept of Stress (normal, shear) and Strain (linear, lateral, volumetric). Hooke's Law and Elastic Limits. Stress-Strain Diagram for ductile and brittle materials. Elastic Constants: Young's Modulus (E), Shear Modulus (G), Bulk Modulus (K), and Poisson's Ratio (μ). Relationship between elastic constants. Bars of Varying Cross-section and Composite Bars under axial load. Thermal Stresses and strains.

UNIT-II

Shear Force and Bending Moment

Types of Beams (simply supported, cantilever, overhanging) and Types of Loads (point, uniformly distributed, uniformly varying). Shear Force (S.F.) and Bending Moment (B.M.): Definitions, sign conventions. Relationship between load, S.F., and B.M. Drawing S.F. and B.M. Diagrams for simply supported beams and cantilevers under various loading conditions.

UNIT-III

Bending and Shear Stresses in Beams

Theory of Simple Bending: Assumptions, Bending Equation ($y\sigma = IM = RE$). Moment of Resistance and Section Modulus (Z). Calculating Bending Stresses in symmetrical and unsymmetrical sections. Shear Stresses in Beams: Derivation of Shear Stress Formula ($\tau = I_b V A y$). Shear stress distribution across standard sections (rectangular, circular, I-section).

UNIT-IV

Torsion and Springs

Torsion: Introduction, assumptions, and Torsion Equation ($R\tau = JT = LG\theta$). Shear Stress and Angle of Twist in solid and hollow circular shafts. Power Transmitted by a Shaft. Springs: Types of springs. Closely Coiled Helical Springs (subjected to axial load): calculation of maximum shear stress and deflection.

UNIT-V

Compound Stresses and Strain Energy

Principal Stresses and Strains: Stresses on an inclined plane. Compound Stresses (e.g., combined axial and shear stresses). Mohr's Circle for plane stress (construction and interpretation). Strain Energy: Definition. Strain Energy due to Axial Load, Bending, Shear, and Torsion (Simple formulas). Theories of Failure: Introduction to Maximum Principal Stress Theory and Maximum Shear Stress Theory.

List of Experiments

1. **Tensile Test on Mild Steel:** Conduct a **Tensile Test** on a Mild Steel specimen using a Universal Testing Machine .
2. Determine the **Yield Strength, Ultimate Tensile Strength, Percentage Elongation, and Percentage Reduction in Area.**
3. **Compressive Test:** Conduct a **Compression Test** on a specimen of wood or cast iron to determine its compressive strength.
4. **Shear Test:** Perform a **Double Shear Test** on a metal specimen to determine the ultimate shear strength.
5. **Torsion Test:** Conduct a **Torsion Test** on a circular shaft specimen and determine the **Modulus of Rigidity** and the angle of twist.
6. **Hardness Test:** Perform **Rockwell and Brinell Hardness Tests** on metal specimens and compare the results.
7. **Impact Test:** Perform an **Impact Test** (Charpy or Izod) on a standard specimen to determine the material's toughness and energy absorption capability.
8. **Deflection of a Simply Supported Beam:** Conduct an experiment to determine the **Deflection** of a simply supported beam under central or eccentric point loads and verify with theoretical calculations.
9. **Strain Gauge Application:** Use **Strain Gauges** and a strain indicator to measure the **Strain** developed in a cantilever or a simple tensile specimen.
10. **Spring Testing:** Conduct a load-deflection test on a **Helical Coil Spring** and determine the **Stiffness of the Spring** and the Modulus of Rigidity of the spring material.
11. **Moment of Inertia Verification:** Determine the **Moment of Inertia** of different beam cross-sections experimentally and compare with theoretical values.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Strength of Materials** by R. K. Bansal, Laxmi Publications.
2. **Mechanics of Materials** by Gere and Goodno, Cengage Learning.
3. **Strength of Materials** by S. S. Bhavikatti, Vikas Publishing House.
4. **Mechanics of Solids** by E. P. Popov, Prentice Hall.
5. **Laboratory Manual for Strength of Materials** (Relevant institutional publication).

Farm Machinery and Equipment-I

UNIT-I

Introduction and Classification of Farm Machinery

Importance and Scope of farm mechanization in agriculture. Sources of Power on the farm (human, animal, mechanical, electrical) and their comparative study. Tillage: Definition, types (primary, secondary), and objectives. Classification of Farm Machinery based on function. Selection of Farm Machinery: Factors affecting selection, estimation of Field Capacity (Theoretical and Effective) and Field Efficiency.

UNIT-II

Primary Tillage Equipment

Plows: Definition and functions. Mould Board (MB) Plow: Construction, types of bottoms (general purpose, stubble, sod), and identification of parts (share, mould board, landslide, frog). Forces Acting on a MB Plow (concept only). Disc Plow: Construction, types (standard, vertical), and effect of Disc Angle and Tilt Angle on operation. Deep Tillage Implements: Subsoiler and Chisel Plow.

UNIT-III

Secondary Tillage and Seedbed Preparation Equipment

Harrows: Classification and functions. Disc Harrow: Types (single action, tandem), parts, and adjustments (angling). Tine Harrows: Spring-tine, spike-tooth, and spring-tooth harrows. Rotary Tiller (Rotavator): Construction, types of blades (L-type, C-type), and its working principle. Puddlers: Construction and use in wet cultivation. Land Leveling and Shaping Equipment (Levelers and Scrapers).

UNIT-IV

Seeding and Planting Equipment

Methods of Sowing: Broadcasting, drilling, dibbling, transplanting. Seed Drill: Components, types of Metering Mechanisms (fluted roller, internal double run, cup feed) and Furrow Openers (shoe type, disc type). Calibration of a Seed Drill: Theoretical and field methods. Planters: Distinction from seed drills, working principle of planters for row crops (e.g., maize, cotton). Transplanters (basic concept).

UNIT-V

Intercultivation and Plant Protection Equipment

Intercultivation Equipment: Need for intercultivation. Cultivators and Weeders (power tillage operated and manual). Sprayers: Classification based on energy source and mounting (manual power, boom). Components: Pump, agitator, tank, nozzle (types and selection). Dusters: Principles of dust application and types of dusters. Basic maintenance of spraying and dusting equipment.

List of Experiments

1. **Tillage Implement Classification:** Study and classify various **Tillage Implements** based on their function and power source.
2. **Mould Board (MB) Plow Study:** Study and identify the components of an **MB Plow**. Practice assembling and setting the plow bottom.
3. **Disc Plow Study and Adjustment:** Study the components of a **Disc Plow** and demonstrate the effect of adjusting the **Disc Angle and Tilt Angle**.
4. **Harrow Adjustment:** Study the types of **Disc Harrows** (e.g., Tandem) and practice the procedure for **angling the gangs** for varying penetration.
5. **Rotary Tiller Study:** Study the construction and working of a **Rotary Tiller** and identify different types of blades and the transmission system.
6. **Seed Drill Component Identification:** Study and identify the different types of **Metering Mechanisms** and **Furrow Openers** used in seed drills.
7. **Seed Drill Calibration (Laboratory):** Calibrate a **Seed-cum-Fertilizer Drill** to deliver a specified rate of seed using a laboratory stand.
8. **Planter Study:** Study the mechanism and components of a **Planter** for a specific crop (e.g., maize) and understand the functions of the seed plate/metering mechanism.
9. **Sprayer Components and Nozzles:** Study the components of a **Field Sprayer** and identify different types of **Nozzles** and their spray patterns.
10. **Field Capacity Measurement:** Measure the **Theoretical Field Capacity, Effective Field Capacity, and Field Efficiency** of a secondary tillage implement (e.g., cultivator) during a trial run (or demonstration).

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Principles of Agricultural Engineering (Vol. I)** by A. M. Michael and T. P. Ojha, Jain Brothers.
2. **Farm Machinery** by R. A. Kepner, R. Bainer, and E. L. Barger, CBS Publishers.
3. **Elements of Agricultural Engineering** by Jagdishwar Sahay, Standard Publishers Distributors.
4. **Agricultural Machinery Design** by C. P. Gupta and A. K. Mishra, Standard Publishers.

Farm Power

UNIT-I

Farm Power Sources and Introduction to IC Engines

Sources of Farm Power: Study and comparison of various sources: Human, Animal, Electrical, Wind, Solar, and Mechanical (Tractors and Stationary Engines). Trends in farm mechanization. Internal Combustion (IC) Engines: Classification based on fuel (Petrol/Diesel), cycle (2-Stroke/4-Stroke), cooling, and ignition systems. Terminology of IC Engines: Bore, stroke, TDC, BDC, compression ratio, clearance volume, piston displacement.

UNIT-II

4-Stroke and 2-Stroke Engines

Working Principle: Detailed study of the four strokes (Suction, Compression, Power, Exhaust) of a 4-Stroke S-I (Spark Ignition) Engine and a 4-Stroke C-I (Compression Ignition) Engine. Comparison of S-I and C-I engines. 2-Stroke Engine: Working principle, port timing diagram, and comparison with 4-Stroke engines. Valve Timing Diagram for 4-Stroke engines.

UNIT-III

Engine Systems

Fuel Supply System (Diesel): Components (fuel tank, filters, pump, injector). Working principle of Fuel Injection Pump (FIP) and Injector. Carburation (Petrol Engine): Principle of carburetion and main parts of a simple carburetor. Ignition System: Battery and magneto ignition systems (basic principles). Lubrication System: Types (splash, pressure), lubricant properties, and functions. Cooling System: Types (air-cooled, water-cooled) and their components.

UNIT-IV

Engine Performance and Air Standard Cycles

Air Standard Cycles: Study of Otto Cycle and Diesel Cycle on P-V and T-S diagrams. Derivation of Thermal Efficiency for the Otto and Diesel cycles. Actual vs. Theoretical Cycles. Engine Power: Definitions of Indicated Power (I-P), Brake Power (B-P), Frictional Power (F-P), and Mechanical Efficiency (η_m). Specific Fuel Consumption (S-F-C) and Thermal Efficiency. Heat Balance Sheet for an IC engine.

UNIT-V

Tractor Power Transmission and Auxiliary Systems

Tractor: Definition, types, and classification (wheel, crawler, two-wheel). Power Train: Concept of clutch, gearbox, differential, and final drive. Tractor Power Measurement: Drawbar Power (D-B-P), Power Take-Off (P-T-O) Power, and Belt Power. Tractor Steering and Braking Systems. Tractor Hydraulic System: Principles and components of the 3-point linkage system and its control (draft and position control).

List of Experiments

1. **Engine Familiarization:** Study and identify the main components and systems of a typical **4-Stroke Diesel/Petrol Engine** using a cut-section model.
2. **Valve Timing Diagram:** Draw and interpret the **Valve Timing Diagram** for a 4-Stroke engine and understand the concept of valve overlap.
3. **Fuel Injection System:** Study the working principle and components of the **Fuel Injection Pump (FIP)** and **Injector** used in a diesel engine.
4. **Cooling and Lubrication Systems:** Study the components and working of the **Water Cooling System** (pump, radiator, thermostat) and the **Pressure Lubrication System**.
5. **Diesel Engine Performance Test (Load Test):** Conduct a load test on a **4-Stroke Diesel Engine** and determine **Brake Power**, **Brake Specific Fuel Consumption**, and **Brake Thermal Efficiency**.
6. **Petrol Engine Performance Test:** Conduct a load test on a **4-Stroke Petrol Engine** and determine its performance parameters.
7. **Heat Balance Sheet:** Prepare a **Heat Balance Sheet** for a Diesel/Petrol Engine under a specific load condition.
8. **Tractor Controls and Systems:** Study and identify the operational controls and working of the **Steering, Braking, and Power Take-Off** systems of a tractor.
9. **Tractor Hydraulic System:** Study the components of the **3-Point Hitch Hydraulic System** and the function of draft and position control levers.
10. **Tractor Performance Parameters (Demonstration):** Demonstration of measuring **Tractor Wheel Slip** and calculating **Drawbar Power** in the field.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Elements of Agricultural Engineering** by Jagdishwar Sahay, Standard Publishers Distributors.
2. **Principles of Agricultural Engineering (Vol. I)** by A. M. Michael and T. P. Ojha, Jain Brothers.
3. **IC Engines** by V. Ganesan, Tata McGraw Hill Education.
4. **Farm Machinery and Power** by J. P. Sharma and R. K. Goyal, Sarup & Sons.
5. **A Textbook of Thermal Engineering** by R. S. Khurmi and J. K. Gupta, S. Chand & Co.

Fluid Mechanics

UNIT-I

Fluid Properties and Fluid Statics

Introduction: Definition of a Fluid (liquid and gas). Fluid Properties: Density, Specific Weight, Specific Volume, Specific Gravity. Viscosity (dynamic and kinematic), Newton's Law of Viscosity, effect of temperature on viscosity. Surface Tension and Capillarity (relevant to soil water movement). Fluid Statics: Pascal's Law, variation of pressure with depth. Measurement of Pressure: Piezometers, Manometers (U-tube and Differential). Total Pressure and Centre of Pressure on a plane surface (submerged vertically and inclined).

UNIT-II

Fluid Kinematics and Dynamics

Fluid Kinematics: Types of flow (steady, unsteady, uniform, non-uniform, laminar, turbulent, rotational, irrotational). Continuity Equation in one and three dimensions (Cartesian coordinates). Velocity Potential and Stream Function (basic concepts). Fluid Dynamics: Euler's Equation of Motion along a streamline. Bernoulli's Equation (derivation and limitations). Applications of Bernoulli's equation: Venturimeter and Orifice Meter.

UNIT-III

Flow Measurement and Orifices

Measurement of Flow Rate: Use of Venturimeter and Orifice Meter for pipe flow (determination of coefficient of discharge). Pitot Tube for velocity measurement. Orifices and Mouthpieces: Classification of orifices. Determination of hydraulic coefficients (C_c , C_v , C_d). Time of emptying a tank through an orifice. Notches and Weirs: Classification, discharge formulas for Rectangular and Triangular (V-notch) Weirs.

UNIT-IV

Flow Through Pipes and Boundary Layer

Laminar Flow: Flow through circular pipes (Hagen-Poiseuille equation - statement only). Turbulent Flow: Reynolds Number and its significance. Darcy-Weisbach Equation for head loss due to friction. Major and Minor Energy Losses in pipes (sudden expansion/contraction, bends, pipe fittings). Hydraulic Grade Line (HGL) and Total Energy Line (TEL). Flow through Pipes in Series and Parallel. Boundary Layer Concept (brief introduction)

UNIT-V

Dimensional Analysis and Hydraulic Machines

Dimensional Analysis: Introduction, fundamental and derived dimensions. Buckingham's Theorem (statement and application to simple problems). Dimensionless Numbers (Reynolds, Froude, Weber,

Mach). Hydraulic Machines: Introduction to Pumps (Centrifugal and Reciprocating - working principle and application in irrigation). Turbines (classification and principles - brief overview).

List of Experiments

1. **Verification of Bernoulli's Theorem:** Set up the apparatus to verify **Bernoulli's Theorem** by measuring head at various sections along a diverging flow path.
2. **Flow Measurement (Venturimeter):** Determine the **Coefficient of Discharge** of a **Venturimeter** and calculate the flow rate through the pipe.
3. **Flow Measurement (Orifice Meter):** Determine the **Coefficient of Discharge** of an **Orifice Meter** and compare its performance with the Venturimeter.
4. **Flow Measurement (V-Notch):** Determine the **Coefficient of Discharge** for a **Triangular (V-notch) Weir** by measuring the head over the crest.
5. **Flow Measurement (Rectangular Notch):** Determine the **Coefficient of Discharge** for a **Rectangular Notch**.
6. **Discharge through Orifice:** Determine the hydraulic coefficients for a small circular **Orifice**.
7. **Frictional Head Loss in Pipes:** Determine the **Friction Factor** for flow through a pipe by measuring the **Major Head Loss** over a known length.
8. **Minor Head Losses:** Determine the **Loss Coefficient** for **Minor Losses** due to sudden pipe expansion or contraction.
9. **Verification of Continuity Equation:** Measure the area and velocity at two different sections in a flow path to verify the **Continuity Equation**.
10. **Impact of Jet:** Conduct an experiment to determine the force exerted by a **Water Jet** on a stationary vane (flat or curved).

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Fluid Mechanics and Hydraulic Machines** by R. K. Bansal, Lakshmi Publications.
2. **A Text Book of Fluid Mechanics and Hydraulic Machines** by S. S. Rattan, Khanna Publishers.
3. **Hydraulics and Fluid Mechanics** by P. N. Modi and S. M. Seth, Standard Book House.
4. **Fluid Mechanics** by Frank M. White, McGraw Hill Education.
5. **Engineering Fluid Mechanics** by Clayton T. Crowe, Donald F. Elger, and John A. Roberson, John Wiley & Sons.

Engg. Properties of Biological Materials and Food Quality

UNIT-I

Physical Characteristics of Biological Materials

Introduction: Definition and scope of engineering properties. Importance in the design of machinery and structures. Size and Shape: Measurement of characteristic dimensions (length, width, thickness). Calculation of Geometric Mean Diameter and Arithmetic Mean Diameter. Sphericity and Roundness measurement. Surface Area and Volume determination methods. Density: True density, bulk density, and porosity; their interrelationship.

UNIT-II

Moisture Content and Water Activity

Moisture Content: Definition and significance. Basis of measurement (wet basis and dry basis). Measurement Methods: Direct methods (oven drying, distillation) and Indirect methods (electrical resistance, dielectric constant). Equilibrium Moisture Content (EMC): Concept and determination using Desorption and Adsorption Isotherms (Hygroscopic nature). Water Activity (a_w): Definition, measurement, and its critical role in microbial growth and food stability.

UNIT-III

Mechanical and Rheological Properties

Mechanical Properties: Concepts of Stress, Strain, and Elastic Modulus. Force-Deformation Behavior of biological materials (elastic, plastic, and viscoelastic behavior). Hardness and Firmness measurement techniques (e.g., Penetrometer, Texture Analyzer). Friction: Coefficient of Static and Kinetic Friction on various surfaces. Angle of Repose (static and dynamic). Rheology: Introduction to Viscosity and measurement of viscosity of liquid foods using viscometers (e.g., Brookfield viscometer).

UNIT-IV

Thermal and Electrical Properties

Thermal Properties: Definition and importance. Specific Heat: Measurement methods (method of mixtures). Thermal Conductivity (k): Measurement techniques (steady-state and transient). Thermal Diffusivity (α): Definition and relationship with other thermal properties. Electrical Properties: Dielectric Constant and Dielectric Loss Factor; their application in moisture sensing and microwave heating. Electrical Conductivity (application in sorting).

UNIT-V

Food Quality and Non-Destructive Testing (NDT)

Food Quality Attributes: Classification (physical, chemical, nutritional, microbiological). Color Measurement: Use of Colorimeters and L-a-b system. Textural Analysis: Objective and subjective methods. Nutritional Quality (brief overview). Non-Destructive Testing (NDT): Introduction to N-D-T methods for quality assessment: Spectroscopy (e.g., N-I-R), X-rays, and Ultrasonics (application in internal defect detection).

