# Syllabus – 2016



# B.Tech (Agricultural Engineering)



Kelappaji College of Agricultural Engineering and Technology

**Kerala Agricultural University**

**Tavanur 679 573**

TABLE OF CONTENTS

## Introduction

Agricultural Engineering incorporates many science disciplines and technology practices to the efficient production and processing of food, feed, fibre and fuels. It involves disciplines like mechanical engineering (agricultural machinery and automated machine systems), civil engineering, computer science, electrical engineering, soil science (crop nutrient and fertilization, etc.), environmental sciences (drainage and irrigation), plant biology (seeding and plant growth management), animal science (farm animals and housing) and much more.

The Bachelor of Technology degree in Agricultural Engineering provides a technical program focused on applying advancements in engineering technology to an agricultural and environmentally challenged society. Agriculture engineers find better ways to reduce crop loss from field damage, during handling, sorting, packing and processing. The warehousing of food and fibre are an important part of the agriculture industry. The agricultural engineer is the person who plans the heating, cooling, ventilation, postharvest handling, logistics and more.

Precision farming is a necessity. Today all the ramifications of a high-tech society beckon us to apply new technologies with speed and accuracy. Agriculture is feeding an ever growing world population with better quality food. The means to produce, ship and protect this food supply requires people who can implement and utilize these technologies successfully. The agricultural engineer obtains training in design and engineering problem solving based on an understanding of engineering sciences including mathematics, physics and biology. They must also have skills in computers, communication, teamwork and instrumentation. The feature distinguishing agricultural engineers from other engineers is their interest and commitment to solving agricultural problems

Engineering and technological needs demand highly trained agricultural engineers, equipped with knowledge, skills and practices of engineering technology with full appreciation of biosciences to handle the challenges before them. Courses and curricula call for revisions – skills of shop, drawing board, field surveys moderated in order to create room for computer use, information technology, GIS, computer aided design and computer aided manufacture, even understanding robotics and its application in hazardous situations in agriculture and allied activities.

**The earlier curriculum was aimed at supporting the farming system, whereas the present one gives emphasis to sustaining it.**

## Organization of new Curriculum

The curriculum constitutes 132 fixed credit loads from different disciplines and 9 credits of electives from Agricultural Engineering courses. The student will be required to have a Project of 10 credit hours and a Seminar of one credit hour. The present proposal suggests an experiential form of practical training. It is recommended that there should be In-plant training for a period equivalent to one semester or two trainings of each (20 credits). Two Skill Development Trainings of 5 credits each and an Educational Tour carrying 2 credits. Thus the total credit load for the entire course is fixed at 184 credits.

The recommended new curriculum includes courses on computer programming, data structures, CAD / CAM drawing, entrepreneurship development, communication skills, agri-business management. The basic engineering and agricultural engineering courses have been modified taking into account the technological developments, that have taken place during the last decade. Further, the elective courses and the in-plant-training introduced will infuse greater confidence and improve the employment opportunities of the agricultural engineering graduates.

## Method of Course Coding

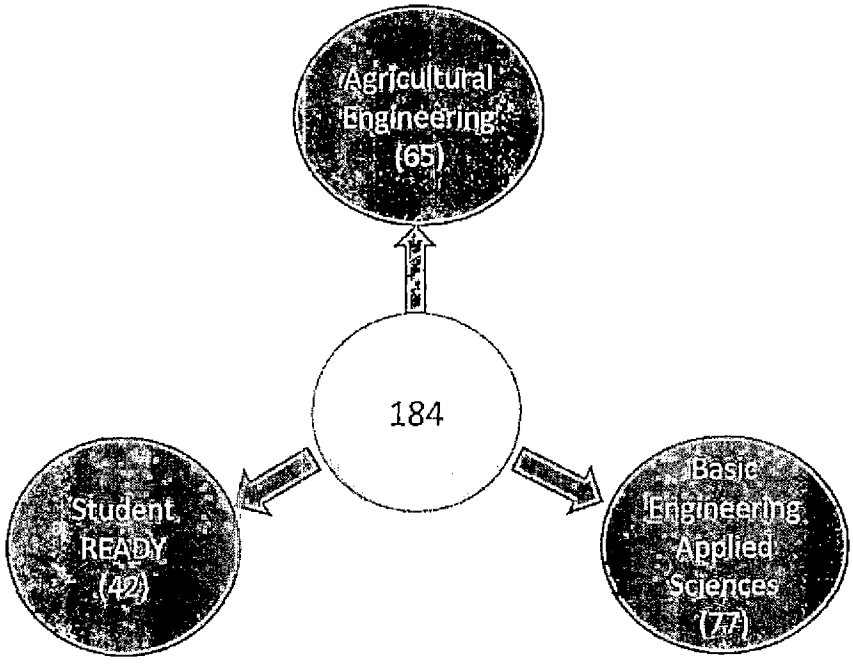
The following course coding method was adopted to easily identify the courses run by various departments in different semesters.

A four letter for department identification tag followed by a four-digit number designates each course. The first digit indicates the year, second for semester and third and fourth jointly indicates the number of the course offered by that department.