List of Experiments

1. **Size and Shape Determination:** Determine the **Geometric Mean Diameter, Sphericity, and Roundness** of seeds/grains (e.g., paddy, wheat) and fruits (e.g., apple, potato).
2. **Density and Porosity:** Determine the **Bulk Density, True Density, and Porosity** of a given grain sample.
3. **Moisture Content Determination:** Determine the **Moisture Content** of a given food/grain sample using the **Standard Oven Drying Method** (wet and dry basis).
4. **Water Activity Measurement:** Use a **Water Activity Meter** to measure the **Water Activity ()** of various food samples (e.g., dried fruit, jam) and correlate it with shelf-life stability.
5. **Angle of Repose:** Determine the **Static and Dynamic Angle of Repose** for a granular material (e.g., wheat, fertilizer) using a tilt-box or funnel method.
6. **Coefficient of Friction:** Determine the **Coefficient of Static Friction** for a biological material on different structural surfaces (e.g., steel, plywood).
7. **Firmness/Hardness Measurement:** Measure the **Firmness or Hardness** of fruits and vegetables using a **Penetrometer or Texture Analyzer**.
8. **Viscosity Measurement:** Determine the **Viscosity** of a liquid food sample (e.g., fruit juice, ketchup) using a **Brookfield Viscometer** at different spindle speeds.
9. **Color Measurement:** Use a **Colorimeter** to measure the **values** of food samples (e.g., tomato, flour) and relate them to quality.
10. **Dielectric Constant (Demonstration):** Demonstrate the principle of measuring **Moisture Content** in grains using an instrument based on **Dielectric Properties**.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Engineering Properties of Foods and Other Biological Materials** by M. R. Okos, N. N. Mohsenin, .
2. **Physical Properties of Plant and Animal Materials** by N. N. Mohsenin, Gordon and Breach Science Publishers.
3. **Post-Harvest Technology of Fruits and Vegetables** by L. P. Singh, K. D. Sharma, and P. S. Chauhan, I. K. International Publishing House Pvt. Ltd.
4. **Fundamentals of Food Process Engineering** by R. P. Singh and D. R. Heldman, Springer.
5. **Design and Analysis of Agricultural Experiments** (Relevant sections on statistical analysis of data).

Heat and Mass Transfer

UNIT-I

Conduction Heat Transfer

Introduction: Modes of Heat Transfer (Conduction, Convection, Radiation). Fourier's Law of Heat Conduction. Thermal Conductivity (k) of materials. General Heat Conduction Equation in Cartesian coordinates (derivation not required). One-Dimensional Steady-State Conduction: Heat transfer through a plane wall, composite wall, and hollow cylinder. Concept of Thermal Resistance. Critical Thickness of Insulation for a pipe.

UNIT-II

Convection Heat Transfer

Introduction: Mechanism of Convection (Free/Natural and Forced). Newton's Law of Cooling. Hydrodynamic and Thermal Boundary Layers. Dimensional Analysis in Convection (Reynolds, Prandtl, Nusselt numbers) and their significance. Empirical Correlations for forced convection over a flat plate and through pipes (conceptual understanding and simple application). Free Convection: Grashof number (Gr) and Rayleigh number (Ra).

UNIT-III

Radiation Heat Transfer

Introduction: Nature of thermal radiation, Electromagnetic Spectrum. Black Body and its characteristics. Stefan-Boltzmann Law. Kirchhoff's Law. Absorptivity (α), Reflectivity (ρ), and Transmissivity (τ). Gray Body and Opaque Body. Shape Factor (View Factor): Definition and its properties. Heat Exchange between two surfaces (simple cases). Solar Radiation (basic concepts).

UNIT-IV

Heat Exchangers and Evaporation

Heat Exchangers: Classification (Parallel-flow, Counter-flow, Shell and Tube, Plate). Overall Heat Transfer Coefficient (U). Log Mean Temperature Difference (LMTD) Method for analysis. Effectiveness (ϵ)-N-T-U Method (conceptual understanding). Evaporation: Principles of evaporation. Introduction to Single-Effect and Multiple-Effect Evaporators (types and working).

UNIT-V

Mass Transfer

Introduction: Fick's Law of Diffusion (molecular diffusion). Mass Diffusivity. Types of Mass Transfer: Molecular and Convective Mass Transfer. Diffusion in Solids and Liquids. Equimolar Counter Diffusion. Convective Mass Transfer: Sherwood number. Drying: Concept of Drying Rate Curve (constant rate and falling rate periods). Psychrometrics: Basic concepts and application in drying (Wet-bulb and Dry-bulb temperatures).

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Heat Transfer** by J. P. Holman, McGraw Hill Education.
2. **Fundamentals of Heat and Mass Transfer** by Incropera, DeWitt, Bergman, and Lavine, John Wiley & Sons.
3. **Principles of Food Engineering** by Dennis R. Heldman and Richard W. Hartel, Springer.
4. **A Textbook on Heat and Mass Transfer** by D. S. Kumar, S. K. Kataria & Sons.
5. **Unit Operations of Chemical Engineering** by W. L. McCabe, J. C. Smith, and P. Harriott, McGraw Hill.

Farm Machinery and Equipment-II

UNIT-I

Harvesting and Threshing Equipment

Harvesting: Definition and methods. Manual vs. Mechanical Harvesting. Reapers: Types (e.g., vertical conveyor, windrower) and working principles. Mowers: Classification (reciprocating, rotary) and components. Threshing: Objectives. Thresher: Types (e.g., spike-tooth, rasp bar), components (cylinder, concave, sieves, blower), and working principle. Cleaning and Separation Mechanism in threshers. Power Take-Off Drive for implements.

UNIT-II

Combine Harvesters

Combine Harvester: Definition, types (self-propelled, tractor-mounted). Functional Components: Header, cutter bar, reel, feeding system, threshing unit, separation unit, cleaning unit, and grain handling system. Working Principle: Sequence of operations. Adjustments and Settings for different crops (e.g., cylinder speed, concave clearance, sieve opening). Field Efficiency and Losses in combining.

UNIT-III

Material Handling and Transportation

Material Handling Equipment: Conveyors (belt, chain, screw, pneumatic) and their applications in agriculture. Elevators (bucket, chain). Silos and Bins for storage (basic concepts). Transportation Equipment: Types of Farm Trailers (tipping, non-tipping), their construction, and capacity calculation. Basic Principles of Safety in handling and transporting farm materials and equipment.

UNIT-IV

Equipment for Specialty Crops and Operations

Potato Diggers/Harvesters: Types and working principle. Groundnut Diggers/Threshers. Cotton Pickers: Spindle and stripper type pickers. Sugarcane Harvesters. Fodder Choppers/Harvesters (chaff cutter). Post-Harvest Equipment: Basic components and functions of cleaners, graders, and destoners used for initial processing.

UNIT-V

Power Transmission and Drive Elements

Power Transmission: Review of $\$P\$-\$T\$-\$O\$$ system. Belt and Pulley Drives: Types of belts (flat, V-belt), velocity ratio, slip, and tensioning. Chain Drives: Components and comparison with belt drives.

Gear Drives: Types of gears (spur, helical, bevel) and application in farm machinery gearboxes.
Clutches and Brakes in implements (basic overview).

List of Experiments

1. Reaper Study: Study and identify the main components and mechanism of a Reaper/Mower (e.g., cutter bar assembly, drive mechanism).
2. Thresher Component Identification: Study and identify the various components of a Thresher (e.g., cylinder, concave, sieves, blower) and their function.
3. Thresher Adjustments: Practice adjusting the Cylinder Speed and Concave Clearance of a thresher for different crops.
4. Combine Harvester Study: Study the working principle and operational controls of a Combine Harvester (using a model or actual machine).
5. Harvesting Losses: Conduct a Field Test (Demonstration) to estimate the Threshing Losses and Cleaning Losses of a thresher/combine.
6. Material Handling Study: Study the construction and working of a Screw Conveyor and a Bucket Elevator used for grain handling.
7. Trailer Capacity: Measure the dimensions of a Farm Trailer and calculate its volumetric and theoretical weight carrying capacity.
8. Power Transmission Systems: Study the use and adjustment of Belt and Pulley Drives and Chain and Sprocket Drives in farm machinery (e.g., chaff cutter).
9. Cleaning and Grading Equipment: Study the construction and working of a Sieve Type Grain Cleaner and Grader and its adjustments.
10. Specialized Equipment Study: Study the components and working of a Potato Digger/Harvester or Groundnut Digger (using available models/machines).

SUGGESTED TEXT BOOKS AND REFERENCES:

1. Principles of Agricultural Engineering (Vol. I) by A. M. Michael and T. P. Ojha, Jain Brothers.
2. Farm Machinery by R. A. Kepner, R. Bainer, and E. L. Barger, CBS Publishers.
3. Elements of Agricultural Engineering by Jagdishwar Sahay, Standard Publishers Distributors.
4. Farm Power and Machinery by J. B. Liljedahl, P. K. Turnquist, and D. W. Smith, Iowa State University Press.
5. Agricultural Mechanization Management by C. P. Gupta, Agro-Tech Publishing Academy.

Renewable Energy Sources

UNIT-I

Solar Energy Fundamentals

Introduction: Global energy scenario, concept of sustainability, and the need for renewable energy. Solar Radiation: Solar constant, spectral distribution, and measurement of solar radiation (Pyranometer). Solar Collectors: Classification (flat plate and concentrating), working principles, materials, and efficiency. Solar Thermal Applications: Solar water heating, solar cookers, and solar dryers (types and design principles).

UNIT-II

Solar Photovoltaic (PV) Systems

Solar Cells: Principles of photovoltaic energy conversion. p-n junction solar cell operation. I-V Characteristics and equivalent circuit. PV Modules and Arrays: Series and parallel connections. Balance of System (BOS) Components: Charge controllers, inverters (DC to AC), and batteries (types and selection). PV System Design: Introduction to stand-alone and grid-connected systems, applications in irrigation (solar pumps).

UNIT-III

Wind and Hydro Energy

Wind Energy: Origin and nature of wind. Site Selection criteria. Wind Turbine Aerodynamics: Basic principles of lift and drag. Wind Power Equation and Betz's limit. Wind Energy Conversion Systems (WECS): Classification of wind turbines (horizontal and vertical axis), components (rotor, nacelle, generator). Hydro Energy: Small hydro power plants, basic components, and water flow considerations.

UNIT -IV

Bioenergy

Biomass: Definition, classification, and availability in the agricultural sector. Bioenergy Conversion Routes: Thermochemical (pyrolysis, gasification, combustion) and Biochemical (anaerobic digestion, fermentation). Biogas Technology: Principles of anaerobic digestion. Biogas Plant Types (fixed dome, floating drum), design considerations, and utilization of biogas and slurry. Biofuels: Production and use of Biodiesel and Bioethanol (overview).

UNIT-V

Geothermal, Ocean, and Energy Storage

Geothermal Energy: Resources, extraction, and applications. Ocean Energy: Tidal energy and Ocean Thermal Energy Conversion (O-T-E-C) (principles only). Energy Storage Systems: Need for energy storage. Mechanical Storage (Pumped Hydro, Flywheels), Thermal Storage, and Electrochemical Storage (Batteries - lead-acid, lithium-ion). Hybrid Renewable Energy Systems (concept).

List of Experiments

1. **Solar Collector Performance:** Conduct a test on a **Flat Plate Solar Collector** to determine its **Thermal Efficiency** under various flow rates.
2. **Solar PV I-V Characteristics:** Plot the **I-V Characteristics** of a **Solar Photovoltaic (PV) Module** under varying light intensity and temperature. Determine **Maximum Power Point**.
3. **Solar Cooker/Dryer Performance:** Test the efficiency and performance parameters (e.g., stagnation temperature) of a **Solar Cooker** or **Solar Dryer**.
4. **Solar Thermal System Study:** Study and identify the components of a **Solar Water Heating System** (e.g., collector, storage tank, circulating pump).
5. **Wind Energy Measurement:** Measure the **Wind Speed** using an **Anemometer** and calculate the theoretical **Wind Power Density** at the measurement site.
6. **Wind Turbine Performance (Model):** Study the components of a **Small Wind Turbine Model** and measure its power output under varying fan speed (simulated wind speed).
7. **Biogas Plant Study:** Study the design, components, and operation of a **Fixed Dome** or **Floating Drum Biogas Plant** model.
8. **Calorific Value of Biofuels:** Determine the **Calorific Value** (or Heating Value) of a solid or liquid biofuel (e.g., wood chip, biodiesel) using a bomb calorimeter (or relevant apparatus).
9. **Battery Charging and Discharging:** Conduct a test on a **Lead-Acid Battery** to study its charging and discharging characteristics relevant to off-grid PV systems.
10. **Fuel Cell Demonstration:** Study the working principle and operation of a **Small Scale Fuel Cell** demonstration unit.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Non-Conventional Energy Sources** by G. D. Rai, Khanna Publishers.
2. **Renewable Energy Sources and Emerging Technologies** by D. P. Kothari, K. C. Singal, and Rakesh Ranjan, Prentice-Hall of India.
3. **Solar Energy: Principles of Thermal Collection and Storage** by S. P. Sukhatme, Tata McGraw-Hill Education.
4. **Wind Power Technology** by J. F. Walker and N. Jenkins, John Wiley & Sons.
5. **Biomass Energy Systems** by B. B. C. Lokesh and R. R. Sharma, Ane Books Pvt. Ltd.

Irrigation Engineering

UNIT-I

Introduction and Water Requirements of Crops

Necessity and Benefits of Irrigation. Sources of Water for irrigation (surface and groundwater). Water Resources of India (overview). Soil-Water-Plant Relationship: Basic concepts of soil moisture constants (Field Capacity, Permanent Wilting Point, Available Water). Consumptive Use and Evapotranspiration (methods of estimation: Blaney-Criddle, Penman). Definition: Delta (Δ), Duty (D), and their relationship.

UNIT-II

Flow Irrigation Systems

Canal Irrigation Systems: Classification of canals (alignment, function, boundary condition). Design of Unlined and Lined Canals (Chezy's and Manning's formulas - concept only). Canal Headworks: Components of a diversion headwork (weir/barrage). Canal Structures: Design principles of simple hydraulic structures (falls, crossings, regulators) and their necessity. Waterlogging and Salinity: Causes and reclamation measures.

UNIT-III

Groundwater Irrigation and Wells

Groundwater: Occurrence and movement of groundwater. Aquifers (confined, unconfined). Wells: Types of wells (shallow, deep, tube wells). Well Hydraulics: Darcy's Law for flow in porous media. Specific Yield, Specific Retention, and Transmissibility. Steady-State Flow into open wells (Dupuit's equation - statement only). Well Construction and Development. Pumps: Selection, installation, and performance characteristics of centrifugal pumps.

UNIT-IV

Irrigation Methods and Water Application

Surface Irrigation Methods: Types (Check basin, Border strip, Furrow) and their suitability. Design Parameters for surface irrigation (infiltration rate, advance, recession). Sprinkler Irrigation: Types (permanent, portable, center pivot, lateral move), components, and design steps. Drip/Trickle Irrigation: Components (head unit, laterals, emitters), advantages, and design procedure (drip spacing, emission uniformity). Evaluation of Irrigation Efficiency (water conveyance, application, storage, and distribution).

UNIT-V

Soil Conservation and Drainage

Soil Erosion: Types (water and wind erosion) and control measures. Runoff: Factors affecting runoff. Water Harvesting techniques. Land Grading and Shaping (basic principles). Drainage: Necessity of drainage. Surface Drainage (field drains, main drains). Subsurface Drainage: Types of drains (tile, mole), design parameters (drainage coefficient, spacing of drains).

List of Experiments

1. **Soil Moisture Measurement:** Determine the **Moisture Content** of a soil sample using the **Oven Drying Method** and relate it to the Field Capacity or Permanent Wilting Point .
2. **Infiltration Measurement:** Determine the **Infiltration Rate** of a soil using a **Single or Double Ring Infiltrometer** and fit the data to an infiltration equation (e.g., Kostiakov).
3. **Soil Texture Determination:** Determine the **Textural Classification** of a soil sample using the **Hydrometer Method** (or feel method) to assess its suitability for irrigation.
4. **Flow Measurement (Canal/Channel):** Measure the **Discharge** in a laboratory flume or a field channel using a **Rectangular or Triangular (V-notch) Weir**.
5. **Flow Measurement (Current Meter):** Determine the **Velocity and Discharge** in a channel using a **Current Meter** by the velocity-area method (demonstration).
6. **Pump Performance Test:** Conduct a performance test on a **Centrifugal Pump** to determine the **Head, Discharge, Efficiency, and Power Requirement** at various speeds.
7. **Sprinkler System Evaluation:** Conduct an **Evaluation Test** for a segment of a **Sprinkler Irrigation System** to determine the **Water Application Rate** and **Uniformity Coefficient** (e.g., Christiansen's Uniformity Coefficient).
8. **Drip System Study:** Study the components of a **Drip Irrigation System** and determine the **Emitter Discharge Rate** and **Emission Uniformity**.
9. **Hydraulic Grade Line (HGL) and Total Energy Line (TEL):** Plot the **HGL and TEL** for flow through a pipe system to demonstrate energy losses.
10. **Time for Irrigation:** Calculate the **Time Required for Irrigation** and the **Irrigation Interval** for a given crop, soil type, and irrigation efficiency.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Irrigation Engineering and Hydraulic Structures** by S. K. Garg, Khanna Publishers.
2. **Irrigation and Water Resources Engineering** by G. L. Asawa, New Age International Publishers.
3. **Irrigation Engineering** by B. C. Punmia, Ashok Kumar Jain, and Arun Kumar Jain, Lakshmi Publications.
4. **Principles of Agricultural Engineering (Vol. II)** by A. M. Michael and T. P. Ojha, Jain Brothers.
5. **Farm Irrigation System Design** by B. K. Sahoo and P. K. Swain, New Age International Publishers.

Crop Process Engineering

UNIT-I

Post-Harvest Operations and Pre-Processing

Introduction: Importance and scope of post-harvest technology. Post-Harvest Losses (magnitude and causes). Cleaning and Grading: Principles and types of cleaners (sieve, air screen, specific gravity separator, magnetic separator). Grading based on size, shape, and weight. Hulling and Shelling: Principles and machines for paddy, maize, and pulses. Milling: Basic principle of rice milling (huller, sheller, polisher).

UNIT-II

Drying Technology

Drying Principles: Need for drying, definition of Moisture Content (wet basis, dry basis). Equilibrium Moisture Content and Water Activity. Drying Theory: Drying Rate Curve (constant rate and falling rate periods). Classification of Dryers: Batch and continuous dryers. Types of Dryers (Tray, Cabinet, Fluidized Bed, Rotary, Tunnel, Solar Dryers) and their working principle.

UNIT-III

Size Reduction and Mixing

Size Reduction: Objectives and applications in food processing. Principles of Size Reduction: Compression, impact, attrition, and cutting. Size Reduction Equipment: Crushers (jaw, gyratory), Grinders/Mills (hammer mill, roller mill, plate mill), and their selection criteria. Energy Requirement for size reduction (Kick's Law, Rittinger's Law, Bond's Law - conceptual). Mixing: Principles of solid and liquid mixing. Types of Mixers (ribbon blender, drum mixer).

UNIT-IV

Heat Processing and Preservation Techniques

Heat Transfer Applications: Review of heat transfer principles in food processing. Blanching: Objectives and methods. Pasteurization and Sterilization: Time-temperature relationships. Canning: Principles and processes (thermal processing). Evaporation and Distillation: Basic principles and equipment (single-effect evaporator). Freezing and Refrigeration (brief overview of application in food).

UNIT-V

Extrusion, Filtration, and Packaging

Extrusion: Working principle of an Extruder (single screw, twin screw). Application in snack food and feed production. Filtration and Centrifugation: Basic principles and applications in separating solids

from liquids (e.g., oil extraction). Storage Systems: Types of storage structures (silos, godowns). Packaging Materials: Classification and selection criteria for agricultural produce.