*The department identification tags are:*

Fpme. : Farm Power Machinery and Energy
Iden. : Irrigation and Drainage Engineering
Lwre. : Land and Water Resource Conservation Engineering
Fape. : Food & Agricultural Process Engineering
Sacs. : Supportive and Allied Courses of Studies.
Supportive and Allied Courses are indicated by the course name itself.

Digit 1 : Year to which the course is attached
Digit 2 : The semester to which the course is attended
Digit 3&4 : The serial number of the course offered by a specific department in a particular semester
Example : Fpme.1111 means a course run by Farm Power Machinery and Energy Department in the 1st Year 1st Semester 11 th Course for B. Tech course.




**Distribution of credits across major disciplines**

## DISCIPLINE –WISE COURSES

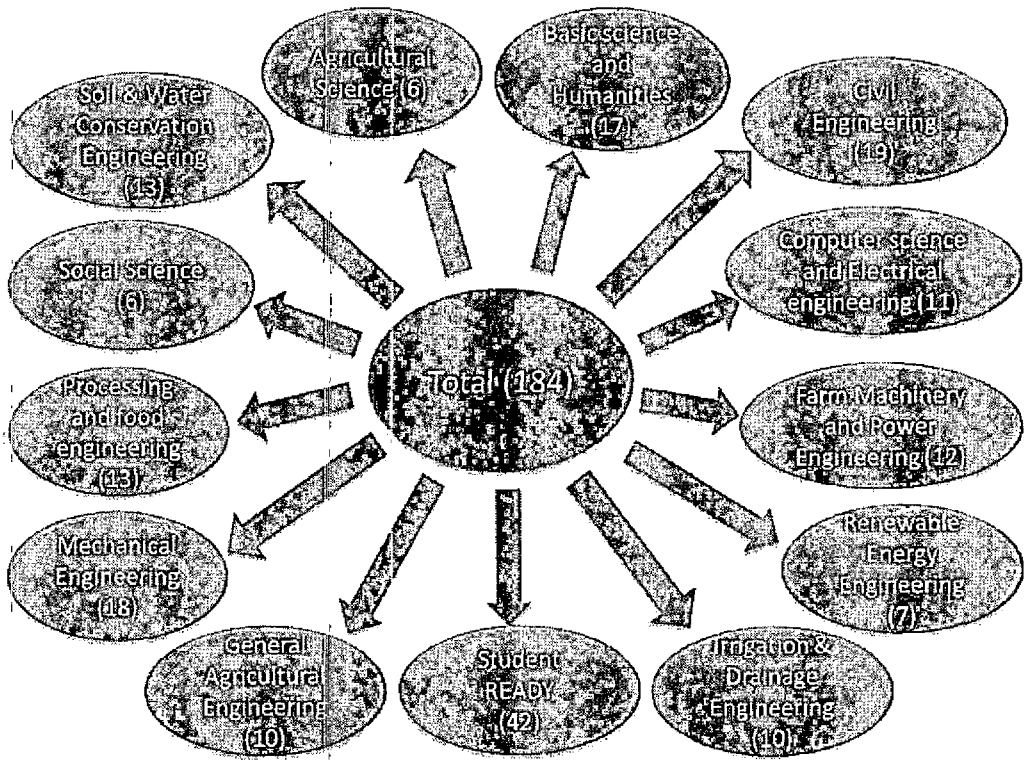
The major disciplines are further subdivided into minor disciplines and the courses are allotted as below.

| Major discipline | Minor discipline | Courses | Credit |
|---|---|---|---|
| Agricultural Engineering (65) | Farm Machinery and Power Engineering (17) | Farm Machinery and Equipment-I (Fpme. 3110) | 3 (2+1) |
| | | Farm Machinery and Equipment-II (Fpme. 3213) | 3 (2+1) |
| | | Tractor and Farm Machinery Operation and Maintenance-I (Fpme. 3112) | 1 (0+1) |
| | | Tractor and Farm Machinery Operation and Maintenance-II (Fpme. 3214) | 1 (0+1) |
| | | Tractor Systems and Controls (Fpme. 3109) | 3 (2+1) |
| | | Ergonomics in Farm Machinery (Fpme. 3216) | 1 (1+0) |
| | | **Sub Total** | **12 (7+5)** |
| | Renewable Energy Engineering (7) | Bio- Energy Systems: Design and Application (Fpme. 3111) | 2 (1+1) |
| | | Energy Technology for Renewable Power production(Fpme. 3215) | 2 (2+0) |
| | | Fundamentals of Renewable Energy Sources (Fpme. 2208) | 3 (2+1) |
| | | **Sub Total** | **7 (5+2)** |
| | Irrigation & Drainage Engineering (10) | Sprinkler and Micro Irrigation Systems (Iden. 3107) | 2 (1+1) |
| | | Drainage Engineering (Iden. 3108) | 2 (1+1) |
| | | Ground Water, Wells and Pumps (Iden. 3209) | 3 (2+1) |
| | | Irrigation Engineering (Iden. 2206) | 3 (2+1) |
| | | **Sub Total** | **10 (6+4)** |
| | Soil & Water Conservation Engineering (13) | Watershed Hydrology (Lwre. 2104) | 3 (2+1) |
| | | Water Harvesting and Soil Conservation Structures (Lwre. 3107) | 3 (2+1) |
| | | Watershed Planning and Management (Lwre. 3208) | 2 (1+1) |
| | | Remote Sensing and GIS Applications (Lwre. 3209) | 2 (1+1) |
| | | Soil and Water Conservation Engineering (Lwre. 2206) | 3 (2+1) |
| | | **Sub Total** | **13 (8+5)** |

| Major discipline | Minor discipline | Courses | Credit |
|---|---|---|---|
| | Processing and Food Engineering (13) | Agricultural Structures and Environmental Control (Fape. 3104) | 3 (2+1) |
| | | Dairy and Food Engineering (Fape. 3207) | 3 (2+1) |
| | | Post-Harvest Engineering of Cereals, Pulses and Oil Seeds (Fape. 2102) | 3 (2+1) |
| | | Engineering Properties of Agricultural Produce (Fape. 1101) | 2 (1+1) |
| | | Post-Harvest Engineering of Horticultural Crops (Fape. 3206) | 2 (1+1) |
| | | **Sub Total** | **13 (8+5)** |
| | General Agricultural Engineering (10) | Electives | 9 (6+3) |
| | | Seminar (Semr. 4201) | 1 (0+1) |
| | | **Sub Total** | **10 (6+4)** |
| | | **Total** | **65** |
| Basic Engineering Applied Sciences (77) | Civil Engineering (19) | Building Construction and Cost Estimation (Iden. 2104) | 2 (2+0) |
| | | Design of Structures (Iden. 2205) | 2 (1+1) |
| | | Engineering Drawing (Lwre. 1101) | 1 (0+1) |
| | | Engineering Mechanics (Iden. 1101) | 3 (2+1) |
| | | Fluid Mechanics and Open Channel Hydraulics (Iden. 1202) | 3 (2+1) |
| | | Surveying and Leveling (Lwre. 1203) | 3 (1+2) |
| | | Strength of Materials (Iden. 1203) | 2 (1+1) |
| | | Soil Mechanics (Lwre. 2205) | 3 (2+1) |
| | | **Sub Total** | **19 (11+8)** |
| | Mechanical Engineering (18) | Auto CAD Applications (Fpme. 2106) | 2 (0+2) |
| | | Heat and Mass Transfer (Fape. 2203) | 2 (2+0) |
| | | Machine Design (Fpme. 2104) | 2 (2+0) |
| | | Machine Drawing(Fpme. 1203) | 1 (0+1) |
| | | Theory of Machines (Fpme. 1202) | 2 (2+0) |
| | | Thermodynamics and Automotive Engines (Fpme. 2207) | 3 (2+1) |
| | | Refrigeration and Air Conditioning (Fape. 3105) | 3 (2+1) |
| | | Workshop Technology and Practices (Fpme. 1201) | 3 (1+2) |
| | | **Sub Total** | **18 (11+7)** |

| Major discipline | Minor discipline | Courses | Credit |
|---|---|---|---|
| | Computer Science & Electrical Engineering (11) | Computers Programming and Data Structures (Sacs. 3214) | 3 (1+2) |
| | | Web Designing and Internet Applications (Sacs. 2111) | 2 (1+1) |
| | | Electrical Machines and Power Utilization (Fpme. 2105) | 3 (2+1) |
| | | Applied Electronics and Instrumentation (Sacs. 2213) | 3 (2+1) |
| | | **Sub Total** | **11 (6+5)** |
| | | | |
| | Basic Sciences and Humanities (17) | Engineering Mathematics-I (Sacs. 1101) | 3 (2+1) |
| | | Engineering Chemistry (Sacs. 1103) | 3 (2+1) |
| | | Engineering Mathematics-II (Sacs. 1206) | 3 (2+1) |
| | | Engineering Mathematics-III (Sacs. 2110) | 3 (2+1) |
| | | Engineering Physics (Sacs. 1102) | 3 (2+1) |
| | | Physical Education (Non-credit) (Sacs. 1209) | 0 (0+0) |
| | | Communication skills and personality development (Sacs. 2112) | 2 (1+1) |
| | | **Sub Total** | **17 (11+6)** |
| | | | |
| | Social Sciences (6) | Entrepreneurship development and Business Management (Sacs. 1207) | 3 (2+1) |
| | | Environmental Studies and Disaster Management (Lwre. 1102) | 3 (2+1) |
| | | **Sub Total** | **6 (4+2)** |
| | Agricultural Sciences (6) | Principles of soil science (Sacs. 1104) | 2 (2+0) |
| | | Principles of Agronomy (Sacs. 1105) | 2 (2+0) |
| | | Principles of Horticultural crops and plant protection (Sacs. 1208) | 2 (1+1) |
| | | **Sub Total** | **6 (5+1)** |
| | | **Total** | **77** |
| Student READY (42) | 20-Weeks Industrial Attachment/Internship (Iplt. 4101) | | 20 (0+20) |
| | Skill Development Training-I ( Skdt. 3101) | | 5 (0+5) |
| | Skill Development Training-II ( Skdt. 4102) | | 5 (0+5) |
| | Educational Tour ( 3 Weeks, All India Tour) (Edtr. 4101) | | 2 (0+2) |

| Major discipline | Minor discipline | Courses | Credit |
|---|---|---|---|
| | Project- Planning, Work and Report Writing (Pprw. 4201) | | 10 (0+10) |
| | | **Sub Total** | **42 (0+42)** |
| | | **GRAND TOTAL** | **184** |