List of Experiments (Lab Component)

The experiments provide hands-on experience with unit operations commonly used in the processing of agricultural crops and food materials.

1. **Cleaning and Grading:** Study and operate an **Air-Screen Cleaner** to separate a grain mixture and determine its cleaning and grading efficiency.
2. **Size Reduction (Hammer Mill):** Operate a **Hammer Mill** at various speeds and screen sizes to grind a grain sample and determine the **Fineness Modulus** of the ground product.
3. **Drying Rate Curve:** Determine the **Drying Rate Curve** and the **Critical Moisture Content** for a biological material (e.g., potato/fruit slices) using a laboratory tray dryer.
4. **Moisture Content and EMC:** Determine the **Moisture Content** of a sample using a standard method and determine the **Equilibrium Moisture Content** at a given temperature and relative humidity.
5. **Heat Treatment (Blanching/Pasteurization):** Conduct an experiment to determine the required **Time and Temperature** for blanching a vegetable sample or pasteurizing a liquid food sample.
6. **Extruder Study:** Study the working principle and components of a **Single or Twin-Screw Extruder** and its effect on product characteristics (demonstration).
7. **Filtration:** Determine the **Filtration Rate** for a solid-liquid suspension using a simple filtration unit (e.g., plate and frame filter press model).
8. **Rice Milling:** Study the sequence of operations and equipment used in a **Rice Mill** and determine the **Milling Recovery and Percentage of Broken Rice**.
9. **Mixing Efficiency:** Conduct an experiment to assess the **Mixing Efficiency** of a solid mixer (e.g., ribbon blender) using samples with a tracer component.
10. **Water Activity Measurement:** Use a **Water Activity Meter** to measure the of different processed food samples and discuss its implication for preservation.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Principles of Agricultural Engineering (Vol. II)** by A. M. Michael and T. P. Ojha, Jain Brothers.
2. **Unit Operations of Agricultural Processing** by P. M. V. Subbarao, Vikas Publishing House.
3. **Fundamentals of Food Process Engineering** by R. P. Singh and D. R. Heldman, Springer.
4. **Post-Harvest Technology of Cereals, Pulses, and Oilseeds** by S. K. K. P. Singh, Oxford & IBH Publishing Co.
5. **Food Science** by N. N. Potter and J. H. Hotchkiss, CBS Publishers.

Engineering Hydrology

UNIT-I

Harvesting and Threshing Equipment

Harvesting: Definition and methods. Manual vs. Mechanical Harvesting. Reapers: Types (e.g., vertical conveyor, windrower) and working principles. Mowers: Classification (reciprocating, rotary) and components. Threshing: Objectives. Thresher: Types (e.g., spike-tooth, rasp bar), components (cylinder, concave, sieves, blower), and working principle. Cleaning and Separation Mechanism in threshers. Power Take-Off (P T O) Drive for implements.

UNIT-II

Combine Harvesters

Combine Harvester: Definition, types (self-propelled, tractor-mounted). Functional Components: Header, cutter bar, reel, feeding system, threshing unit, separation unit, cleaning unit, and grain handling system. Working Principle: Sequence of operations. Adjustments and Settings for different crops (e.g., cylinder speed, concave clearance, sieve opening). Field Efficiency and Losses in combining.

UNIT-III

Material Handling and Transportation

Material Handling Equipment: Conveyors (belt, chain, screw, pneumatic) and their applications in agriculture. Elevators (bucket, chain). Silos and Bins for storage (basic concepts). Transportation Equipment: Types of Farm Trailers (tipping, non-tipping), their construction, and capacity calculation. Basic Principles of Safety in handling and transporting farm materials and equipment.

UNIT-IV

Equipment for Specialty Crops and Operations

Potato Diggers/Harvesters: Types and working principle. Groundnut Diggers/Threshers. Cotton Pickers: Spindle and stripper type pickers. Sugarcane Harvesters. Fodder Choppers/Harvesters (chaff cutter). Post-Harvest Equipment: Basic components and functions of cleaners, graders, and destoners used for initial processing.

UNIT-V

Power Transmission and Drive Elements

Power Transmission: Review of P T O system. Belt and Pulley Drives: Types of belts (flat, V-belt), velocity ratio, slip, and tensioning. Chain Drives: Components and comparison with belt drives. Gear Drives: Types of gears (spur, helical, bevel) and application in farm machinery gearboxes. Clutches and Brakes in implements (basic overview).

List of Experiments

1. **Reaper Study:** Study and identify the main components and mechanism of a **Reaper/Mower** (e.g., cutter bar assembly, drive mechanism).
2. **Thresher Component Identification:** Study and identify the various components of a **Thresher** (e.g., cylinder, concave, sieves, blower) and their function.
3. **Thresher Adjustments:** Practice adjusting the **Cylinder Speed** and **Concave Clearance** of a thresher for different crops.
4. **Combine Harvester Study:** Study the working principle and operational controls of a **Combine Harvester** (using a model or actual machine).
5. **Harvesting Losses:** Conduct a **Field Test (Demonstration)** to estimate the **Threshing Losses and Cleaning Losses** of a thresher/combine.
6. **Material Handling Study:** Study the construction and working of a **Screw Conveyor** and a **Bucket Elevator** used for grain handling.
7. **Trailer Capacity:** Measure the dimensions of a **Farm Trailer** and calculate its volumetric and theoretical weight carrying capacity.
8. **Power Transmission Systems:** Study the use and adjustment of **Belt and Pulley Drives** and **Chain and Sprocket Drives** in farm machinery (e.g., chaff cutter).
9. **Cleaning and Grading Equipment:** Study the construction and working of a **Sieve Type Grain Cleaner and Grader** and its adjustments.
10. **Specialized Equipment Study:** Study the components and working of a **Potato Digger/Harvester** or **Groundnut Digger** (using available models/machines).

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Principles of Agricultural Engineering (Vol. I)** by A. M. Michael and T. P. Ojha, Jain Brothers.
2. **Farm Machinery** by R. A. Kepner, R. Bainer, and E. L. Barger, CBS Publishers.
3. **Elements of Agricultural Engineering** by Jagdishwar Sahay, Standard Publishers Distributors.
4. **Farm Power and Machinery** by J. P. Sharma and R. K. Goyal, Sarup & Sons.
5. **Agricultural Mechanization Management** by C. P. Gupta, Agro-Tech Publishing Academy.

Theory of Machines

UNIT-I

Fundamentals of Mechanisms and Linkages

Basic Concepts: Definition of a Machine, Mechanism, and Structure. Kinematic Link, Kinematic Pair (types: lower and higher pairs, sliding, turning, rolling). Kinematic Chain, Mechanism, and Inversion. Gruebler's Criterion and Kutzbach's Criterion for mobility (degrees of freedom). Four-Bar Chain and its inversions (crank-rocker, double crank, double rocker). Slider-Crank Mechanism and its inversions.

UNIT-II

Velocity and Acceleration Analysis

Analysis of Mechanisms: Instantaneous Center Method for velocity analysis of linkages. Relative Velocity Method (Vector Method) for determining velocities of points on links. Coriolis Component of Acceleration (concept and direction). Relative Acceleration Method (Vector Method) for determining accelerations of points on links in mechanisms (e.g., four-bar chain, slider-crank).

UNIT-III

Gears and Gear Trains

Gears: Terminology (pitch circle, addendum, dedendum, pressure angle). Law of Gearing and Involute Profile. Interference and minimum number of teeth on a pinion. Gear Trains: Classification (simple, compound, reverted, and epicyclic gear trains). Velocity Ratio of gear trains. Analysis of Epicyclic Gear Trains using the tabular method.

UNIT-IV

Cams and Followers

Cams: Definition, types (radial/disc, cylindrical), and application. Followers: Classification (knife edge, roller, flat-faced) and motion types (reciprocating, oscillating). Terminology of radial cams (base circle, prime circle, lift). Follower Motion Programs: Uniform velocity, Simple Harmonic Motion (S.H.M.), and Uniform Acceleration and Retardation (Uniform A & R). Drawing Cam Profile for specified follower motions.

UNIT-V

Flywheels and Balancing

Flywheels: Function and application in IC Engines and punch presses. Turning Moment Diagram for a 4-stroke engine (ideal and actual). Fluctuation of Energy and Coefficient of Fluctuation of Speed. Determination of Mass of Flywheel. Balancing: Static and dynamic balancing. Balancing of Rotating

Masses (single mass and multiple masses in a single plane). Partial Balancing of reciprocating masses in a single cylinder engine.

List of Experiments

1. **Linkages and Mechanisms:** Study and sketch the various inversions of the **Four-Bar Chain Mechanism** and the **Slider-Crank Mechanism**.
2. **Velocity and Acceleration Analysis (Model):** Conduct a graphical analysis to determine the **Velocities and Accelerations** of various points on a mechanism model (e.g., crank-rocker) and compare with theoretical results.
3. **Kinematic Model Analysis:** Verify the **Gruebler's or Kutzbach's Criterion** for various mechanisms available in the lab.
4. **Gear Train Analysis:** Assemble and determine the **Velocity Ratio** of a **Compound Gear Train** and an **Epicyclic Gear Train** (using a simple gear train apparatus).
5. **Cam Profile Design and Study:** Study and trace the profile of a cam with a specific follower motion (e.g., Uniform Acceleration and Retardation) and measure the lift.
6. **Governor Study:** Study the working and compare the characteristics of two types of governors (e.g., **Watt Governor** and **Proell/Porter Governor**).
7. **Gyroscopic Couple:** Demonstrate the effect of a **Gyroscopic Couple** on a rotating disc apparatus.
8. **Balancing of Rotating Masses:** Conduct an experiment to perform **Static and Dynamic Balancing** of rotating masses in a single plane using a balancing machine.
9. **Vibration Analysis:** Determine the **Natural Frequency of Vibration** of a simple spring-mass system or a cantilever beam.
10. **Flywheel Study:** Determine the **Moment of Inertia** of a given flywheel experimentally and observe the effect of the flywheel on the fluctuation of speed (demonstration).

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Theory of Machines** by S. S. Rattan, Tata McGraw Hill Education.
2. **Theory of Machines and Mechanisms** by J. S. Rao and R. V. Dukkipati, New Age International Publishers.
3. **Theory of Machines** by R. K. Bansal, Lakshmi Publications.
4. **Kinematics and Dynamics of Machinery** by R. L. Norton, McGraw Hill Education.
5. **Mechanics of Machines** by V. P. Singh, Dhanpat Rai & Co.

Agribusiness Management and Trade

UNIT-I

Introduction to Agribusiness and Farm Management

Agribusiness: Definition, scope, and sectors (Input, Production, Processing/Manufacturing, and Marketing). Importance of Agribusiness in the national economy. Farm Management: Definition, scope, and characteristics of farm business. Farm Planning and Budgeting: Partial, enterprise, and whole farm budgeting. Risk and Uncertainty in agriculture and strategies for management.

UNIT-II

Agricultural Marketing and Supply Chain Management

Agricultural Marketing: Definition, importance, and functions of marketing (assembling, storage, processing, financing, risk-bearing, standardization). Market Structure: Types of markets, market channels, and price determination. Market Efficiency and imperfections. Supply Chain Management (SCM): Concepts, components, and issues in agricultural SCM (perishability, seasonality). Marketing Costs and Margins.

UNIT-III

Financial Management in Agribusiness

Farm Finance: Sources of credit (institutional and non-institutional) and types of credit (short-term, medium-term, long-term). Financial Statements: Understanding the Balance Sheet and Profit & Loss Account. Financial Analysis: Tools of analysis (Ratio analysis: liquidity, solvency, profitability ratios). Capital Budgeting: Evaluation of investment proposals (Net Present Value - NPV, Internal Rate of Return - IRR, Payback Period).

UNIT-IV

Agricultural Trade and Policy

Agricultural Trade: Need and importance of domestic and international trade. Role of World Trade Organization (WTO) in agriculture (Agreement on Agriculture - AoA). Trade Barriers: Tariffs and Non-Tariff Barriers (NTBs). Trade Agreements and Blocks (overview). Agricultural Policies: Role of Government policies in production and marketing (e.g., Minimum Support Price - MSP, subsidies). Commodity Boards and their functions.

UNIT-V

Human Resource Management and Entrepreneurship

Human Resource Management (HRM): Basic functions (Recruitment, Selection, Training, Motivation, and Performance Appraisal) in agribusiness firms. Organizational Structures (line, staff, functional). Agri-Entrepreneurship: Role of entrepreneurship in agribusiness development. Steps in establishing an agribusiness enterprise (project formulation, feasibility analysis, legal requirements). Contract Farming (concept and issues).

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Agribusiness Management** by S. C. Kuchhal, Vikas Publishing House.
2. **Agricultural Marketing** by S. S. Acharya and N. L. Agarwal, Oxford & IBH Publishing Co.
3. **Farm Management: Theory and Practice** by L. R. Singh and V. K. Sharma, Premier Publishing House.
4. **Financial Management** by I. M. Pandey, Vikas Publishing House.
5. **Agricultural Economics** by D. L. Shahu, Surjeet Publications.

Agricultural Statistics

UNIT-I

Introduction to Statistics and Data Collection

Statistics: Definition, scope, importance, and limitations of statistics. Data: Types of data (primary, secondary), sources of agricultural statistics. Classification and Tabulation of Data: Frequency distribution, cumulative frequency distribution. Diagrammatic and Graphical Presentation of Data: Bar charts, pie charts, histogram, frequency polygon, ogives.

UNIT-II

Measures of Central Tendency and Dispersion

Measures of Central Tendency: Definition, calculation, and properties of Arithmetic Mean, Median, Mode. Concept of Geometric Mean and Harmonic Mean. Measures of Dispersion: Definition, calculation, and properties of Range, Quartile Deviation, Mean Deviation, Standard Deviation (σ), and Variance (σ^2). Coefficient of Variation (C.V.) and its use in comparing variability. Moments, Skewness, and Kurtosis (basic concepts).

UNIT-III

Probability and Theoretical Distributions

Probability: Basic concepts, random experiment, sample space, events. Laws of Probability (Addition and Multiplication theorems). Conditional Probability and Bayes' Theorem (simple applications). Random Variables: Discrete and continuous. Theoretical Distributions: Properties and fitting of Binomial Distribution and Poisson Distribution (for discrete data). Introduction to Normal Distribution (properties and standard normal variate).

UNIT -IV

Sampling and Testing of Hypotheses

Sampling Theory: Need for sampling. Types of Sampling: Random Sampling (Simple, Stratified, Systematic) and Non-Random Sampling (Judgment, Quota). Sampling Distribution and Standard Error. Estimation: Point and Interval estimation (Confidence Limits). Hypothesis Testing: Null hypothesis (H_0) and Alternative hypothesis (H_a), Type I and Type II errors, Level of Significance. Large Sample Tests (Z-test) for mean and proportion.

UNIT-V

Small Sample Tests and Correlation/Regression

Small Sample Tests: Student's t-test for single mean, difference of means (independent and paired data). F-test for comparison of two variances. Chi-square (χ^2) Test: Test of goodness of fit and test of independence of attributes (contingency tables). Correlation: Simple, ~~Partial~~

and Multiple correlation (concept only). Coefficient of Correlation (r) . Regression Analysis: Simple Linear Regression, fitting of regression lines (Y on X and X on Y).

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Statistical Methods** by S. P. Gupta, Sultan Chand & Sons.
2. **Introduction to Mathematical Statistics** by Robert V. Hogg and Allen T. Craig, Pearson Education.
3. **Fundamentals of Applied Statistics** by S. C. Gupta and V. K. Kapoor, Sultan Chand & Sons.
4. **Statistical Methods in Agriculture** by V. G. Panse and P. V. Sukhatme, ICAR.
5. **Design and Analysis of Agricultural Experiments** (Relevant sections on basic statistics).

CAD / CAM Machine Drawing and Computer Graphics

UNIT-I

Introduction to CAD/CAM and Computer Graphics

CAD/CAM: Introduction, definitions, scope, and benefits. Hardware for CAD/CAM: CPU, I/O devices (Digitizers, Plotters, 3D Printers). Software for CAD: Operating system, Graphics packages. Computer Graphics: Introduction, display devices (CRT, LCD), Raster Scan and Vector Scan Displays. Graphics Standards (IGES, STEP).

UNIT-II

Geometric Modeling and Transformations

Geometric Modeling: Types of geometric models: Wireframe Modeling (advantages/disadvantages), Surface Modeling (basic surfaces), and Solid Modeling (Constructive Solid Geometry - CSG, Boundary Representation - B-Rep). Two-Dimensional (2D) Transformations: Translation, Rotation, Scaling, Reflection, and Shear. Homogeneous Coordinates (introduction). Three-Dimensional (3D) Transformations (concepts only).

UNIT-III

Machine Drawing Conventions and Assembly Drawings

Machine Drawing Conventions: Review of Indian Standard (IS) codes for drawing conventions (lines, lettering, dimensioning). Tolerances: Introduction to Limits, Fits, and Tolerances (hole basis and shaft basis systems). Surface Finish Symbols. Working Drawings: Types and features. Assembly Drawings: Drawing and detailing of simple machine components (e.g., Flanged coupling, Screw jack, Plummer block).

UNIT-IV

Detailing and Part Modeling using CAD

CAD Detailing: Creating Orthographic Views (Sectional Views, Auxiliary Views) from 3D models. Dimensioning and Annotation according to I-S standards within CAD software. Part Modeling: Techniques for creating 3D solid models using basic features: Extrude, Revolve, Sweep, and Loft. Using Boolean Operations (Union, Difference, Intersection) in solid modeling.

UNIT-V

Introduction to CAM and NC Machines

Computer-Aided Manufacturing (CAM): Introduction, NC (Numerical Control) and CNC (Computer Numerical Control) machines. Components of a CNC Machine (e.g., machine control unit - M-C-U)

CNC Part Programming: Introduction to G-Codes and M-Codes (preparatory and miscellaneous codes). Tool Path Generation (basic concepts). Application of CNC in manufacturing agricultural components.

List of Experiments

1. **CAD Environment Familiarization:** Familiarization with a professional **CAD Software Interface** (e.g., AutoCAD, SolidWorks, Fusion 360). Setting up drawing limits, units, and layers.
2. **2D Drafting and Editing:** Practice creating complex 2D geometry using various **Draw and Modify Commands** (e.g., trim, extend, offset, array).
3. **Orthographic Views:** Draw the **Orthographic Views** (Front View, Top View, Side View) of an engineering component, including **Sectional Views**, using CAD.
4. **Isometric and Perspective Views:** Create **Isometric and Perspective Views** of simple machine parts using 2D and 3D CAD tools.
5. **Limits and Fits:** Create a drawing demonstrating the application of **Limits and Fits** (e.g., a shaft and hole assembly) with proper tolerance notation.
6. **3D Part Modeling (Extrude and Revolve):** Create two different 3D solid models of machine components (e.g., a simple bracket, a flange) using the **Extrude** and **Revolve** commands.
7. **3D Part Modeling (Boolean Operations):** Create a 3D model using **Constructive Solid Geometry (CSG)** by applying **Boolean Operations** (Union, Subtract, Intersect) to primitive solids.
8. **Assembly Drawing (CAD):** Create a simple **Assembly Drawing** (e.g., a simple bearing block or coupling) by assembling two or three independently modeled parts in the CAD environment.
9. **NC Part Programming (Manual):** Write and verify a simple manual **-Code** program for a basic machining operation (e.g., straight line cutting or drilling) on an NC/CNC simulator (demonstration).
10. **Rendering and Plotting:** Practice applying materials and lighting to a 3D model (**Rendering**) and prepare a finalized drawing layout for **Plotting** (printing) with title blocks and bill of materials (BOM).