**Distribution of credits across minor disciplines**

All the courses mentioned above are further distributed among the five statutory departments of the Faculty of Agricultural Engineering and Technology for its proper conduct.

# COURSES OFFERED BY DIFFERENT DEPARTMENTS

## (1) Farm Power Machinery and Energy

**(a) Core Courses**

| Sl.No. | Catalogue No. | Course Title | Credit Hrs. |
|---|---|---|---|
| 1. | Fpme. 1201 | Workshop Technology and Practice | 3 (1+2) |
| 2. | Fpme. 1202 | Theory of Machines | 2 (2+0) |
| 3. | Fpme. 1203 | Machine Drawing | 1 (0+1) |
| 4. | Fpme. 2104 | Machine Design | 2 (2+0) |
| 5. | Fpme. 2105 | Electrical Machines and Power Utilization | 3 (2+1) |
| 6. | Fpme. 2106 | Auto CAD Applications | 2 (0+2) |
| 7. | Fpme. 2207 | Thermodynamics and Automotive Engines | 3 (2+1) |
| 8. | Fpme. 2208 | Fundamentals of Renewable Energy Sources | 3 (2+1) |
| 9. | Fpme. 3109 | Tractor systems and control | 3 (2+1) |
| 10. | Fpme. 3110 | Farm Machinery and Equipment-I | 3 (2+1) |
| 11. | Fpme. 3111 | Bio- Energy Systems: Design and Application | 2 (1+1) |
| 12. | Fpme. 3112 | Tractor and Farm Machinery Operation and Maintenance-I | 1 (0+1) |
| 13. | Fpme. 3213 | Farm Machinery and Equipment-II | 3 (2+1) |
| 14. | Fpme. 3214 | Tractor and Farm Machinery Operation and Maintenance-II | 1 (0+1) |
| 15. | Fpme. 3215 | Energy Technology for Renewable Power production. | 2 (2+0) |
| 16. | Fpme 3216 | Ergonomics in Farm Machinery | 1 (1+0) |
| | | **Total credits** | **35 (21+14)** |

**(b) Elective Courses**

| Sl.No. | Catalogue No. | Course Title | Credit Hrs. |
|---|---|---|---|
| 1. | Elfm. 4201 | Mechanics of Tillage and Traction | 3(2+1) |
| 2. | Elfm. 4202 | Farm Machinery Design and Production | 3 (2+1) |
| 3. | Elfm. 4203 | Human Engineering and Safety | 3 (2+1) |
| 4. | Elfm. 4204 | Tractor Design and Testing | 3 (2+1) |
| 5. | Elfm. 4205 | Hydraulic Drives and Controls | 3 (2+1) |
| 6. | Elfm. 4206 | Precision Agriculture and Management | 3 (2+1) |
| 7. | Elfm. 4207 | Photovoltaic Technology and Systems | 3(2+1) |
| 8. | Elfm. 4208 | Mechatronics | 3 (2+1) |
| | | **Total credits** | **24 (16+8)** |

## (II) Irrigation and Drainage Engineering

| (a) Core Courses | | | |
|---|---|---|---|
| **Sl.No.** | **Catalogue No.** | **Course Title** | **Credit Hrs.** |
| 1 | Iden. 1101 | Engineering Mechanics | 3 (2+1) |
| 2 | Iden. 1202 | Fluid Mechanics and Open Channel Hydraulics | 3 (2+1) |
| 3 | Iden. 1203 | Strength of Materials | 2 (1+1) |
| 4 | Iden. 2104 | Building Construction and Cost Estimation | 2 (2+0) |
| 5 | Iden. 2205 | Design of Structures | 2 (1+1) |
| 6 | Iden. 2206 | Irrigation Engineering | 3 (2+1) |
| 7 | Iden. 3107 | Sprinkler and Micro Irrigation Systems | 2 (1+1) |
| 8 | Iden. 3108 | Drainage Engineering | 2 (1+1) |
| 9 | Iden. 3209 | Ground Water, Wells and Pumps | 3 (2+1) |
| | | **Total credits** | **22 (14+8)** |