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Computer Aided Design and Manufacturing** by M. Groover and E. Zimmers, Prentice Hall.
2. **Machine Drawing** by N. D. Bhatt, Charotar Publishing House.
3. **Computer Graphics** by Donald Hearn and M. P. Baker, Pearson Education.
4. **CAD/CAM: Theory and Practice** by Ibrahim Zeid and R. Sivasubramanian, McGraw Hill Education.
5. **AutoCAD / SolidWorks / Fusion 360 Reference Manuals** (Relevant software guides).

Machine Design

UNIT-I

Introduction to Design and Design for Static Loads

Design Fundamentals: Definition of Machine Design. Phases of Design. Classification of Machine Design (Adaptive, Developmental, New). Design Considerations (Strength, Stiffness, Wear, Safety, Cost). Materials of Construction and their mechanical properties (selection criteria). Factor of Safety (FOS): Definition and selection based on material and loading. Design Stress and Allowable Stress.

UNIT-II

Design for Fatigue Loads

Fluctuating Stresses: Definition and representation (completely reversed, fluctuating, repeated). Fatigue Failure: Mechanism of failure. Endurance Limit (S_e): Factors affecting the endurance limit (surface finish, size, stress concentration). Stress Concentration Factor (K_t). Design for Fatigue Loading: Application of Soderberg, Goodman, and Gerber criteria for different types of fluctuating loads (conceptual understanding and application).

UNIT-III

Design of Joints

Cotter and Knuckle Joints: Types, applications, and Design Procedure for cotter joints (e.g., spigot and socket) and knuckle joints (design against failure due to tension, shear, and crushing). Riveted Joints: Types, terminology, and analysis of riveted joints (single and double riveted lap and butt joints). Welded Joints: Types of welds (butt, fillet), terminology, and basic design of parallel and transverse fillet welds under tension and shear.

UNIT-IV

Design of Shafts and Couplings

Shafts: Definition, materials, and types. Design of Shafts subjected to: Torsional Load only (strength and rigidity criteria), Bending Load only, and Combined Torsional and Bending Loads (using maximum shear stress and maximum normal stress theories). Keys and Splines: Types of keys (sunk, saddle), terminology, and Design of Square and Rectangular Sunk Keys. Couplings: Purpose, types (rigid: muff, flange; flexible: bush pin), and Design of Flange Coupling.

UNIT-V

Design of Power Screws and Springs

Power Screws: Terminology (major, minor, pitch diameter). Types of Screw Threads (Square, Acme, Buttress). Design of Power Screw for lifting and lowering loads (efficiency, maximum efficiency). Self-



Locking Property. Stresses in Power Screws (shear and crushing). Springs: Types of springs. Design of Helical Compression and Tension Springs (Wahl Factor, stress, and deflection). Design of Leaf Springs (simple concepts).

List of Experiments

1. **Machine Component Study (Joints):** Study, sketch, and measure the dimensions of the components of a **Cotter Joint** (e.g., **Gib and Cotter Joint**) and a **Knuckle Joint** and identify their failure modes.
2. **Coupling Study:** Study, sketch, and measure the dimensions of the components of a **Flange Coupling** (rigid or flexible) and understand the procedure for assembly and disassembly.
3. **Power Screw Study:** Study the working principle and measure the dimensions of a **Square Threaded Power Screw** (e.g., in a screw jack) and identify the stresses involved.
4. **Gear Box Analysis:** Disassemble and study the arrangement and type of **Gears** used in a simple **Gear Box** (e.g., lathe gearbox or simple agricultural machine gearbox).
5. **Failure Analysis: Examine and document** different types of **Failed Machine Components** (e.g., broken shaft, fatigued bolt) and classify the failure mode (e.g., static overload, fatigue, creep).
6. **Bearing Study:** Study the types, construction, and applications of **Rolling Contact Bearings** (e.g., Deep Groove Ball Bearing, Taper Roller Bearing) and **Sliding Contact Bearings**.
7. **Drawing of a Connecting Rod:** Draw the detailed **Working Drawing** of a component like a simple **Connecting Rod End** or a **Crank** as per IS codes, applying proper dimensioning and tolerances.
8. **Design Data Book Familiarization:** Practice using a standard **Machine Design Data Book** to find material properties, standard dimensions for fasteners, and design constants.
9. **Spring Stiffness Test:** Conduct a load-deflection test on a **Helical Compression Spring** and determine its stiffness and compare it with the theoretical design value.
10. **Shaft and Key Design (Manual/CAD):** Manually or using CAD, design and detail a **Shaft and Key Assembly** subjected to a known torque.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Machine Design** by R. S. Khurmi and J. K. Gupta, S. Chand & Co.
2. **Design of Machine Elements** by V. B. Bhandari, Tata McGraw Hill Education.
3. **Machine Design: Theory and Practice** by Murthy, S. Chand & Co.
4. **Machine Design** by P. C. Sharma and D. K. Aggarwal, S. K. Kataria & Sons.
5. **P. S. G. College of Technology, Design Data Book** (Standard reference for design parameters).

Dairy and Food Engineering

UNIT-I

Milk and Dairy Processing Fundamentals

Milk Composition and Properties: Chemical and physical properties of milk (density, viscosity, specific heat). Market Milk: Classification (pasteurized, standardized, homogenized). Dairy Plant Layout: Basic requirements and flow diagrams. Reception and Filtration/Clarification of Milk. Cream Separation: Principles and working of a Cream Separator, fat standardization. Homogenization: Principle, types of homogenizers, and effect on milk quality.

UNIT-II

Thermal Processing of Milk

Pasteurization: Definition, objectives, and methods (LTLT, HTST, UHT). Sterilization: Principles and equipment (in-bottle, continuous sterilizers). Thermal Death Time (TDT) and F-value: Concepts for process calculation. Dairy Heat Exchangers: Types (plate, tubular, scraped surface) and their selection for milk processing. Evaporation of Milk: Principles and types of evaporators (single and multiple effect).

UNIT-III

Processing of Dairy Products

Butter Manufacture: Cream ripening, churning principles, factors affecting churning, and equipment. Cheese Manufacture: Basic steps (coagulation, cutting, stirring, cooking, pressing), types of cheese. Ice Cream Manufacture: Ingredients, mix formulation, freezing process (batch and continuous freezers), and overrun calculation. Milk Powder: Principles of drying (spray drying, roller drying) and factors affecting powder quality.

UNIT - IV

Food Preservation by Refrigeration and Freezing

Refrigeration: Principles and application in food preservation (cold storage design). Freezing: Definition and freezing curve. Freezing Rate: Factors affecting the freezing time. Freezing Methods: Air blast, plate, and cryogenic freezing. Freezing Equipment (freezers, cold stores). Design of Cold Storage (estimation of refrigeration load). Controlled Atmosphere (CA) and Modified Atmosphere (MA) Storage.

UNIT-V

Food Materials Handling and Packaging

Food Material Properties: Review of engineering properties (size, shape, density, moisture content) relevant to food handling. Material Handling Equipment: Conveyors and elevators used in food

plants. Filtration and Centrifugation: Application in clarification of juices and separation of food components. Food Packaging: Functions of packaging. Packaging Materials (metal, glass, plastics, laminates) and selection criteria. Aseptic Packaging (concept).

List of Experiments

1. **Milk Composition Analysis:** Determine the **Specific Gravity, Fat Content (using Gerber's method), and Solids-Not-Fat (SNF)** of a given milk sample.
2. **Cream Separation:** Study and operate a **Cream Separator** to separate cream from milk and calculate the **Separation Efficiency**.
3. **Milk Pasteurization:** Perform **HTST Pasteurization** of milk using a laboratory setup and evaluate the effectiveness using the **Phosphatase Test**.
4. **Homogenization Study:** Study the effect of **Homogenization** pressure on the **Fat Globule Size** and the stability of milk.
5. **Ice Cream Overrun:** Prepare an **Ice Cream Mix**, freeze it using a batch freezer, and determine the **Percentage Overrun**.
6. **Butter Churning:** Conduct a laboratory-scale **Butter Churning** operation and determine the **Butter Yield** and the composition of the butter.
7. **Drying of Food:** Determine the **Drying Rate Curve** for a liquid food product or milk using a **Spray Dryer** (demonstration) or a laboratory dryer and calculate the drying efficiency.
8. **Thermal Process Calculation:** Study the application of the **Thermal Death Time (TDT)** curve and calculate the **F-value** for a simplified sterilization process.
9. **Heat Exchanger Study:** Study the working of a **Plate Heat Exchanger** and determine the **Overall Heat Transfer Coefficient** for a liquid food product.
10. **Refrigeration Load Estimation (Cold Store):** Study the components of a **Cold Storage Unit** and calculate the various components of the **Refrigeration Load** for storing a food item.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Dairy Engineering** by T. M. Paul, V. G. Kulkarni, and K. G. Lulla, ICAR.
2. **Fundamentals of Food Process Engineering** by R. P. Singh and D. R. Heldman, Springer.
3. **Principles of Dairy Processing** by James A. Law, Wiley-Blackwell.
4. **Food Engineering** by M. A. Rao, P. E. Rizvi, and A. K. Datta, CRC Press.
5. **Milk and Dairy Products: Technology and Engineering** by A. H. Varnam and J. P. Sutherland, Woodhead Publishing.

Tractor Systems and Controls

UNIT-I

Tractor Fundamentals and Engine Review

Tractor Types and Classification: Wheel, crawler, two-wheel, and specialized tractors. Tractor Chassis and Power Layout: Component arrangement. Review of I C Engine: Principles of 2-stroke and 4-stroke cycles, key engine components (cylinder head, block, crankcase, piston assembly). Engine Performance Parameters (Brake Power, Indicated Power, Torque, Specific Fuel Consumption). Engine Systems Overview: Fuel, cooling, lubrication, and ignition.

UNIT-II

Clutch and Transmission System

Clutch: Functions, requirements, and types (Single plate, Multi-plate, Over-running, Dual clutch, Wet vs. Dry). Clutch Construction and Working Principle. Clutch Adjustment and Maintenance (free play). Transmission System: Function and requirements. Gear Box: Types of gear arrangements (Sliding mesh, Constant mesh, Synchromesh) and their working. Differential and Final Drive: Function, construction, and principle of operation.

UNIT-III

Steering, Braking, and Chassis

Steering System: Function and requirements. Steering Gears (Worm and sector, Rack and pinion). Types of Steering (Manual, Power Steering). Front Axle Types (caster, camber, toe-in). Braking System: Function and requirements. Types of Brakes (Drum, Disc, Mechanical, Hydraulic). Brake Adjustment and Equalization. Chassis and Frame: Construction (unit frame, frameless construction). Tyre Mechanics: Types of tyres, tyre sizes, inflation pressure, and lug design.

UNIT-IV

Hydraulic System and Three-Point Linkage

Hydraulic System: Function, basic components (Pump, Valves, Cylinder, Reservoir). Hydraulic Pump Types (Gear, Vane, Piston). Hydraulic Controls: Draft Control, Position Control, and Response Control. Three-Point Hitch System: Components (upper link, lower links, check chains) and categories (I, II, III). Hitch Geometry for proper implement functioning. Power Take-Off: Types (live, independent) and standard P-T-O speed.

UNIT-V

Tractor Testing and Field Performance

Tractor Testing: Objectives and standard procedures (e.g., O-E-C-D codes). Measurement of Tractor Power: P-T-O Power, Drawbar Power and Belt Power. Traction and Tractive Efficiency. Slip of Driving Wheels: Factors affecting slip and methods to reduce it (ballasting). Cost Analysis: Calculation of Cost of Operation of a tractor (fixed and variable costs). Safety in tractor operation and maintenance.

List of Experiments

1. **Tractor Controls and Familiarization:** Study and identify all operational controls, gauges, and instrument panel of a standard **Agricultural Tractor**.
2. **Engine Cooling and Lubrication:** Study the components of the **Water Cooling System** (radiator, pump, thermostat) and the **Pressure Lubrication System** of a tractor engine.
3. **Clutch Adjustment:** Measure and adjust the **Free Play** in the **Clutch Pedal** of a tractor and demonstrate the consequences of improper adjustment.
4. **Gear Box Study:** Disassemble and study the construction and working of a **Sliding Mesh or Constant Mesh Gear Box** (using a cut-section model).
5. **Differential and Final Drive Study:** Study the components and working of the **Differential Unit** and **Final Drive** of a tractor (using a cut-section model).
6. **Braking System Adjustment:** Study the components of the **Braking System** (e.g., disc or drum) and practice the procedure for **Adjusting and Equalizing the Brakes**.
7. **Hydraulic System Components:** Study and identify the main components of the **Tractor Hydraulic System** (pump, control valve, lifting cylinder) and their function.
8. **Three-Point Hitch Settings:** Practice connecting an implement (e.g., cultivator) to the **Three-Point Linkage** and demonstrate the adjustment of **Draft Control and Position Control** levers.
9. **Tractor Wheel Slip Measurement:** Conduct a field experiment to measure the **Percentage Wheel Slip** of a tractor at different loads and discuss the effect of ballasting.
10. **Tractor Performance Test (Demonstration):** Observe and record data during a **Tractor or Drawbar Performance Test** to calculate **Power or Drawbar Power** and **Specific Fuel Consumption**.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Farm Machinery and Power** by J. P. Sharma and R. K. Goyal, Sarup & Sons.
2. **Principles of Agricultural Engineering (Vol. I)** by A. M. Michael and T. P. Ojha, Jain Brothers.
3. **Farm Power and Machinery** by R. A. Kepner, R. Bainer, and E. L. Barger, CBS Publishers.
4. **The Agricultural Tractor** by P. A. B. Crolla .
5. **Elements of Agricultural Engineering** by Jagdishwar Sahay, Standard Publishers Distributors.

Electrical Machines and Power Utilization

UNIT-I

DC Machines

Direct Current (DC) Generators: Constructional features, working principle, E M F Equation. Classification of DC generators (series, shunt, compound) and their characteristics. DC Motors: Working principle, concept of Back E M F, torque equation. Types of DC motors, their characteristics, and applications in farm machinery. Speed Control methods of DC shunt motors. Starters for DC motors (three-point, four-point).

UNIT-II

Single-Phase Transformers

Transformer: Construction, working principle, and classification (core type, shell type). E M F Equation of a transformer. Transformation Ratio. Ideal Transformer. Losses (copper and iron) and Efficiency. Voltage Regulation. Equivalent Circuit of a transformer. Open Circuit (O C) and Short Circuit (S C) Tests for finding equivalent circuit parameters and efficiency. Auto-Transformers (basic concept).

UNIT -III

Three-Phase Induction Motors

Three-Phase Alternating Current (AC) Fundamentals: Star and delta connections. Three-Phase Induction Motor: Constructional features (stator and rotor: squirrel cage and slip ring). Working Principle. Rotor Frequency, Slip, and Torque. Torque-Slip Characteristics. Starting of Induction Motors: Star-Delta starter and Auto-Transformer starter. Speed Control methods. Applications in irrigation pumps and farm processing.

UNIT-IV

Single-Phase and Special Purpose Motors

Single-Phase Induction Motors: Necessity for a starting mechanism. Types: Split-Phase, Capacitor-Start, Capacitor-Run, and Shaded-Pole motors. Working Principle and applications in household and small farm appliances. Synchronous Motors: Principles and applications (conceptual). Stepper Motors and Servo Motors (brief introduction) and their use in automation and control.

UNIT-V

Power Utilization in Agriculture

Electric Power Supply: Single-phase and three-phase supply systems in rural areas. Tariff Systems for agricultural consumption. Electric Motors for Farm Applications: Selection criteria for motors used in irrigation pumps, feed processing, threshing, and dairy operations. Electric Heating and Lighting: Principles and applications (e.g., brooding, dairy heating). Electrical Safety on the farm (earthing, fuses, circuit breakers).

List of Experiments

1. **DC Shunt Motor Characteristics:** Perform a load test on a **DC Shunt Motor** to determine its speed-torque and efficiency-output characteristics.
2. **Speed Control of DC Motor:** Study and demonstrate the **Speed Control** of a **DC Shunt Motor** using Armature Control and Field Control methods.
3. **Transformer O C and S C Tests:** Conduct the **Open Circuit (O C) and Short Circuit (S C) Tests** on a **Single-Phase Transformer** to determine its equivalent circuit parameters and efficiency.
4. **Voltage Regulation of Transformer:** Determine the **Voltage Regulation** of a single-phase transformer at different power factors.
5. **Three-Phase Induction Motor Characteristics:** Perform a no-load and block rotor test (or load test) on a **Three-Phase Squirrel Cage Induction Motor** and plot the **Torque-Slip Characteristic**.
6. **Starting of Induction Motor:** Study the operation and connection of a **Star-Delta Starter** used for starting a three-phase induction motor.
7. **Single-Phase Induction Motor Study:** Study the components and working of a **Capacitor-Start/Capacitor-Run Single-Phase Induction Motor** and reverse its direction of rotation.
8. **Power Factor Improvement:** Conduct an experiment to demonstrate the method of **Power Factor Improvement** for an inductive load using a capacitor bank.
9. **Power Measurement:** Measure the **Three-Phase Power** consumed by an induction motor using the **Two-Wattmeter Method**.
10. **Motor Selection for Pumps:** Study and select the appropriate type, rating, and speed of an electric motor for a given **Irrigation Pump** application based on head and discharge requirements.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Electrical Technology (Vol. II)** by B. L. Theraja and A. K. Theraja, S. Chand & Company.
2. **Electric Machines** by I. J. Nagrath and D. P. Kothari, Tata McGraw Hill Education.
3. **Utilization of Electric Power and Electric Traction** by J. B. Gupta, S. K. Kataria & Sons.
4. **Electrical Machines** by P. S. Bimbhra, Khanna Publishers.
5. **Elements of Agricultural Engineering** by Jagdishwar Sahay, Standard Publishers Distributors (for power utilization).

Soil and Water Conservation Engineering

UNIT-I

Introduction to Soil Erosion

Soil Erosion: Definition, types (geological, accelerated), and agencies (water, wind). Water Erosion: Forms (splash, sheet, rill, gully) and mechanics. Factors Affecting Water Erosion: Rainfall characteristics (intensity, duration), soil properties, topography (slope length, gradient), and vegetation cover. Erosion Control: Basic principles (reducing detachment, runoff velocity). Soil Loss Estimation: Introduction to the Universal Soil Loss Equation (USLE) and its factors.

UNIT-II

Water Management in Erosion Control

Runoff: Definition, measurement (review), and factors influencing runoff. Hydrograph: Review of components and its use in conservation design. Conservation Tillage: Types (no-till, minimum tillage), benefits, and limitations. Agronomical Measures: Contour farming, strip cropping, cover cropping, and their effectiveness in reducing erosion. Terracing: Types (broad-based, bench), design criteria (vertical interval, grade), and layout.

UNIT-III

Gully Erosion Control Structures

Gully Erosion: Stages of gully formation and classification. Gully Control Measures: Vegetative and structural methods. Temporary Structures: Brushwood, loose rock, and wire mesh check dams (design principles). Permanent Structures: Gabion Structures and Drop Structures (drop spillways, chute spillways). Design considerations for small gully control structures (weir notch, capacity).