**(b) Elective Courses**

| **Sl.No.** | **Catalogue No.** | **Course Title** | **Credit Hrs.** |
|---|---|---|---|
| 1. | Elid. 4201 | Management of Canal Irrigation System | 3 (2+1) |
| 2. | Elid. 4202 | Minor Irrigation and Command Area Development | 3 (2+1) |
| 3. | Elid. 4203 | Water Quality and Management Measures | 3 (2+1) |
| 4. | Elid. 4204 | Design and Maintenance of Greenhouse | 3 (2+1) |
| 5. | Elid. 4205 | Landscape Irrigation Design and Management | 3 (2+1) |
| 6. | Elid. 4206 | Application of Geospatial techniques in Water Resources | 3 (2+1) |
| 7. | Elid. 4207 | Environmental Engineering | 3 (2+1) |
| 8. | Elid. 4208 | Numerical Methods in Water Resources | 3 (2+1) |
| 9. | Elid. 4209 | Irrigation Structures | 3 (2+1) |
| 10. | Elid. 4210 | Climate change and use of Geoinformatics | 3 (2+1) |
| | | **Total credits** | **30 (20+10)** |

## (III) Land and Water Resource conservation Engineering

| (a) Core Courses | | | |
|---|---|---|---|
| **Sl.No.** | **Catalogue No.** | **Course Title** | **Credit Hrs.** |
| 1 | Lwre. 1101 | Engineering Drawing | 1 (0+1) |
| 2 | Lwre. 1102 | Environmental Studies and Disaster Management | 3 (2+1) |
| 3 | Lwre. 1203 | Surveying and Levelling | 3 (1+2) |
| 4 | Lwre. 2104 | Watershed Hydrology | 3 (2+1) |
| 5 | Lwre. 2205 | Soil Mechanics | 3 (2+1) |
| 6 | Lwre. 2206 | Soil and Water Conservation Engineering | 3 (2+1) |
| 7 | Lwre. 3107 | Water Harvesting and Soil Conservation Structures | 3 (2+1) |
| 8 | Lwre. 3208 | Watershed Planning and Management | 2 (1+1) |
| 9 | Lwre. 3209 | Remote Sensing and GIS Applications | 2 (1+1) |
| | | **Total credits** | **23 (13+10)** |

**(b) Elective Courses**

| Sl.No. | Catalogue No. | Course Title | Credit Hrs. |
|---|---|---|---|
| 1. | Ellw. 4201 | Floods and Control Measures | 3 (2+1) |
| 2. | Ellw. 4202 | Wasteland Development | 3 (2+1) |
| 3. | Ellw. 4203 | Information Technology for Land and Water Management | 3 (2+1) |
| 4. | Ellw. 4204 | Precision Farming Techniques for Protected Cultivation | 3 (2+1) |
| 5. | Ellw. 4205 | Water Quality and Management Measures | 3 (2+1) |
| 6. | Ellw. 4206 | Plastic Applications in Agriculture | 3 (2+1) |
| 7. | Ellw. 4207 | Quantity Surveying and Valuation | 3 (2+1) |
| | | **Total credits** | **21 (14+7)** |

**(IV) Food & Agricultural Process Engineering**

**(a) Core Courses**

| Sl.No. | Catalogue No. | Course Title | Credit Hrs. |
|---|---|---|---|
| 1 | Fape. 1101 | Engineering Properties of Agricultural Produce | 2 (1+1) |
| 2 | Fape. 2102 | Post-Harvest Engineering of Cereals, Pulses and Oil Seeds | 3 (2+1) |
| 3 | Fape. 2203 | Heat and Mass Transfer | 2 (2+0) |
| 4 | Fape. 3104 | Agricultural Structures and Environmental Control | 3 (2+1) |
| 5 | Fape. 3105 | Refrigeration and Air Conditioning | 3 (2+1) |
| 6 | Fape. 3206 | Post Harvest Engineering of Horticultural Crops | 2 (1+1) |
| 7 | Fape. 3207 | Dairy and Food Engineering | 3 (2+1) |
| | | **Total credits** | **18 (12+6)** |

**(b) Elective Courses**

| Sl. No. | Catalogue No. | Course Title | Credit Hrs. |
|---|---|---|---|
| 1 | Elfa. 4201 | Food Quality and Safety | 3 (2+1) |
| 2 | Elfa. 4202 | Food Plant Design and Management | 3 (2+1) |
| 3 | Elfa. 4203 | Food Packaging Technology | 3 (2+1) |
| 4 | Elfa. 4204 | Development of Processed Products | 3 (2+1) |
| 5 | Elfa. 4205 | Process Equipment Design | 3 (2+1) |
| 6 | Elfa. 4206 | Agricultural By-Product Utilization | 3 (2+1) |
| 7 | Elfa. 4207 | Emerging Methods of Food Preservation | 3 (2+1) |
| 8 | Elfa. 4208 | Processing of Fish and Marine Products | 3 (2+1) |
| 9 | Elfa. 4209 | Processing of Spices and Plantation Crops | 3 (2+1) |
| | | **Total credits** | **18 (12+6)** |