UNIT-IV

Soil Conservation Structures

Farm Ponds: Types (excavated, embankment), site selection, and design features (storage capacity, side slopes, spillway). Grassed Waterways: Design, alignment, and selection of suitable grass species. Spillways and Outlets: Types and design of service and emergency spillways for small earth dams. Sedimentation: Basic principles, design of small Sediment Basins/Traps.

UNIT-V

Wind Erosion and Watershed Management

Wind Erosion: Mechanics of wind erosion (saltation, surface creep, suspension). Factors Affecting Wind Erosion (wind velocity, soil moisture, vegetative cover). Control Measures: Tillage practices, windbreaks, shelterbelts, and strip cropping (design and effectiveness). Watershed Management: Definition, concept, and characteristics. Integrated Watershed Management approach. Priority fixing in watershed development.

List of Experiments

1. **Runoff Measurement:** Study and operate a **Runoff Measuring Flume (e.g., Parshall Flume)** or a **Weir** model and calculate the discharge and runoff volume.
2. **Rainfall Simulator Test:** Use a **Rainfall Simulator** to demonstrate the effect of rainfall intensity and ground cover (bare vs. covered soil) on **Infiltration Rate and Runoff**.
3. **Soil Loss Estimation (USLE):** Calculate the **Potential Soil Loss** for a given field area using the **Universal Soil Loss Equation (USLE)** factors .
4. **Sieve Analysis for Erosion:** Perform **Sieve Analysis** on a soil sample to determine the percentage of **Erodible Fractions** (particles susceptible to wind and water erosion).
5. **Wind Erosion Study (Demonstration):** Use a **Wind Tunnel Apparatus** to demonstrate the three modes of soil movement (saltation, creep, suspension) under wind erosion.
6. **Terrace Design:** Design the layout and calculate the dimensions (vertical interval, bench width) for **Bench Terraces** on a given topographic map or data set.
7. **Grassed Waterway Design:** Design the cross-section and grade for a **Grassed Waterway** to safely convey a given peak runoff rate, considering permissible velocity.
8. **Farm Pond Capacity:** Determine the **Storage Capacity** of a proposed or existing **Farm Pond** given its dimensions or topographic data.
9. **Gully Control Structure Design:** Design the basic dimensions of a **Temporary Gully Control Structure** (e.g., loose rock check dam) to stabilize the gully bed.
10. **Sedimentation Analysis:** Collect and analyze a **Runoff Sample** to determine the **Sediment Concentration** (or total sediment load) during a storm event.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Soil and Water Conservation Engineering** by R. Suresh, Standard Publishers Distributors.
2. **Hydrology and Soil Conservation Engineering** by G. L. Asawa, New Age International Publishers.
3. **Soil and Water Conservation Engineering** by Schwab, Frevert, Edminster, and Barnes, John Wiley & Sons.
4. **Soil Erosion and Conservation** by R. P. C. Srivastava and S. K. Wadhwa, Oxford & IBH Publishing Co.
5. **Engineering Hydrology** by K. Subramanya (Relevant sections on runoff).

Drainage Engineering

UNIT-I

Introduction and Fundamentals of Drainage

Drainage: Definition, necessity, and objectives (controlling water logging, salinity, improving trafficability). Sources of Excess Water (rainfall, seepage, irrigation return flow). Classification of Drainage Systems: Surface and Subsurface Drainage. Effects of Poor Drainage on soil, crop yield, and farm operations. Soil-Water Relationships: Review of concepts relevant to drainage (Porosity, Hydraulic Conductivity/Permeability, Specific Yield).

UNIT-II

Soil and Drainage Investigations

Soil Investigation for Drainage: Determining soil profile, soil texture, and structure. Determination of Hydraulic Conductivity (K) : Field methods (Auger hole method, Piezometer method) and Laboratory methods (Constant/Falling Head Permeameters). Water Table Measurement: Use of Piezometers and Observation Wells (bore wells). Drainage Coefficient: Definition and determination for various crops and regions.

UNIT-III

Surface Drainage Systems

Surface Drainage: Objectives and methods. Types of Surface Drains: Field Drains (parallel field ditch, cross slope ditch), Collector Drains, and Main Drains. Design of Surface Drains: Factors affecting design, calculation of capacity (Manning's formula), and stability analysis (non-scouring velocity). Land Grading and Smoothing: Principles and methods for enhancing surface drainage. Mole Drainage (concept and suitability).

UNIT-IV

Subsurface Drainage Systems

Subsurface Drainage: Necessity and benefits. Types of Subsurface Drains: Tile Drains (pipe drains), Mole Drains, and Filter/Envelope Materials. Groundwater Flow to Drains: Steady-State Flow (Hooghoudt's equation, Ernst's equation - conceptual). Drain Spacing and Depth: Determination of optimum spacing and depth based on soil and hydraulic conductivity. Layout of Tile Drains (gridiron, herringbone, random).

UNIT-V

Drainage Structures and Salinity Control

Drainage Outlets: Design of suitable outlets for surface and subsurface systems. Pumping for Drainage: Selection of appropriate drainage pumps. Drainage Structures: Design of simple drains.

structures and junction boxes. Salinity and Sodicity Control: Causes of soil salinity. Leaching Requirement (LR) for reclamation. Drainage requirement for salt balance. Reuse of Drainage Water (basic concepts).

List of Experiments

1. **Hydraulic Conductivity (Laboratory):** Determine the Hydraulic Conductivity of a permeable soil sample using a **Constant Head Permeameter**.
2. **Hydraulic Conductivity (Field):** Conduct a field test (e.g., using the **Auger Hole Method** - demonstration) to determine the in-situ **Hydraulic Conductivity** of the subsoil.
3. **Soil Profile and Water Table:** Conduct a **Soil Survey** to draw a **Soil Profile Diagram** and measure the depth and fluctuation of the **Groundwater Table** using Piezometers/Observation Wells.
4. **Drainage Coefficient:** Calculate the **Design Drainage Coefficient** for a specific crop and region based on precipitation and soil data.
5. **Design of Surface Drains:** Design the cross-section (depth, bottom width, side slope) of a trapezoidal **Field Drain** to carry a given discharge, using **Manning's formula**.
6. **Subsurface Drain Spacing (Hooghoudt's Equation):** Apply **Hooghoudt's Steady-State Equation** to calculate the **Optimum Spacing** between parallel subsurface drains for a given set of soil and water table data.
7. **Sizing of Tile Drains:** Determine the **Diameter** of a subsurface **Tile Drain** needed to convey the design discharge, considering the grade.
8. **Land Grading and Layout:** Study the principles of **Land Grading** and practice designing a simple **Grade Plan** for a small field for improved surface drainage.
9. **Salinity Assessment:** Determine the Electrical Conductivity of a soil solution sample to assess the level of **Soil Salinity** and calculate the Leaching Requirement .
10. **Drainage System Layout:** Draw the **Layout Plan** for a **Subsurface Drainage System** (e.g., Herringbone pattern) for a given field area.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Soil and Water Conservation Engineering** by R. Suresh, Standard Publishers Distributors.
2. **Drainage Engineering** by J. N. Luthin, John Wiley & Sons.
3. **Drainage of Agricultural Lands** by J. van Schilfgaarde
4. **Irrigation and Water Resources Engineering** by G. L. Asawa, New Age International Publishers.
5. **Land and Water Management Engineering** by V. V. N. Murthy, Kalyani Publishers.

Database Management and Internet Applications Lab

List of Experiments

1. **Hydraulic Conductivity (Laboratory):** Determine the **Hydraulic Conductivity (K)** of a permeable soil sample using a **Constant Head Permeameter**.
2. **Hydraulic Conductivity (Field):** Conduct a field test (e.g., using the **Auger Hole Method** - demonstration) to determine the in-situ **Hydraulic Conductivity** of the subsoil.
3. **Soil Profile and Water Table:** Conduct a **Soil Survey** to draw a **Soil Profile Diagram** and measure the depth and fluctuation of the **Groundwater Table** using **Piezometers/Observation Wells**.
4. **Drainage Coefficient:** Calculate the **Design Drainage Coefficient** for a specific crop and region based on precipitation and soil data.
5. **Design of Surface Drains:** Design the cross-section (depth, bottom width, side slope) of a trapezoidal **Field Drain** to carry a given discharge, using **Manning's formula**.
6. **Subsurface Drain Spacing (Hooghoudt's Equation):** Apply **Hooghoudt's Steady-State Equation** to calculate the **Optimum Spacing** between parallel subsurface drains for a given set of soil and water table data.
7. **Sizing of Tile Drains:** Determine the **Diameter** of a subsurface **Tile Drain** needed to convey the design discharge, considering the grade.
8. **Land Grading and Layout:** Study the principles of **Land Grading** and practice designing a simple **Grade Plan** for a small field for improved surface drainage.
9. **Salinity Assessment:** Determine the **Electrical Conductivity (EC)** of a soil solution sample to assess the level of **Soil Salinity** and calculate the **Leaching Requirement (LR)**.
10. **Drainage System Layout:** Draw the **Layout Plan** for a **Subsurface Drainage System** (e.g., Herringbone pattern) for a given field area.

Agricultural Structures and Environmental Control

UNIT-I

Planning and Farmstead Design

Farm Structures: Classification, types, and functions. Planning and Layout of Farmstead: Factors affecting layout, general principles, and planning for specific farms (e.g., dairy, poultry, grain). Site Selection for farm structures. Functional Requirements of farm structures (e.g., ventilation, insulation, sanitation). Orientation of Buildings (sun, wind consideration). Building Materials: Properties and selection of common materials (concrete, masonry, timber, steel).

UNIT-II

Design of Structural Elements

Loads on Structures: Dead load, live load, wind load, seismic load, and snow load (basic concepts). Properties of Sections: Review of Centroid and Moment of Inertia of simple shapes. Design of Simple Structural Elements: Design principles for a simple Beam (bending and shear). Design of a short Column (axial load). Foundations: Types (shallow, deep) and basic design considerations.

UNIT- III

Storage Structures and Silos

Grain Storage: Principles, objectives, and factors affecting storage losses. Storage Structures: Types of Godowns (flat storage). Bulk Storage Structures: Design and types of Silos and Bins (cylindrical, rectangular). Forces in Silos: Basic concepts of Janssen's and Airy's theories. Ventilation and Aeration Systems for grain storage (design principles). Pest and Rodent Control in storage.

UNIT-IV

Livestock and Poultry Structures

Housing for Dairy Animals: Functional requirements, types of dairy barns (loose housing, stanchion barn), and design of feeding and watering facilities. Poultry Housing: Functional requirements, types (cage system, deep litter system), and design for broiler and layer houses. Swine Housing: Basic considerations. Waste Management Systems in livestock and poultry farms (manure handling and disposal).

UNIT-V

Environmental Control in Agricultural Buildings

Thermal Environment: Heat balance in agricultural buildings. Concepts of Ventilation: Natural and mechanical ventilation. Design of Mechanical Ventilation Systems (fan selection, air flow rate). Insulation and Vapor Barriers: Need and selection of insulating materials. Cooling and Heating: Basic principles of evaporative cooling (pad and fan system) and supplemental heating. Greenhouses: Types, design, and environmental control systems (heating, cooling, shading).

List of Experiments

1. **Survey of Farm Structures:** Visit a local farmstead (dairy, poultry, or grain) to study the **Layout and Design** of various functional buildings and draw a basic layout plan.
2. **Structural Material Testing:** Determine the **Compressive Strength** of standard **Concrete Cubes or Bricks** used in agricultural construction.
3. **Beam Design Verification:** Determine the **Reactions and Bending Moment** for a simple beam model under various loads and verify with theoretical calculations.
4. **Shed Truss Design:** Study the components of a **Roof Truss** used in farm buildings (e.g., Fink, Howe) and calculate the forces in selected members (demonstration/manual calculation).
5. **Grain Aeration System Design:** Design the **Air Flow Rate, Fan Capacity, and Duct Spacing** required for an aeration system for a specific grain storage bin.
6. **Silo Pressure Study:** Use a laboratory model to study the **Lateral Pressure** exerted by granular material in a silo (demonstration of Janssen's or Airy's theory concept).
7. **Ventilation Rate Measurement:** Use an **Anemometer** to measure the **Air Velocity and Calculate the Ventilation Rate** inside a naturally or mechanically ventilated livestock/poultry house.
8. **Thermal Insulation:** Conduct an experiment to compare the **Heat Transfer Rate** through different **Insulating Materials** used in cold storage or livestock houses.
9. **Environmental Parameter Measurement:** Measure and record environmental parameters inside a controlled environment structure (e.g., **Greenhouse or Storage Unit**) including **Temperature, Relative Humidity, and Light Intensity**.
10. **Evaporative Cooling System Study:** Study the components and working of an **Evaporative Cooling System** (e.g., pad and fan) and measure the **Cooling Efficiency**.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Agricultural Structures** by R. Suresh, Standard Publishers Distributors.
2. **Farm Structures** by H. J. Barre and L. L. Sammet, John Wiley & Sons.
3. **Principles of Agricultural Engineering (Vol. II)** by A. M. Michael and T. P. Ojha, Jain Brothers.
4. **Farm Buildings** by Longman Scientific & Technical.
5. **Design of Steel Structures** by S. K. Duggal, Tata McGraw Hill Education (for structural design basics).

Drying and Storage Engineering

UNIT-I

Fundamentals of Drying

Drying: Definition, necessity, and objectives. Moisture Content: Definition and expression (wet basis and dry basis), methods of determination (oven, rapid methods). Equilibrium Moisture Content (EMC): Definition, factors affecting EMC, and Moisture Sorption Isotherms (Adsorption and Desorption). Water Activity (a_w): Definition, measurement, and its relationship with EMC and microbial growth.

UNIT-II

Drying Theory and Air-Vapour Mixtures

Drying Theory: Mechanism of moisture movement (liquid and vapor diffusion). Drying Rate Curve: Constant Rate Period and Falling Rate Period. Critical Moisture Content. Psychrometrics: Properties of air-vapor mixtures (Dry-Bulb Temperature (DBT), Wet-Bulb Temperature (WBT), Relative Humidity (RH), Dew Point Temperature, Specific Humidity). Psychrometric Chart: Construction and application to drying processes (heating, cooling, humidification, dehumidification).

UNIT-III

Drying Equipment and Design

Classification of Dryers: Batch and continuous dryers. Types of Dryers: Tray Dryer, Cabinet Dryer, Tunnel Dryer, Rotary Dryer, Fluidized Bed Dryer, Recirculating Batch Dryer, and Continuous Flow Dryer. Design Principles: Calculation of Heat and Mass Transfer Rates during drying. Drying Efficiency. Solar Dryers: Types (direct, indirect, mixed mode) and their performance evaluation.

UNIT-IV

Grain Storage Structures and Handling

Storage: Need for safe storage, factors affecting safe storage (moisture, temperature, insects, rodents). Storage Structures: Traditional (Bukhari, Mud Bins) and modern structures. Bulk Storage Structures: Silos and Bins (types, design forces using Janssen's and Airy's theories - concept only). Bag Storage (Godowns): Design and planning considerations. Aeration System: Principles, need, and design (air flow rate, duct design, fan selection).

UNIT-V

Storage Environment and Management

Temperature Control: Importance of temperature control, basic principles of Refrigeration and Cold Storage design (review). Controlled Atmosphere (CA) and Modified Atmosphere (MA) Storage: Principles and applications for fresh produce. Storage Pests and Control: Common pests and methods of

control (fumigation, chemical, non-chemical). Storage Losses: Assessment and minimization. Cost of Drying and Storage.

List of Experiments

1. **Moisture Content and Equilibrium Moisture Content (EMC):** Determine the **Moisture Content** (wet and dry basis) of a grain sample and determine its **Equilibrium Moisture Content (EMC)** at a specified relative humidity using the Desiccator Method.
2. **Psychrometric Properties:** Use a **Sling Psychrometer** and the **Psychrometric Chart** to determine the **Relative Humidity, Dew Point Temperature, and Specific Humidity** of ambient air.
3. **Drying Rate Curve Determination:** Conduct an experiment using a **Laboratory Tray Dryer** to obtain the **Drying Rate Curve** for a food or grain sample and determine the **Critical Moisture Content**.
4. **Batch Dryer Performance:** Operate a **Batch Dryer** (e.g., Recirculating Batch Dryer) and determine its **Drying Efficiency** and **Specific Energy Consumption**.
5. **Fluidized Bed Drying:** Study the concept of **Minimum Fluidization Velocity** and operate a **Fluidized Bed Dryer** to dry a granular material.
6. **Solar Dryer Evaluation:** Conduct a performance test on an available **Solar Dryer** (direct or indirect type) to determine its **Temperature Profile** and **Drying Rate** under solar radiation.
7. **Aeration System Design:** Design the required **Air Flow Rate, Static Pressure, and Fan Capacity** for an aeration system to cool a specific volume of stored grain.
8. **Bulk Density and Porosity:** Determine the **Bulk Density and Porosity** of a grain sample and compare it to the same parameters for a milled product.
9. **Silo Pressure (Demonstration):** Study a laboratory setup to demonstrate the concept of **Lateral Pressure** exerted by grain on the walls of a storage bin.
10. **Storage Pest Study:** Study and identify the common **Insect Pests and Rodents** found in stored grain and discuss practical control measures.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Principles of Agricultural Engineering (Vol. II)** by A. M. Michael and T. P. Ojha, Jain Brothers.
2. **Drying of Solids** by A. S. Mujumdar, John Wiley & Sons.
3. **Post-Harvest Technology of Cereals, Pulses, and Oilseeds** by S. P. Singh, Oxford & IBH Publishing Co.
4. **Farm Structures** by H. J. Barre and L. L. Sammet, John Wiley & Sons.
5. **Food Processing Technology: Principles and Practice** by P. Fellows, Woodhead Publishing.

Design of Structures

UNIT-I

Introduction and Design Philosophy

Loads on Structures: Review of types of loads (Dead, Live, Wind, Seismic). Design Philosophies: Introduction to Working Stress Method (W S M) and Limit State Method (L S M). Advantages of L S M. Design Codes: Introduction to Indian Standard codes (e.g., IS 456:2000 for R C C and IS 800:2007 for Steel). Properties of Concrete and Steel (stress-strain curves, characteristic strength, modular ratio).

UNIT-II

Limit State Design of R C C Beams

Limit States: Limit state of Collapse (flexure, shear, compression) and Limit state of Serviceability (deflection, cracking). Assumptions in L S M for Flexure. Design of Singly Reinforced Rectangular Beams (determining depth, width, and steel area) for flexure. Design of Doubly Reinforced Beams (basic concept). Design for Shear: Concept of shear stress and design of Shear Reinforcement (stirrups).

UNIT-III

Design of R C C Slabs and Columns

Design of One-Way and Two-Way Slabs: Distinction, boundary conditions, and typical reinforcement detailing. Design of Simply Supported One-Way Slab (flexure and shear). Columns: Classification (short, long), failure modes. Design of Short Axially Loaded Columns (square, rectangular, circular). Types of Reinforcement (longitudinal, transverse/lateral ties). Design of Eccentrically Loaded Columns (conceptual).

UNIT-IV

Design of R C C Foundations

Footings: Purpose and types (isolated, combined, raft). Pressure Distribution under footings. Design of Isolated Pad Footings (square and rectangular) for: Bending Moment, One-Way Shear, and Two-Way Shear (Punching Shear). Reinforcement Details in footings. Design of simple rectangular footings resting on firm soil.

UNIT-V

Introduction to Steel Structures

Steel Structures: Advantages and disadvantages. Properties of Structural Steel. Limit State Design of Steel Structures (IS 800:2007). Design of Tension Members (basic design for gross and net areas). Design of Compression Members (concept of slenderness ratio and buckling). Design of Simple

Connections: Introduction to Bolted Connections (types of bolts, failure modes, design of lap and butt joints for tension).