## (V) Supportive and Allied Courses of Studies

| Sl.No. | Catalogue No. | Course Title | Credit Hrs. |
|---|---|---|---|
| 1 | Sacs. 1101 | Engineering Mathematics-I | 3 (2+1) |
| 2 | Sacs. 1102 | Engineering Physics | 3 (2+1) |
| 3 | Sacs. 1103 | Engineering Chemistry | 3 (2+1) |
| 4 | Sacs. 1104 | Principles of soil science | 2 (2+0) |
| 5 | Sacs. 1105 | Principles of Agronomy | 2 (2+0) |
| 6 | Sacs. 1206 | Engineering Mathematics-II | 3 (2+1) |
| 7 | Sacs. 1207 | Entrepreneurship development and Business Management | 3 (2+1) |
| 8 | Sacs. 1208 | Principles of Horticultural crops and plant protection | 2 (1+1) |
| 9 | Sacs. 1209 | Physical Education | 0 (0+0) |
| 10 | Sacs. 2110 | Engineering Mathematics-III | 3 (2+1) |
| 11 | Sacs. 2111 | Web Designing and Internet Applications | 2 (1+1) |
| 12 | Sacs. 2112 | Communication skills and personality development | 2 (1+1) |
| 13 | Sacs. 2213 | Applied Electronics and Instrumentation | 3 (2+1) |
| 14 | Sacs. 3214 | Computer programming and Data Structures | 3 (1+2) |
| | | **Total credits** | **34 (22+12)** |

## DISTRIBUTION OF COURSES IN DIFFERENT SEMESTERS

| Semester 1 | | | | |
|---|---|---|---|---|
| Sl.No. | Catalogue No. | Course Title | Credits | |
| | | | Theory | Practical |
| 1. | Sacs. 1101 | Engineering Mathematics-I | 2 | 1 |
| 2. | Sacs. 1102 | Engineering Physics | 2 | 1 |
| 3. | Sacs. 1103 | Engineering Chemistry | 2 | 1 |
| 4. | Sacs. 1104 | Principles of soil science | 2 | 0 |
| 5. | Sacs. 1105 | Principles of Agronomy | 2 | 0 |
| 6. | Fape. 1101 | Engineering Properties of Agricultural Produce | 1 | 1 |
| 7. | Iden. 1101 | Engineering Mechanics | 2 | 1 |
| 8. | Lwre. 1101 | Engineering Drawing | 0 | 1 |
| 9. | Lwre. 1102 | Environmental Studies and Disaster Management | 2 | 1 |
| | | **Total Credits 22 (15+7)** | **15** | **7** |

| Semester 2 | | | | |
|---|---|---|---|---|
| Sl.No. | Catalogue No. | Course Title | Credits | |
| | | | Theory | Practical |
| 1. | Sacs. 1206 | Engineering Mathematics-II | 2 | 1 |
| 2. | Sacs. 1207 | Entrepreneurship development and Business Management | 2 | 1 |
| 3. | Sacs. 1208 | Principles of Horticultural crops and plant protection | 1 | 1 |
| 4. | Sacs. 1209 | Physical Education | 0 | 0 |
| 5. | Fpme. 1201 | Workshop Technology and Practices | 1 | 2 |
| 6. | Fpme. 1202 | Theory of Machines | 2 | 0 |
| 7. | Fpme. 1203 | Machine Drawing | 0 | 1 |
| 8. | Iden. 1202 | Fluid Mechanics and Open Channel Hydraulics | 2 | 1 |
| 9. | Iden. 1203 | Strength of Materials | 1 | 1 |
| 10. | Lwre. 1203 | Surveying and Levelling | 1 | 2 |
| | | **Total Credits 22 (12+10)** | **12** | **10** |

| Semester 3 | | | | |
|---|---|---|---|---|
| Sl.No. | Catalogue No. | Course Title | Credits | |
| | | | Theory | Practical |
| 1. | Sacs. 2110 | Engineering Mathematics-III | 2 | 1 |
| 2. | Sacs. 2111 | Web Designing and Internet Applications | 1 | 1 |
| 3. | Sacs. 2112 | Communication skills and personality development | 1 | 1 |
| 4. | Fape. 2102 | Post Harvest Engineering of Cereals, Pulses and Oil Seeds | 2 | 1 |

| | | | | |
|---|---|---|---|---|
| 5. | Fpme. 2104 | Machine Design | 2 | 0 |
| 6. | Fpme. 2105 | Electrical Machines and Power Utilization | 2 | 1 |
| 7. | Fpme. 2106 | Auto CAD Applications | 0 | 2 |
| 8. | Iden. 2104 | Building Construction and Cost Estimation | 2 | 0 |
| 9. | Lwre. 2104 | Watershed Hydrology | 2 | 1 |
| | | **Total Credits 22 (14+8)** | **14** | **8** |

**Semester 4**

| Sl.No. | Catalogue No. | Course Title | Credits | |
|---|---|---|---|---|
| | | | Theory | Practical |
| 1. | Sacs. 2213 | Applied Electronics and Instrumentation | 2 | 1 |
| 2. | Fape. 2203 | Heat and Mass Transfer | 2 | 0 |
| 3. | Fpme. 2207 | Thermodynamics and Automotive Engines | 2 | 1 |
| 4. | Fpme. 2208 | Fundamentals of Renewable Energy Sources | 2 | 1 |
| 5. | Iden. 2205 | Design of Structures | 1 | 1 |
| 6. | Iden. 2206 | Irrigation Engineering | 2 | 1 |
| 7. | Lwre. 2205 | Soil Mechanics | 2 | 1 |
| 8. | Lwre. 2206 | Soil and Water Conservation Engineering | 2 | 1 |
| | | **Total Credits 22 (15+7)** | **15** | 7 |

**Skill Development Training- I in Summer break June-July after 4th Semester (Student READY)**

**Semester 5**

| Sl.No. | Catalogue No. | Course Title | Credits | |
|---|---|---|---|---|
| | | | Theory | Practical |
| 1. | Fape. 3104 | Agricultural Structures and Environmental Control | 2 | 1 |
| 2. | Fape. 3105 | Refrigeration and Air Conditioning | 2 | 1 |
| 3. | Fpme. 3109 | Tractor Systems and Controls | 2 | 1 |
| 4. | Fpme. 3110 | Farm Machinery and Equipment-I | 2 | 1 |
| 5. | Fpme. 3111 | Bio-Energy Systems: Design and Applications | 1 | 1 |
| 6. | Fpme. 3112 | Tractor and Farm Machinery Operation and Maintenance-I | 0 | 1 |
| 7. | Iden. 3107 | Sprinkler and Micro Irrigation Systems | 1 | 1 |
| 8. | Iden. 3108 | Drainage Engineering | 1 | 1 |
| 9. | Lwre. 3107 | Water Harvesting and Soil Conservation Structures | 2 | 1 |
| 10. | Skdt. 3101 | Skill Development Training-I (Student READY) | 0 | 5 |
| | | **Total Credits 27 (13+14)** | **13** | **14** |

| Semester 6 | | | | |
|---|---|---|---|---|
| Sl.No. | Catalogue No. | Course Title | Credits | |
| | | | Theory | Practical |
| 1. | Sacs. 3214 | Computer programming and Data Structures | 1 | 2 |
| 2. | Fape. 3206 | Post Harvest Engineering of Horticultural Crops | 1 | 1 |
| 3. | Fape. 3207 | Dairy and Food Engineering | 2 | 1 |
| 4. | Fpme. 3213 | Farm Machinery and Equipment-II | 2 | 1 |
| 5. | Fpme. 3214 | Tractor and Farm Machinery Operation and Maintenance-II | 0 | 1 |
| 6. | Fpme. 3215 | Energy Technology for Renewable Power production | 2 | 0 |
| 7. | Fpme. 3216 | Ergonomics in Farm Machinery | 1 | 0 |
| 8. | Iden. 3209 | Groundwater, Wells and Pumps | 2 | 1 |
| 9. | Lwre. 3208 | Watershed Planning and Management | 1 | 1 |
| 10. | Lwre. 3209 | Remote Sensing and GIS Applications | 1 | 1 |
| | | **Total Credits 22 (13+9)** | **13** | **9** |
| **Skill Development Training- II in Summer break June-July after 6th Semester (Student READY** | | | | |

| Semester 7 Student READY (Rural and Entrepreneurship Awareness Development Yojana) | | | | | | |
|---|---|---|---|---|---|---|
| Sl.No. | Catalogue No. | Course Title | | | Credits | |
| | | | | | Theory | Practical |
| 1. | Edtr. 4101 | Educational Tour (3 Weeks, All India Tour) | | | 0 | 2 |
| 2. | Iplt. 4101 | 20-Weeks Industrial Attachment/Internship (Student READY) (5 weeks per department) | Fpme | 5 | 0 | 20 |
| | | | Ide | 5 | | |
| | | | Lwre | 5 | | |
| | | | Fape | 5 | | |
| 3. | Skdt. 4101 | Skill Development Training-II (Student READY) | | | 0 | 5 |
| | | **Total Credits 27 (0+27)** | | | **0** | **27** |
| **Educational Tour during winter/January break** | | | | | | |

| Semester 8 Student READY (Rural and Entrepreneurship Awareness Development Yojana) | | | | |
|---|---|---|---|---|
| Sl.No. | Catalogue No. | Course Title | Credits | |
| | | | Theory | Practical |
| 1. | El.. 42.. | Elective course | 2 | 1 |
| 2. | El.. 42.. | Elective course | 2 | 1 |
| 3. | El.. 42.. | Elective course | 2 | 1 |
| 4. | Pprw. 4201 | Project –Planning, Work and Report Writing (Student READY) | 0 | 10 |
| 5. | Semr. 4201 | Seminar | 0 | 1 |
| | | **Total Credits 20 (6+14)** | **6** | **14** |
| | | **Grand Total Credits 184 (88+96)** | **88** | **96** |

**Department of Farm Power Machinery and Energy- Core Courses**

## Fpme. 1201 Workshop Technology and Practice 3(1+2)

**Objective**

- To impart knowledge on various production and manufacturing processes and equipments.