List of Experiments

1. **Concrete Compressive Strength:** Prepare and test **Concrete Cubes** of a specified grade to determine the **Characteristic Compressive Strength** of the concrete mix.
 2. **Tensile Strength of Steel:** Conduct a **Tensile Test** on a standard specimen of **Reinforcing Steel Bar** to determine its **Yield Strength** and **Ultimate Tensile Strength**.
 3. **Reinforcement Detailing for Beams:** Practice **Detailing the Reinforcement** (longitudinal steel and stirrups) for a given singly reinforced R C C beam design, including **Bar Bending Schedule (B B S)**.
 4. **Reinforcement Detailing for Slabs:** Practice **Detailing the Reinforcement** for a **One-Way Simply Supported R C C Slab**, including main and distribution steel.
 5. **Punching Shear Verification:** Study and analyze the failure mechanism of a **R C C Footing Model** subjected to concentric loading to understand the concept of **Punching Shear**.
 6. **Load Test on a Beam:** Conduct a **Load Test** on a small-scale **R C C Beam** to measure its **Deflection** and verify its serviceability under a given load.
 7. **Bolted Connection Study:** Study and measure the dimensions of a **Bolted Lap/Butt Joint** model, identify potential **Failure Modes** (shear, tearing, crushing).
 8. **Slenderness Ratio of Columns:** Measure the effective length and cross-sectional dimensions of a model column to calculate its **Slenderness Ratio** and comment on its stability.
 9. **Simple R C C Design Exercise (Manual/CAD):** Manually design and draw the cross-section of a **Short Axially Loaded Column** for a given load and material grades.
 10. **Design Data Book and Code Familiarization:** Practice using the relevant **Design Codes (456, 800)** and **R C C/Steel Design Data Books** to locate material properties and design coefficients.
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SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Limit State Design of Reinforced Concrete** by P. C. Varghese, Prentice Hall of India.
2. **Design of R C C Structures** by A. K. Jain, Nem Chand & Bros.
3. **Limit State Design of Steel Structures** by S. K. Duggal, Tata McGraw Hill Education.
4. **Design of Steel Structures** by Ram Chandra, Standard Publishers Distributors.
5. **R C C Design and Drawing** by Neelam Sharma, Pearson Education.

Groundwater, Wells and Pumps

UNIT-I

Groundwater Hydrology Fundamentals

Groundwater: Definition, occurrence, and importance in irrigation. Hydrological Cycle (review). Zones of Aeration and Saturation. Aquifers: Classification (confined, unconfined, semi-confined, perched) and their characteristics. Geological Formations as aquicludes, aquifuges, and aquitards. Specific Yield (S_y), Specific Retention (S_r), and Porosity (ϕ). Groundwater Budget Equation.

UNIT-II

Groundwater Movement and Well Hydraulics

Flow in Porous Media: Darcy's Law and its validity. Coefficient of Permeability (K) and Transmissivity (T) Storage Coefficient (S). Steady-State Flow: Flow into a Gravity Well (Unconfined Aquifer) - Dupuit's Equation (derivation and limitations). Flow into an Artesian Well (Confined Aquifer) - Theim's Equation (conceptual). Radius of Influence.

UNIT-III

Well Construction and Development

Wells: Classification (open wells, tube wells) and components. Open Wells: Construction and capacity determination. Tube Wells: Types (Strainer, Slotted, Cavity), advantages, and limitations. Design of Tube Wells: Selection of well screen, diameter, and slot size. Well Construction Methods: Drilling methods (percussion, rotary, jetting). Well Development: Purpose and methods (surging, backwashing). Well Loss and Well Efficiency.

UNIT -IV

Groundwater Exploration and Recharge

Groundwater Exploration: Need for exploration. Methods of Exploration: Geological, Geophysical (Seismic Refraction, Electrical Resistivity). Pumping Tests: Step-Drawdown Test and Constant Rate Test (principle only) for determining aquifer parameters (T and S). Groundwater Quality: Standards for irrigation. Artificial Groundwater Recharge: Methods (check dams, spreading basins, percolation tanks) and selection criteria.

UNIT-V

Pumping Equipment and Installation

Pumps: Types of pumps used in agriculture (Centrifugal, Submersible, Deep Well Turbine, Propeller). Centrifugal Pumps: Working principle, components, and characteristics curves (Head-Discharge, Power-Discharge, Efficiency-Discharge). Pump Efficiency (overall, pump). Pump Selection: ~~Matching~~

the pump to the well characteristics and head requirements. Pump Installation (suction lift, setting depth). Troubleshooting in pumping systems.

List of Experiments

1. **Hydraulic Conductivity (Laboratory):** Determine the Hydraulic Conductivity of a saturated soil sample using a **Constant Head Permeameter**.
2. **Hydraulic Conductivity (Field):** Conduct a field demonstration of the **Auger Hole Method** or **Piezometer Method** to determine the in-situ **Hydraulic Conductivity** of the subsoil.
3. **Porosity and Specific Yield:** Determine the Porosity and Specific Yield of an aquifer material sample in the laboratory.
4. **Verification of Darcy's Law:** Verify **Darcy's Law** for laminar flow through a porous medium using a laboratory apparatus and determine the permeability coefficient.
5. **Steady-State Well Flow (Model):** Study a laboratory model of a **Groundwater Well** (confined or unconfined) and measure the **Drawdown** at observation points to analyze the flow pattern.
6. **Well Construction Study:** Study and sketch the components of various **Tube Wells** (e.g., strainer type, cavity type) and open wells using cut-section models or charts.
7. **Centrifugal Pump Study:** Study the components, installation procedure (priming, foot valve), and operational controls of a **Centrifugal Pump**.
8. **Centrifugal Pump Performance Test:** Conduct a **Load Test** on a **Centrifugal Pump** (or similar pump) to determine its characteristic curves: **Head vs. Discharge (H-Q)**, **Efficiency vs. Discharge**, and **Power vs. Discharge (P-Q)**.
9. **Pump Matching and Selection:** Given the **Well Discharge and Total Dynamic Head (TDH)** requirement, practice selecting the most suitable type and size of a pump from manufacturers' characteristic charts.
10. **Groundwater Exploration (Demonstration):** Study the principles and field setup of the **Electrical Resistivity Method** for groundwater investigation (demonstration or chart study).

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Groundwater Hydrology** by David K. Todd and Larry W. Mays, John Wiley & Sons.
2. **Hydrology and Water Resources Engineering** by S. K. Garg, Khanna Publishers.
3. **Irrigation and Water Resources Engineering** by G. L. Asawa, New Age International Publishers.
4. **Pumps and Pumping** by I. J. Karassik, W. C. Krutzsch, H. R. Fraser, J. T. Messina, and W. C. Walter, McGraw-Hill.
5. **Principles of Agricultural Engineering (Vol. II)** by A. M. Michael and T. P. Ojha, Jain Brothers.

Soil and Water Conservation Structures

UNIT-I

Introduction and Design Principles

Soil and Water Conservation: Review of necessity, scope, and basic principles. Runoff and Peak Flow Estimation: Review of the Rational Method for peak runoff determination. Hydraulic Design Principles: Flow through open channels (Manning's formula review), non-scouring and non-silting velocities. Factors of Safety and Design Life for conservation structures. Role of Structural Measures in integrated soil and water conservation planning.

UNIT-II

Erosion Control Structures

Gully Control: Classification of gullies, stages of formation. Temporary Structures: Design and layout of Brushwood, Loose Rock, and Wire Mesh Check Dams (determining crest height, side slopes, and spacing). Permanent Structures: Gabion Structures (design and construction). Spillways: Types (ogee, chute, drop), and selection criteria.

UNIT-III

Drop and Drop Inlet Structures

Drop Structures: Function and necessity. Design of Vertical Drop Spillways: Components (headwall, apron, wing walls, downstream protection). Hydraulic Jump as an energy dissipator. Design of Chute Spillways: Basic components and function. Drop Inlet Spillways: Purpose, types (straight drop, box inlet), and design considerations for small farm ponds.

UNIT-IV

Terracing and Water Harvesting Structures

Terracing: Review of types of terraces (Bench, Broad-Based, Conservation), their layout, and design (vertical interval, channel capacity). Grassed Waterways: Design for safe conveyance of runoff (cross-section, grade, permissible velocity). Farm Ponds: Types, site selection, and design of small Earth Dams (embankment design, freeboard, side slopes). Water Harvesting Structures: Simple check bunds, dug-out ponds, and percolation tanks.

UNIT-V

Reservoir Sedimentation and Structural Safety

Reservoir Sedimentation: Sources of sediment, measurement (hydrographic survey - concept only). Trap Efficiency of reservoirs. Measures to Control Sedimentation (watershed management, sediment traps). Structural Safety and Maintenance: Common failure modes of earthen dams and spillways. Inspection and Repair of conservation structures. Cost-Benefit Analysis of structural measures (conceptual).

List of Experiments

1. **Peak Runoff Calculation:** Calculate the **Peak Rate of Runoff** for a small agricultural watershed using the **Rational Method**, selecting appropriate runoff coefficients and rainfall intensity.
2. **Manning's Formula Verification:** Conduct an experiment in a hydraulic flume to verify **Manning's Formula** and determine the **Manning's Roughness Coefficient** for different channel linings.
3. **Gully Control Structure Design (Temporary):** Design the basic dimensions (crest height, apron length) and determine the **Spacing** for a **Loose Rock Check Dam** in a small gully.
4. **Gabion Structure Design:** Study the components of a **Gabion Structure** and calculate the required **Volume of Gabion** for a small retaining wall or check dam.
5. **Design of a Drop Spillway:** Given the discharge and drop height, calculate the dimensions of the **Head Wall and Impact Basin/Apron** for a simple **Vertical Drop Spillway**.
6. **Hydraulic Jump Analysis:** Conduct an experiment in a flume to demonstrate and analyze the characteristics of a **Hydraulic Jump** formed at the base of a spillway (measuring pre- and post-jump depths).
7. **Grassed Waterway Design:** Design the **Cross-Sectional Area and Longitudinal Slope** of a **Grassed Waterway** to carry a specified peak discharge without causing erosion (using permissible velocity).
8. **Terrace Design and Layout:** Design the specifications (**Vertical Interval, Channel Grade**) and prepare a simple **Layout Plan** for **Broad-Based Terraces** on a given contour map.
9. **Earthen Bund Design:** Design the cross-section (height, top width, side slopes, freeboard) of a small **Earthen Embankment/Bund** for water harvesting.
10. **Sedimentation Trap Efficiency:** Study the concept of a **Sediment Basin** and manually calculate the theoretical **Trap Efficiency** for a small farm pond based on inflow and settling velocity (conceptual exercise).

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Soil and Water Conservation Engineering** by R. Suresh, Standard Publishers Distributors.
2. **Soil and Water Conservation Engineering** by Schwab, Frevert, Edminster, and Barnes, John Wiley & Sons.
3. **Irrigation and Water Resources Engineering** by S. K. Garg, Khanna Publishers.
4. **Engineering Hydrology** by K. Subramanya, Tata McGraw Hill Education (for runoff and flow analysis).
5. **Engineering for Agricultural Development** by S. K. Wadhwa and R. P. C. Srivastava, Oxford & IBH Publishing Co.
6. **Design of Small Dams** by U. S. Bureau of Reclamation (USBR) (for detailed structural design concepts).

Refrigeration and Air Conditioning

UNIT-I

Fundamentals of Refrigeration

Refrigeration: Definition, applications in agriculture and food industry. Refrigerating Effect and Coefficient of Performance (COP). Units of Refrigeration (Tonne of Refrigeration - TR). Thermodynamic Cycles: Review of Carnot cycle. Reversed Carnot Cycle and its P-V and T-S diagrams. Vapour Compression Refrigeration (V C R) Cycle: Components (Compressor, Condenser, Expansion Valve, Evaporator), working principle, P-H and T-S diagrams.

UNIT-II

Vapour Compression and Vapour Absorption Systems

Vapour Compression Cycle Analysis: Effect of superheating and subcooling on COP and refrigerating effect. Simple Saturation Cycle. Refrigerants: Classification (primary, secondary), desirable properties (thermodynamic, chemical, safety, environmental: ODP,GWP), and common refrigerants (R11,R12,R22,R134a,R717). Vapour Absorption Refrigeration (V A R) System: Basic principle, components (Generator, Absorber, Pump, etc.), and working of Ammonia-Water and Water-Lithium Bromide systems.

UNIT-III

Refrigeration Equipment and Components

Compressors: Types (reciprocating, rotary, centrifugal) and their working principle. Condensers: Types (air-cooled, water-cooled, evaporative) and selection. Evaporators: Types (dry expansion, flooded, plate, finned coil) and applications. Expansion Devices: Types (capillary tube, thermostatic expansion valve, automatic expansion valve) and function. Ancillary Components: Accumulators, receivers, filters, dryers.

UNIT-IV

Psychrometrics and Human Comfort

Air Conditioning: Definition, applications. Psychrometric Properties of Air: Dry-Bulb Temperature (DBT), Wet-Bulb Temperature (WBT), Dew Point Temperature (DPT), Relative Humidity (RH), Specific Humidity, Enthalpy. Psychrometric Chart: Construction and use in analyzing air conditioning processes. Comfort Conditions: Effective Temperature, factors affecting human comfort. Heat Load Estimation for simple rooms.

UNIT-V

Air Conditioning Processes and Applications

Air Conditioning Processes: Simple heating and cooling, humidification, dehumidification. and chemical dehumidification. Adiabatic Mixing of Air Streams. Cooling Coil Bypass Factor, $\frac{t_{a1}-t_{a2}}{t_{a1}-t_{c1}}$

Distribution Systems: Ducts (materials, shapes), Fans (types and selection), and Diffusers. Air Conditioning Systems: Classification (Unitary, Central, All-air, All-water). Air Conditioning for Cold Storages and Food Processing Areas.

List of Experiments

1. **Vapour Compression Refrigeration (V C R) Test:** Conduct an experimental test on a **Vapour Compression Test Rig** to determine the **Refrigerating Effect, Compressor Work, and Coefficient of Performance (COP)**.
2. **Effect of Subcooling and Superheating:** Study the effect of varying the degree of **Subcooling** and **Superheating** on the of the V C R cycle.
3. **Vapour Absorption Refrigeration (V A R) Study:** Study the components, flow circuit, and working principle of a **Vapour Absorption Refrigeration System** (e.g., Ammonia-Water system).
4. **Psychrometric Measurement:** Use a **Sling Psychrometer** or **Aspiration Psychrometer** to measure the and and determine other psychrometric properties using the **Psychrometric Chart**.
5. **Refrigerant Identification:** Study different types of **Refrigerants** and their identification methods, and familiarize with manifold gauge operation.
6. **Insulation Effectiveness:** Conduct an experiment to compare the **Heat Gain** through insulated and uninsulated cold box walls to understand the role of insulation.
7. **Air Conditioning Processes:** Demonstrate and analyze a simple **Air Conditioning Process** (e.g., cooling and dehumidification) using the Psychrometric Chart.
8. **Air Flow Measurement:** Use an **Anemometer** and a **Pitot Tube** to measure the **Air Velocity and Flow Rate** in a duct system.
9. **Heat Exchanger Study (Condenser/Evaporator):** Study the working of a **Plate or Shell and Tube Heat Exchanger** used as a condenser or evaporator and determine the **Overall Heat Transfer Coefficient**.
10. **Cold Storage Refrigeration Load (Exercise):** Calculate the **Refrigeration Load (T R)** components (wall gain, product load, infiltration) for a small cold storage room.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Refrigeration and Air Conditioning** by C. P. Arora, Tata McGraw Hill Education.
2. **Refrigeration and Air Conditioning** by P. L. Ballaney, Khanna Publishers.
3. **Principles of Refrigeration** by Roy J. Dossat, Pearson Education.
4. **Basic Refrigeration and Air Conditioning** by Ananthanarayanan P., Tata McGraw Hill Education.
5. **Heating, Ventilating, and Air Conditioning: Analysis and Design** by F. C. McQuiston, J. D. Parker, and J. E. Spitler, John Wiley & Sons.
6. **ASHRAE Handbooks (Fundamentals and HVAC Systems)** (Reference for standard data and design procedures).

Entrepreneur. Develop. & Technical Report Writing

UNIT-I

Entrepreneurship and Agribusiness

Entrepreneur: Definition, characteristics, and role in economic development. Entrepreneurship: Concept, types (e.g., social, corporate). Agri-entrepreneurship: Scope, importance, and opportunities in the agricultural and allied sectors (e.g., input supply, farming, processing, marketing). Motivational Factors and Constraints to entrepreneurship development in the rural sector.

UNIT-II

Business Planning and Project Formulation

Idea Generation and Opportunity Identification: Methods (e.g., brain-storming, market survey). Project Concept: Definition, classification, and life cycle. Project Formulation: Essential components of a project report/proposal (technical, financial, and managerial aspects). Feasibility Analysis: Market, technical, financial, economic, and social feasibility. Techno-Economic Analysis.

UNIT-III

Financing and Legal Aspects of Agribusiness

Sources of Finance: Equity capital and debt capital. Institutional Financing: Role of Banks (commercial, regional rural banks), National Bank for Agriculture and Rural Development (NABARD), and other financial institutions. Government Schemes and Subsidies for agribusiness. Legal Formalities: Forms of business organization (sole proprietorship, partnership, company), registration, and basic legal compliance. Incentives and Support to small and medium enterprises (SMEs).

UNIT-IV

Technical Report Writing Fundamentals

Technical Communication: Definition, importance, and characteristics (clarity, conciseness, objectivity). Technical Report: Definition, purpose, and classification (formal, informal, long, short, proposal). Structure of a Technical Report: Preliminary parts (Title Page, Table of Contents, Abstract/Summary), Text (Introduction, Body/Findings, Conclusion, Recommendations), and Supplementary parts (Appendices, References/Bibliography).

UNIT-V

Report Drafting and Presentation

Data Collection and Documentation: Methods of collecting information (primary and secondary). Drafting the Report: Principles of effective writing (coherence, unity, emphasis). Visual Aids: Use of tables, charts, graphs, and figures in technical reports. Citations and Referencing: Styles (e.g., APA, MLA, Chicago).

Chicago) and proper documentation of sources. Oral Presentation of Technical Reports: Preparation and delivery techniques.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Entrepreneurship Development** by S. S. Khanka, S. Chand & Co.
2. **Dynamics of Entrepreneurship Development** by Vasant Desai, Himalaya Publishing House.
3. **Technical Writing and Professional Communication** by R. G. R. S. L. T., McGraw Hill Education.
4. **Business Communication and Report Writing** by C. B. Gupta, S. Chand & Co.
5. **Project Management: A Managerial Approach** by S. C. Kuchhal, Vikas Publishing House.
6. **Agribusiness Management** (Relevant chapters on financial analysis and planning).

Micro Irrigation System Design Lab

1. **Determination of Infiltration Rate:** Measure the **Infiltration Rate** of the soil in a given area using a **Double Ring Infiltrometer** to determine the soil's water absorption characteristics.
2. **Soil Moisture Constant Determination:** Determine the **Field Capacity (FC)** and **Permanent Wilting Point (PWP)** of the representative soil samples for irrigation scheduling.
3. **Soil Survey and Classification:** Conduct a **Soil Survey** to collect samples, determine **Soil Texture** using the hydrometer or feel method, and classify the soil.
4. **Pump Performance Testing:** Conduct a **Performance Test on a Centrifugal or Submersible Pump** to determine its **Head, Discharge, Power Requirement, and Efficiency** for matching with system requirements.
5. **Fertigation System Study:** Study the components and working principles of various **Fertigation Equipment** (e.g., Venturi injector, differential pressure tank, fertilizer pump) used in micro irrigation.
6. **Emitter/Dripper Discharge Characteristics:** Determine the **Relationship between Operating Pressure and Discharge** for different types of **Drippers/Emitters** and calculate the emitter exponent
7. **Sprinkler/Micro-Sprinkler Performance Evaluation:** Conduct a performance test on a **Sprinkler or Micro-Sprinkler** to determine its **Application Rate** and **Wetted Diameter** under various pressures.
8. **Drip System Emission Uniformity:** Conduct a field test on a portion of a **Drip Irrigation System** to calculate the **Coefficient of Variation (CV)** and **Emission Uniformity (EU)**.
9. **Hydraulic Loss Determination:** Determine the **Head Loss** in different sections of a micro irrigation pipeline (laterals, mainlines) due to **Friction** using pressure gauges.
10. **Hydraulic Component Study:** Study the function and operation of various **Control and Filtration Units** in a micro irrigation head unit, including screen/disc filters, pressure regulators, and air vents.
11. **Drip System Design Exercise:** Based on crop water requirements, soil, and hydraulic data, manually or using software, **Design the Layout and Calculate the Dimensions (main, sub-main, lateral diameters)** for a simple drip irrigation system.
12. **Micro-Sprinkler System Design Exercise:** Design the **Layout and Calculate the Hydraulic Parameters** for a micro-sprinkler system, focusing on overlapping patterns and pressure loss.

Watershed Management

UNIT-I

Introduction to Watershed

Watershed Concept: Definition, classification (size, drainage pattern), and characteristics (area, perimeter, slope, drainage density). Integrated Watershed Management (IWM): Objectives, principles, and components (land, water, biomass, human resource development). Need for Watershed Management in agriculture and rural development. Delineation of Watersheds using topographic maps.

UNIT-II

Watershed Planning and Prioritization

Watershed Survey: Types of surveys (reconnaissance, detailed). Data Requirement for watershed planning (meteorological, hydrological, soil, socio-economic). Problem Identification and Analysis: Inventory of resources, identification of critical erosion areas. Watershed Prioritization: Criteria and methods (sediment yield index - SYI). Preparation of Action Plans and implementation strategies.

UNIT-III

Water Harvesting and Storage

Water Harvesting: Principles and techniques. In-situ Water Harvesting: Contour bunds, contour trenching, vegetative barriers. Ex-situ Water Harvesting: Construction and design of small Earthen Embankments (farm ponds, check dams). Seepage and Evaporation Control in storage structures. Recycling and Efficient Use of Water.

UNIT-IV

Erosion Control and Management Measures

Agronomical Measures: Review of contour farming, strip cropping, cover crops, and mulch. Engineering Measures: Design principles for simple Bunds and Trenches (contour, graded). Gully Stabilization: Review of temporary and permanent check dams (brushwood, loose rock, gabion). Grassed Waterways: Design and selection of grass species. Role of Afforestation in watershed protection.

UNIT-V

Socio-Economic and Institutional Aspects

People's Participation: Importance and methods for involving local communities (User Groups). Institutional Arrangements: Role of government agencies, Non-Governmental Organizations (NGOs), and local institutions (Panchayats). Economic Evaluation: Basic concepts of Cost-Benefit Analysis (C B

A) and Economic Viability of watershed projects. Monitoring and Evaluation (M & E) of watershed programs (indicators of success).

List of Experiments

1. **Watershed Delineation:** Delineate a small watershed or sub-watershed and its sub-basins using **Topographic Maps**
2. **Morphometric Analysis:** Calculate key **Morphometric Parameters** for a delineated watershed (e.g., area, perimeter, drainage density, stream order, form factor).
3. **Thematic Map Preparation:** Prepare basic **Thematic Maps** (e.g., land use/land cover, slope map, drainage map) for a project area using traditional methods (demonstration).
4. **Runoff and Soil Loss Estimation:** Calculate the **Peak Rate of Runoff** (Rational Method) and estimate the **Potential Annual Soil Loss (USLE)** for different micro-watershed areas.
5. **Sediment Yield Index (SYI) Calculation:** Practice the method of calculating the **Sediment Yield Index (SYI)** to prioritize sub-watersheds based on their erosion potential.
6. **Earthen Bund Design:** Design the cross-section (base width, top width, height) and determine the **Layout Spacing** for simple **Contour Bunds** on a given terrain profile.
7. **Farm Pond Planning:** Select a suitable site for a **Farm Pond** on a contour map and calculate its **Storage Capacity** using average end-area or contour interval methods.
8. **Slope and Gradient Measurement:** Use field instruments (**Abney Level or Dumpy Level**) to measure the **Slope and Gradient** of a sample plot to determine its suitability for conservation measures.
9. **Socio-Economic Data Collection:** Prepare a structured **Questionnaire** for a basic **Socio-Economic Survey** in a watershed village (classroom exercise).
10. **Cost-Benefit Analysis (Exercise):** Perform a simple **Cost-Benefit Analysis** calculation for a proposed watershed activity (e.g., check dam construction) to assess its economic feasibility.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Watershed Management** by J. V. S. Murthy, New Age International Publishers.
2. **Soil and Water Conservation Engineering** by R. Suresh, Standard Publishers Distributors.
3. **Integrated Watershed Management** by R. K. Sahoo and B. C. Tripathy, Kalyani Publishers.
4. **Engineering Hydrology** by K. Subramanya, Tata McGraw Hill Education (for hydrological analysis).
5. **Soil and Water Conservation Engineering** by Schwab, Frevert, Edminster, and Barnes, John Wiley & Sons.
6. **Handbooks on Watershed Development** by National Bank for Agriculture and Rural Development (NABARD) / Ministry of Rural Development, Govt. of India (Reference for practical guidelines).

Remote Sensing & GIS Applications

UNIT-I

Remote Sensing Fundamentals

Remote Sensing: Definition, scope, and process. Electromagnetic (E M) Spectrum: Characteristics, regions relevant to RS. Energy Interactions: Interaction with atmosphere (scattering, absorption) and interaction with Earth's surface (reflection, absorption, transmission). Spectral Signatures: Typical spectral curves for vegetation, soil, and water. Atmospheric Windows.

UNIT-II

Remote Sensing Systems and Platforms

Sensors: Types (active vs. passive, photographic, scanner), characteristics (spatial, spectral, radiometric, temporal resolution). Platforms: Ground-based, air-borne, and space-borne platforms. Satellite Systems: Characteristics of common Remote Sensing Satellites (e.g., Landsat, Sentinel, I R S series) and their sensors. Geometric and Radiometric Corrections (basic concepts).

UNIT-III

Digital Image Processing

Digital Image: Pixels, file formats. Image Processing Techniques: Image Enhancement (contrast stretching, histogram equalization, filtering). Image Transformation (Principal Component Analysis - PCA). Image Classification: Unsupervised Classification (K-Means) and Supervised Classification (Maximum Likelihood Classifier - MLC). Accuracy Assessment (confusion matrix, Kappa coefficient). Vegetation Indices (e.g., NDVI).

UNIT-IV

Geographic Information System (GIS) Fundamentals

G I S: Definition, components (Hardware, Software, Data, People, Procedures). Data Models: Raster Data Model (cells, resolution) and Vector Data Model (points, lines, polygons). Coordinate Systems: Latitude and Longitude. Map Projections (types and distortion). Data Input Methods: Digitization, scanning. Database Management System (D B M S) concepts in GIS.

UNIT-V

G I S Applications in Agriculture

G I S Data Analysis: Spatial Analysis (overlay, buffer, neighborhood operations). Attribute Data Analysis. Digital Elevation Model (D E M): Generation and application (slope, aspect analysis). Applications in Agriculture: Land Use/Land Cover (L U L C) Mapping, Soil Mapping, Crop Area and Yield Estimation, Irrigation Management, and Precision Agriculture (variable rate application). Global Positioning System (G P S): Principles and integration with GIS.

List of Experiments

1. **Electromagnetic Spectrum and Spectral Signatures:** Study the **E M Spectrum** and plot the characteristic **Spectral Signatures** of healthy vegetation, bare soil, and water (conceptual exercise).
2. **Image Display and Enhancement:** Open a multi-spectral satellite image in software and perform **False Color Composite (F C C) generation** and **Contrast Enhancement** (e.g., Histogram Equalization).
3. **Vegetation Index Calculation:** Calculate and map the **Normalized Difference Vegetation Index (N D V I)** for an agricultural area and interpret the results regarding crop health.
4. **Image Classification (Supervised):** Perform **Supervised Classification** on a satellite image to generate a basic **L U L C Map** of the study area (e.g., identifying agriculture, forest, water bodies).
5. **Classification Accuracy Assessment:** Generate a **Confusion Matrix** and calculate the **Overall Accuracy and Kappa Coefficient** for a classified image.
6. **G I S Data Input (Digitization):** Learn the process of **Georeferencing** a scanned map and perform on-screen **Digitization** to create Vector Layers (points, lines, polygons).
7. **Map Projection and Coordinate System:** Practice **Defining and Projecting Spatial Data** from one coordinate system to another in software.
8. **Spatial Analysis (Buffer and Overlay):** Perform **Buffer Analysis** (e.g., creating a buffer around a river) and **Overlay Analysis** (e.g., intersection of soil and maps) for a defined area.
9. **D E M Analysis:** Generate a **Slope and Aspect Map** from a **Digital Elevation Model (D E M)** and interpret the results for potential erosion/watershed planning.
10. **G P S Data Integration:** Use a **G P S** receiver (or simulated data) to collect point data and import/integrate it into software for mapping.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Remote Sensing and Image Interpretation** by T. M. Lillesand, R. W. Kiefer, and J. W. Chipman, John Wiley & Sons.
2. **Principles of Geographical Information Systems** by P. A. Burrough and R. A. McDonnell, Oxford University Press.
3. **Fundamentals of Remote Sensing** by Universities Press (India).
4. **Remote Sensing and GIS** by Basudeb Bhatta, Oxford University Press.
5. **Introduction to Geographic Information Systems** by Kang-Tsung Chang, McGraw Hill Education.
6. **Remote Sensing Applications in Agriculture and Allied Fields** (Various specialized texts and journal papers).

System Engineering (Operation Research)

UNIT-I

Introduction to Operations Research and Linear Programming

Operations Research (O R): Definition, scope, phases, and limitations. Modeling in O R: Types of models (iconic, analog, symbolic). Linear Programming Problem (L P P): Formulation of L P P (objective function, constraints, non-negativity restrictions). Assumptions of L P P. Graphical Method: Solution of two-variable L P P (maximization and minimization cases). Concepts of Slack, Surplus, and Artificial Variables.

UNIT-II

Simplex Method and Duality

Simplex Method: Standard form of L P P. Simplex Algorithm for solving L P P (maximization case). Minimization Problem using the Simplex method (Big M Method - conceptual). Special Cases in Simplex: Degeneracy, unbounded solution, and infeasibility. Duality in L P P: Formulation of the Dual Problem from the Primal. Economic Interpretation of the dual variables (shadow prices).

UNIT-III

Transportation and Assignment Problems

Transportation Problem (T P): Formulation and balanced/unbalanced T P. Initial Basic Feasible Solution (I B F S): Methods (North-West Corner Rule - N W C R, Least Cost Method - L C M, Vogel's Approximation Method - V A M). Optimality Test: Modified Distribution (M O D I) Method and Stepping Stone Method. Assignment Problem (A P): Formulation. Hungarian Method for solving A P (minimization case).

UNIT-IV

Queuing Theory and Inventory Control

Queuing Theory: Elements of a queuing system (arrival process, service mechanism, queue discipline). Single-Channel Queuing Model: M/M/1 Model (formulae for expected waiting time, queue length, system size - application only). Inventory Control: Types of inventory. Inventory Costs (holding, ordering, shortage). Economic Order Quantity (E O Q) Model (determination of EOQ, reorder point).

UNIT-V

Network Analysis (P E R T / C P M)

Network Representation: Activity, event, network diagram (A O A and A O N). Project Evaluation and Review Technique (P E R T): Three time estimates (optimistic, pessimistic, most likely). Calculation of Expected Time and Variance. Critical Path Method (C P M): Calculation of Earliest Start (ES), Earliest

Finish (EF), Latest Start (LS), Latest Finish (LF). Critical Path and Float (Slack). Project Crashing (conceptual).

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Operations Research: An Introduction** by H. A. Taha, Pearson Education.
2. **Introduction to Operations Research** by F. S. Hillier and G. J. Lieberman, McGraw Hill Education.
3. **Operations Research** by V. K. Sharma, S. K. Gupta, and M. P. Gupta, S. Chand & Co.
4. **Operations Research: Theory and Applications** by J. K. Sharma, Macmillan Publishers India.
5. **Engineering Optimization: Theory and Practice** by S. S. Rao, John Wiley & Sons (for a deeper dive into optimization concepts).

Food Packaging Technology

UNIT-I

Introduction to Food Packaging Food Packaging: Definition, functions (containment, protection, convenience, communication), and importance in the food supply chain. **Types of Packaging:** Primary, secondary, and tertiary. **Evolution of Packaging.** **Selection Criteria:** Factors influencing the choice of packaging material (product properties, environmental conditions, cost, regulatory requirements). **Role of Packaging in Minimizing Food Loss.**

UNIT-II

Packaging Materials: Part I (Paper and Glass) Paper and Paperboard: Composition, properties (strength, permeability), and types (cartons, corrugated board, greaseproof). **Laminates:** Principles of lamination, types of laminated structures, and their applications. **Glass:** Composition, properties (barrier, clarity, inertness), advantages, and limitations. **Manufacturing of Glass Containers** (basic process).

UNIT-III

Packaging Materials: Part II (Plastics and Metals) Plastics: Classification (thermoplastics, thermosets). **Common Packaging Plastics:** Properties, structure, and applications of **Polyethylene (PE)**, **Polypropylene (PP)**, **Polyethylene Terephthalate (PET)**, **Polyvinyl Chloride (PVC)**, and **Polystyrene (PS)**. **Metals:** Properties and applications of **Tinplate**, **Tin-free Steel (TFS)**, and **Aluminum**. **Metal Cans:** Manufacturing and corrosion prevention.

UNIT-IV

Packaging Systems and Environment Control Aseptic Packaging: Principle, equipment, and materials. **Retortable Pouches** and their advantages. **Vacuum Packaging and Gas Flushing:** Principles and applications. **Modified Atmosphere Packaging (MAP):** Theory, gases used (N₂, CO₂, O₂), and selection of film permeability. **Active Packaging** (oxygen scavengers, moisture absorbers). **Intelligent Packaging** (TTI - Time-Temperature Indicators).

UNIT-V

Testing, Machinery, and Regulations Packaging Testing: Methods for determining **Permeability** (Oxygen/Water Vapor Transmission Rate - OTR, WVTR), **Mechanical Strength** (bursting strength, tensile strength), and **Sealing Integrity**. **Packaging Machinery:** Form-Fill-Seal (FFS), vacuum packaging machines, capping machines (basic concepts). **Coding and Labeling Requirements**. **Environmental Issues:** Biodegradable packaging, recycling, and sustainability in packaging. **Food Packaging Regulations** (overview).

List of Experiments

1. **Water Vapor Transmission Rate (W V T R):** Determine the **Water Vapor Transmission Rate (W V T R)** of different packaging films using the **Gravimetric Method (Desiccator Method)**.
2. **Oxygen Transmission Rate (O T R):** Study the principle and use of an instrument (or simulation) to measure the **Oxygen Transmission Rate (O T R)** of flexible packaging materials.
3. **Thickness and GSM Measurement:** Measure the **Thickness** and determine the **Grammage per Square Meter (GSM)** of various plastic films and paperboard samples.
4. **Tensile Strength and Elongation:** Conduct a test to determine the **Tensile Strength** and **Percentage Elongation** of a flexible packaging film using a Universal Testing Machine (UTM).
5. **Bursting Strength of Board:** Determine the **Bursting Strength** of a corrugated fiberboard or carton sample using a **Mullen Burst Tester**.
6. **Seal Strength and Integrity:** Measure the **Seal Strength** (peel strength) of heat-sealed flexible packages and perform a **Dye Penetration Test** to check seal integrity.
7. **Paperboard Absorptiveness (Cobb Test):** Determine the **Water Absorptiveness** of paper and paperboard using the **Cobb Test** method.
8. **Chemical Resistance of Plastics:** Test the **Chemical Resistance** and basic identification of different plastic films (e.g., solubility test) commonly used in food packaging.
9. **Vacuum Packaging and M A P:** Demonstrate the operation of a **Vacuum Packaging Machine** and a **M A P System** (gas flushing) and measure the residual oxygen concentration (demonstration).
10. **Drop Test and Package Performance:** Conduct a **Drop Test** or similar mechanical test on a filled package to evaluate its **Shock Resistance** and overall performance.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Food Packaging: Principles and Practice** by G. L. Robertson, CRC Press.
2. **Principles of Food Processing** by D. R. Heldman and R. P. Singh (Relevant chapters on Packaging and Preservation), Springer.
3. **The Technology of Food Packaging** by S. F. P. and F. S., Academic Press.
4. **Packaging Technology** by S. C. Sacharow, Van Nostrand Reinhold.
5. **Plastics in Food Packaging** by N. B. R. H., Marcel Dekker

Water Harvesting & Ground Water Recharge

UNIT-I

Introduction to Water Harvesting and Groundwater

Water Harvesting (W H): Definition, necessity, and scope in arid and semi-arid regions. Components of a W H System (catchment, conveyance, storage). Types of W H: In-situ (soil moisture conservation) and Ex-situ (storage). Groundwater Recharge: Definition, need, and importance. Review of Groundwater Fundamentals: Aquifers, Darcy's Law, Permeability, and Transmissivity.

UNIT-II

Catchment and Runoff Estimation

Catchment Area: Characteristics affecting runoff (size, slope, land use, soil type). Runoff Estimation: Review of the Rational Method and S C S Curve Number (C N) Method for predicting runoff volume and peak rate from small watersheds. Runoff Coefficients for various land covers. Design Storm: Selection of design rainfall intensity and duration.

UNIT-III

In-situ Water Harvesting Structures

Soil Moisture Conservation: Techniques (contour bunds, contour trenches, tied ridging, mulching). Contour Bunds: Purpose, design principles, cross-section, and spacing. Graded Bunds/Terraces: Necessity and design. Trenching: Types (staggered, continuous) and design for afforestation and horticulture. Vegetative Barriers (concept and effectiveness).

UNIT-IV

Ex-situ Water Harvesting and Storage Structures

Farm Ponds: Types (excavated, embankment), site selection, and design considerations (storage capacity, freeboard, side slopes, spillway). Silt and Sedimentation Control (sediment basins). Small Reservoirs/Tanks: Design of small earthen dams (embankment stability, seepage control). Lining of Ponds: Need and common lining materials (clay, geomembranes) to minimize seepage losses.

UNIT-V

Groundwater Recharge Structures and Management

Artificial Recharge Methods: Classification (direct and indirect). Direct Methods: Recharge Pits, Recharge Trenches, Shafts, and Wells (tube well recharge). Indirect Methods: Check Dams,

Percolation Tanks, and Sub-surface Dykes. Design of Recharge Structures: Hydraulic considerations, filter media selection. Water Quality for recharge (clogging issues). Legal and Institutional Aspects of groundwater management.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. Water Harvesting and Conservation by V. N. Murthy and B. K. Sahoo, Kalyani Publishers.
2. Water Harvesting and Ground Water Recharge: A Practical Manual by NABARD/Ministry of Water Resources, India (Reference for field practices).
3. Soil and Water Conservation Engineering by R. Suresh, Standard Publishers Distributors.
4. Engineering Hydrology by K. Subramanya, Tata McGraw Hill Education (for runoff and flow analysis).
5. Groundwater Hydrology by David K. Todd and Larry W. Mays, John Wiley & Sons (for recharge concepts).
6. Water Resources Engineering by McGraw Hill Education (for dam and spillway design concepts).

Minor Project

Project Topics

1. Farm Power and Machinery

- **Design and Fabrication of a Small-Scale Seed Sowing Attachment** for a two-wheel power tiller.
- **Performance Evaluation of a Tractor-Mounted Multi-Crop Thresher** for specific local crops (e.g., soybean, pigeon pea).
- **Design Optimization of a Rotary Tiller Blade** for reduced power consumption.
- **Ergonomic Assessment of Controls** on a selected piece of farm equipment.

2. Soil and Water Conservation / Irrigation

- **Design and Layout of a Subsurface Drip Irrigation System** for a high-value horticultural crop field (e.g., precision design based on soil data).
- **Hydraulic Design and Performance Analysis of a Gabion Structure** for gully control (using model simulation or field data).
- **Design and Construction of a Sand Filter** for micro-irrigation system water quality improvement.
- **Assessment of Runoff and Soil Loss** from different tillage practices using a rainfall simulator.

3. Post-Harvest Technology and Food Engineering

- **Design and Fabrication of a Low-Cost Solar Tunnel Dryer** for drying specific fruits or vegetables.
- **Development of a Continuous Flow Grain Moisture Meter** using microwave or capacitance principles.
- **Optimization of Parboiling Parameters** for a local rice variety to minimize breakage.
- **Design and Fabrication of a Pedal-Operated Decorticator** for groundnut or cashew.

4. Agricultural Structures and Environmental Control

- **Feasibility Study and Basic Design of a Cold Storage Unit** for a small farmer cooperative (focusing on insulation and refrigeration load).
- **Design and Simulation of a Natural Ventilation System** for a specific type of livestock house (e.g., a poultry broiler house).
- **Structural Design and Cost Estimation** for a low-cost, prefabricated farm storage shed.

5. Remote Sensing and GIS Applications

- **Crop Health Assessment (NDVI Analysis)** for a specific field using open-source satellite imagery and GIS tools.
- **GIS-Based Prioritization of Micro-Watersheds** for water harvesting structures based on slope and soil erosion factors.
- **Mapping and Quantification of Land Use/Land Cover Changes** in a farm area over the past five years using multi-temporal satellite data.

Minor Irrigation and Command Area Development

UNIT-I

Introduction to Irrigation Projects

Irrigation Projects: Classification (major, medium, minor) and characteristics. Minor Irrigation: Definition, importance, and role in decentralized water management. Assessment of Irrigation Water Requirement: Review of Crop Water Requirement (ET_c), Effective Rainfall (Re), and Net/Gross Irrigation Requirement. Irrigation Efficiencies (Conveyance, Application, Distribution, Water Use Efficiency).

UNIT-II

Water Lifting Devices and Conveyance

Lifting Devices: Classification (manual, animal, mechanical). Traditional Devices (Dhenkli, Rahat, Swing basket). Mechanical Devices: Introduction to Pumps (Centrifugal, Submersible) and their selection criteria (review of H-Q curves). Water Conveyance: Open channels (e.g., kachha/pucca canals, flumes) and closed conduits (pipes). Design of Earthen Channels using Manning's Formula (review of non-scouring velocity).

UNIT-III

Well Irrigation Systems

Wells: Review of types (open wells, tube wells) and components. Well Design and Construction: Basic principles for open and tube wells. Well Hydraulics: Review of Steady-State Flow (Dupuit's and Theim's equations). Specific Capacity and Well Efficiency. Pumping Tests: Review of Step-Drawdown Test for estimating well loss. Well Interference (conceptual).

UNIT-IV

Command Area Development (C A D)

C A D: Definition, objectives, and components (e.g., On-Farm Development - OFD). Water Use Efficiency Improvement: Concept of volumetric water pricing. Warabandi System: Principles, need, and implementation. On-Farm Development (O F D) Works: Land Levelling/Shaping, Field Channel Construction, and Field Drain Construction. Land Irrigability Classification (basic concept).

UNIT-V

Irrigation Structures and Management

Measurement Structures: Review of Weirs and Flumes (V-notch, Rectangular, Parshall flume) for measuring discharge in minor irrigation systems. Water Control and Diversion Structures: Basic principles of Diversion Headworks (weir, barrage). Cross Drainage Works (types and selection).

Operation and Maintenance of minor irrigation systems. Participatory Irrigation Management (P I M): Role of Water Users Associations (WUAs).

List of Experiments (Lab Component)

1. **Discharge Measurement using Weirs:** Determine the **Discharge (Q)** through **V-Notch and Rectangular Weirs** installed in a channel or laboratory flume, and compare measured and theoretical results.
2. **Discharge Measurement using Flumes:** Determine the **Discharge (Q)** using a **Parshall Flume** or cutthroat flume model.
3. **Water Lifting Device Study:** Study the components, working, and performance (or operational parameters) of various **Traditional and Mechanical Water Lifting Devices** (e.g., centrifugal pump, submersible pump).
4. **Well Discharge Measurement:** Determine the **Discharge** from an existing well using methods like the **Volumetric Method** or **Orifice Meter Method**.
5. **Design of an Open Earthen Channel:** Design the **Cross-Sectional Dimensions** (bed width, depth, side slopes) of an open earthen irrigation channel to carry a specific discharge using **Manning's Formula**.
6. **Irrigation Requirement Calculation:** Given meteorological and crop data, calculate the **Net and Gross Irrigation Water Requirement** and the **Irrigation Interval** for a specific crop.
7. **Irrigation Efficiencies:** Given field data (pump discharge, application time, water collected), calculate the **Water Application Efficiency, Water Conveyance Efficiency, and Water Distribution Uniformity**.
8. **Field Channel Layout:** Prepare a **Layout Plan** for the **Field Channel and Field Drain Network** for a given farm size as part of On-Farm Development () works.
9. **Land Levelling/Shaping Calculations:** Analyze topographic survey data for a field and perform basic calculations for **Cut and Fill** volumes necessary for land levelling.
10. **Hydraulic Design of Small Structure:** Design the basic dimensions (e.g., weir crest length, downstream apron length) for a simple **Water Control Structure** (e.g., pipe outlet or simple check structure).

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Irrigation and Water Resources Engineering** by G. L. Asawa, New Age International Publishers.
2. **Principles of Agricultural Engineering (Vol. II)** by A. M. Michael and T. P. Ojha, Jain Brothers.
3. **Irrigation Theory and Practice** by A. M. Michael, Vikas Publishing House.
4. **Minor Irrigation Works** by B. C. P. S., Standard Publishers Distributors.
5. **Water Resources Engineering** by McGraw Hill Education (for structures and hydraulics).
6. **Groundwater Hydrology** by David K. Todd and Larry W. Mays, John Wiley & Sons (for well hydraulics).

Food Process Plant Design & Layout

UNIT-I

Introduction and Site Selection

Plant Design: Definition, scope, and objectives. Design Procedure: Phases of design (feasibility study, preliminary design, detailed design). Feasibility Study: Market, technical, financial, and economic aspects. Plant Location/Site Selection: Factors influencing site selection (raw material availability, market, labor, utilities, waste disposal, transportation). Regulatory Requirements and zoning laws.

UNIT-II

Plant Layout Principles and Types

Plant Layout: Definition, objectives, and importance. Principles of Good Layout: Flow, minimum travel, cubic space utilization, flexibility, and safety. Types of Layouts: Product Layout (line layout), Process Layout (functional layout), Fixed Position Layout, and Combination Layouts. Tools and Techniques for layout planning (templates, models, CAD). Space Estimation for equipment, storage, and utilities.

UNIT-III

Material Handling and Flow Analysis

Material Handling: Objectives, principles, and types of material handling equipment (conveyors, elevators, forklifts). Selection of Material Handling Equipment. Flow Diagram: Importance and construction of a Process Flow Diagram and Block Flow Diagram for a food product. Flow Analysis: Flow Process Chart, Activity Relationship Chart, and Travel Chart for minimizing movement and bottlenecks. Utilities Planning (water, steam, power).

UNIT-IV

Sanitation, Safety, and Waste Management

Sanitary Design: Principles of Hygienic Design for food equipment and plant structures (smooth surfaces, easy-to-clean corners, material selection). Cleaning-In-Place (C I P) systems: Principles and layout considerations. Safety in Plant Design: Fire safety, access, ventilation, lighting, and worker comfort. Waste Management: Classification of wastes (solid, liquid), methods of Waste Treatment and Disposal (effluent treatment plant - ETP concept).

UNIT-V

Economics of Plant Design

Cost Estimation: Types of costs (fixed, variable, capital, operating). Estimation of Total Capital Investment (T C I) and Total Manufacturing Cost (T M C) (conceptual). Economic Evaluation: Review of Time Value of Money. Techniques for evaluating profitability: Payback Period, Net Present Value (N P V), and Internal Rate of Return (I R R). Cost Optimization in design and layout.

List of Experiments

1. **Process Flow Diagramming:** Prepare a detailed **Process Flow Diagram (P F D)** for a selected food process (e.g., fruit juice extraction, milk pasteurization) including equipment, unit operations, and material balances.
2. **Block Flow Diagramming and Site Selection:** Prepare a **Block Flow Diagram** for a complex food process and perform a comparative analysis for **Site Selection** based on weighted factors (raw material, utilities, etc.).
3. **Space Estimation and Allocation:** Based on a given production capacity and equipment list, calculate the **Area Requirement** for the main processing hall, storage areas, and utilities.
4. **Activity Relationship Chart (A R C):** Prepare an **Activity Relationship Chart (A R C)** and a resulting **Relationship Diagram** for the different sections of a small food plant (e.g., bakery or dairy).
5. **Drafting a Process Layout:** Using software or physical templates, draft a **Preliminary Process Layout** for a selected food unit (e.g., a spice grinding unit) minimizing material travel.
6. **Material Handling Analysis:** Analyze the flow path of a key raw material through a processing line and select the most appropriate **Material Handling Equipment** (e.g., conveyor, screw auger) based on cost and safety.
7. **Sanitary Design Principles:** Study and sketch the design features of food equipment illustrating **Hygienic Design Principles** (e.g., easy-to-clean joints, self-draining surfaces).
8. **C I P System Study (Demonstration):** Study the flow circuit and components of a **C I P System** (tanks, pumps, valves) used in a liquid food processing environment.
9. **Feasibility Study Analysis:** Analyze a simple case study project report and calculate the **Payback Period** and **Average Rate of Return** to assess the project's financial viability.
10. **T C I and T M C Estimation (Exercise):** Given basic capacity data, perform a preliminary estimation of the **Total Capital Investment (T C I)** and the major components of the **Total Manufacturing Cost (T M C)** for a small plant.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Food Processing Plant Design** by K. R. K. B. and P. A. B., Academic Press.
2. **Food Plant Sanitation: Design, Maintenance, and Good Manufacturing Practices** by G. W., Blackwell Publishing.
3. **Plant Layout and Material Handling** by W. R. H., McGraw Hill Education.
4. **Fundamentals of Food Process Engineering** by R. P. Singh and D. R. Heldman (Relevant chapters on Process Design and Economics), Springer.
5. **Chemical Engineering Plant Design** by F. C. Peters and K. D. Timmerhaus, McGraw Hill (Principles applicable to food processing).
6. **Economic Analysis of Agricultural Projects** by J. P. Gittinger, Johns Hopkins University Press (For economic evaluation concepts).

Mechanics of Tillage and Traction

UNIT-I

Introduction to Soil Dynamics and Tillage

Soil Dynamics: Definition, scope, and importance in agricultural engineering. Soil Physical Properties affecting tillage: Bulk Density, Moisture Content, Plastic Limit, Cohesion, Adhesion, and Angle of Internal Friction (ϕ). Tillage: Definition, objectives, and classification (primary, secondary). Soil Failure: Modes of soil failure under tool action (shear, compression, tension). Soil Resistances to tillage tools.

UNIT-II

Mechanics of Tillage Implements

Moldboard Plow: Components (share, moldboard, landside), types of moldboards. Forces on a Moldboard Plow: Analytical determination of forces (draft, side force, vertical force) using C A Taylor's approach or similar models (conceptual). Tillage Tool Forces: Measurement techniques (dynamometers). Draft Power and Specific Draft calculation. Design parameters of simple tools (e.g., cultivator sweeps, discs).

UNIT-III

Soil-Tool Interaction Models

Simplified Soil Cutting Models: Analysis of force components for Tillage Tools (e.g., inclined blade, vertical cutting edge). Soil Reaction Theory: Application of soil mechanics principles to predict soil resistance. Effect of Tool Geometry: Influence of Rake Angle, Lift Angle, and Sweep Angle on draft and soil manipulation. Factors affecting implement performance (speed, depth, soil condition).

UNIT-IV

Traction Theory and Analysis

Traction: Definition, necessity, and factors affecting traction. Traction Devices: Wheel (pneumatic tyres), tracks (crawler). Tyre Mechanics: Construction, types (bias-ply, radial), size nomenclature. Tractive Performance: **Gross Tractive Effort, Net Tractive Effort, Dynamic Load, Tractive Efficiency (η_t) **. Slip: Definition, measurement, and effects. Tyre Lugs: Function and design characteristics.

UNIT-V

Power Transmission to Soil

Tractive Force Analysis: R. S. A. S.'s (Rolling Surface Area and Shape) model or similar empirical models (conceptual). Mobility Number (N) and its application. Ballasting: Importance, types (water, cast iron weights), and calculation of optimum weight. Wheel Sinkage and Rolling Resistance. Pneumatic Tyre Selection for different soil conditions. Power Loss in transmission and traction

List of Experiments

1. **Soil Physical Properties Measurement:** Determine the **Moisture Content, Bulk Density, and Cone Index (Penetration Resistance)** of the soil in a test field or soil bin.
2. **Soil Frictional Properties:** Determine the **Angle of Internal Friction and Cohesion** of a soil sample using a **Shear Box Test** (laboratory exercise).
3. **Tillage Tool Force Measurement:** Measure the **Draft Force, Vertical Force, and Side Force** exerted on a simple **Tillage Tool** (e.g., sweep, vertical tine) using a **Tillage Dynamometer** setup in a soil bin or field.
4. **Effect of Rake Angle on Draft:** Study the effect of varying the **Rake Angle** of a simple inclined blade on the **Draft Requirement** and specific draft.
5. **Plow Performance Evaluation:** Conduct a field test on a **Moldboard Plow** to measure its **Draft, Specific Draft, Depth of Cut, and Width of Cut**, and calculate **Field Capacity**.
6. **Tyre Dimensions and Terminology:** Study the **Nomenclature and Dimensions** of different types of **Pneumatic Tractor Tyres** (e.g., measuring circumference, diameter, section width).
7. **Wheel Slip Measurement:** Conduct a field experiment to measure the **Percentage Wheel Slip** of a tractor driving wheel at different **Drawbar Loads** and speeds.
8. **Tractive Efficiency Determination:** Conduct a test to measure the **Gross Tractive Effort, Drawbar Pull (Net Tractive Effort), and Dynamic Wheel Load** to calculate the Tractive Efficiency of a drive wheel.
9. **Effect of Ballasting:** Demonstrate and quantify the effect of adding **Ballast** (e.g., water or weights) to the driving wheels on **Wheel Slip and Tractive Efficiency**.
10. **Soil Penetration Resistance Mapping:** Use a **Penetrometer** (manual or electronic) to map the **Penetration Resistance** profile of a field to assess its tillability.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Tillage and Traction** by W. R. Gill and G. E. VandenBerg, American Society of Agricultural Engineers (ASAE).
2. **Farm Machinery and Power** by J. P. Sharma and R. K. Goyal, Sarup & Sons.
3. **Principles of Agricultural Engineering (Vol. I)** by A. M. Michael and T. P. Ojha, Jain Brothers.
4. **Farm Power and Machinery** by R. A. Kepner, R. Bainer, and E. L. Barger, CBS Publishers.
5. **Soil Dynamics in Tillage and Traction** by Michigan State University (Advanced reference on soil mechanics).
6. **Tractor Engineering and Applications** by J. I. Luthy, Tata McGraw Hill Education (Relevant chapters on traction).

Manufacturing Process of Agricultural Machinery

UNIT-I

Introduction to Manufacturing Processes

Manufacturing Processes: Definition and classification (forming, machining, joining, finishing).
Materials in Agricultural Machinery: Properties and selection of common materials (cast iron, carbon steel, alloy steel, aluminum, plastics). Fits, Tolerances, and Limits: Principles of interchangeability and standardization (IS standards). Metrology and Inspection (basic measuring tools).

UNIT-II

Casting and Forming Processes

Casting: Principles of sand casting, types of patterns, molding techniques, and common defects.
Casting Applications in farm machinery (e.g., gearbox housing, plow shares). Forming Processes: Forging (open-die, closed-die), Rolling (hot/cold), Extrusion, and Drawing. Sheet Metal Working: Shearing, bending, punching, and deep drawing. Hydraulic and Pneumatic Presses (basic working).

UNIT-III

Machining Processes

Lathe Operations: Principles of turning, facing, threading, and boring. Lathe Accessories (chucks, steady rest). Drilling and Boring Machines: Types and operations (reaming, counterboring). Milling Machines: Types (horizontal, vertical) and operations (plane milling, gear cutting). Grinding Machines: Types and applications for surface finishing and tool sharpening. Introduction to C N C (Computer Numerical Control) Machines (conceptual).

UNIT-IV

Joining and Fastening Processes

Welding: Classification (fusion, pressure). Arc Welding: Principles of Shielded Metal Arc Welding (SMAW), Gas Metal Arc Welding (GMAW), and Gas Tungsten Arc Welding (GTAW). Brazing and Soldering: Principles and applications. Thermal Cutting: Oxygen Acetylene Gas Cutting. Riveting: Types of joints and rivets. Threaded Fasteners: Bolts, nuts, screws, and washers. Jigs and Fixtures: Importance in mass production of machinery components.

UNIT-V

Finishing, Assembly, and Plant Layout

Surface Finishing Processes: Need for finishing. Processes like Lapping, Honing, Polishing, and Buffing. Protective Coatings: Principles of Electroplating, Galvanizing, and Painting for corrosion

resistance. Assembly Process: Sequence of component assembly, sub-assembly, and final assembly. Quality Control at different stages. Layout Planning: Basic principles and types of Manufacturing Plant Layout (e.g., process vs. product layout) for a small agricultural machinery unit.

SUGGESTED TEXT BOOKS AND REFERENCES:

1. **Manufacturing Processes** by B. H. Amstead, P. F. Ostwald, and M. L. Begeman, John Wiley & Sons.
2. **Workshop Technology (Volume I & II)** by S. K. Choudhury and A. K. Choudhury, Media Promoters and Publishers Pvt. Ltd.
3. **Manufacturing Technology (Foundry, Forming and Welding)** by P. N. Rao, Tata McGraw Hill Education.
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