**Theory**

**Module I** **(4 Hours)**

Safety in workshop. Plant layouts – types, advantages and disadvantages, factors influencing layouts. Mechanical and Technological properties types and description. Introduction to various carpentry tools, materials, seasoning, types of wood and their characteristics and operations in wood working. Introduction to smithy tools and operations.

**Module II** **(4 Hours)**

Introduction to welding, types of welding, oxyacetylene gas welding, types of flames, welding techniques and equipment. Principle of arc welding, equipment and tools. Brazing and Soldering.

**Module III** **(4 Hours)**

Casting processes. Foundry tools, Pattern: types materials and allowances. Foundry sand and sand additives, types, uses and desired properties. Core and core prints. Moulding processes, types, advantages and disadvantages, casting defects.

**Module IV** **(4 Hours)**

Classification, constructional details of center lathe, main accessories and attachments. Main operations and functions. Constructional details of standard shaper. Types of shaper and main operations. Types of drilling machines. work Constructional details and main operations. Twist drill nomenclature. Types of Milling machines. Types of milling machines. Constructional details and main operations.

**Practical**

Study of types of wood and wooden joints and of carpentry tools. Preparation of simple carpentry joints: Cross half Lap joint, Dovetail joint, T- Lap joint. Jobs on carpentry – Plane to size. Introduction to welding equipment, processes tools, their use and precautions. Study of gas and arc welding. Jobs on arc welding - Straight line welding, Single 'V' butt joint welding, Lap joint, butt joint, T-Joint and corner joint in arc welding. Introduction to tools and measuring instruments for fitting. Jobs on sawing, filing and right angle fitting of MS Flat, Tongue and groove making, N-joint. Introduction to metal casting equipment, tools and their use. Study of foundry engineering: sand and allowances. Study of foundry tools. Jobs on foundry – Circular disc, Oval flange. Introduction to smithy tools and operations. Jobs on smithy – Square prism, Hexagonal prism. Introduction to machine shop machines and tools. Practical jobs on simple turning, step turning, taper turning. Introduction to tools and operations in sheet metal work. Making different types of sheet metal joints using G.I. sheets.

**Lecture schedule**

1. Introduction. Safety in workshop
2. Plant layouts – types, advantages and disadvantages, factors influencing layouts.
3. Mechanical and Technological properties types and description
4. Introduction to various carpentry tools, materials
5. Types of wood and their characteristics. Seasoning of wood, operations in wood working

6. Introduction to Smithy tools and operations
7. Introduction to welding. Types of welding, oxyacetylene gas welding
8. Types of flames, welding techniques and equipment
9. Principle of arc welding, equipment and tools
10. Foundry tools, Pattern: types materials and allowances. Foundry sand and sand additives, types, uses and desired properties.
11. Core and core prints. Moulding processes, types, advantages and disadvantages, casting defects.
12. Lathe- Classification, Constructional details of center lathe
13. Main accessories and attachments. Main operations and functions of center lathes
14. Shaper machine- Constructional details of standard shaper. Types of shapers and main operations.
15. Types of drilling machines. Constructional details and main operations.
16. Types of milling machines. Constructional details and main operations.

**Practical schedule**

1. Study of types of wood and wooden joints.
2. Study of types of carpentry tools.
3. Preparation of simple carpentry joints: Cross half Lap joint.
4. Preparation of simple carpentry joints: Dovetail joint.
5. Preparation of simple carpentry joints: T- Lap joint.
6. Jobs on carpentry – Plane to size.
7. Introduction to welding equipment, processes tools, their use and precautions
8. Study of gas and arc welding.
9. Jobs on arc welding - Straight line welding.
10. Jobs on arc welding - Single 'V' butt joint welding.
11. Jobs on arc welding - Lap joint, butt joint,
12. Jobs on arc welding- T-Joint and corner joint in arc welding
13. Introduction to tools for fitting.
14. Introduction to measuring instruments for fitting.
15. Jobs on sawing, filing and right angle fitting of MS Flat.
16. Jobs on fitting – Tongue and groove making.
17. Jobs on fitting – N-joint.
18. Practical in more complex fitting job
19. Introduction to metal casting equipment, tools and their use
20. Study of foundry engineering: sand and allowances.
21. Study of foundry tools.
22. Jobs on foundry – Circular disc.
23. Jobs on foundry – Oval flange.
24. Introduction to smithy tools and operations.
25. Jobs on smithy – Square prism.
26. Jobs on smithy – Hexagonal prism.
27. Introduction to machine shop machines and tools
28. Practical jobs on simple turning,
29. Practical jobs on step turning
30. Practical job on taper turning
31. Introduction to tools and operations in sheet metal work
32. Making different types of sheet metal joints using G.I. sheets.

**Suggested Readings**


1. Hajra, Choudari S K and Bose S K. 1982. Elements of Workshop Technology (Vol. I and II). Media Promoters and Publishers Pvt. Ltd., Mumbai.
2. Chapman W A J. 1989. Workshop Technology (Part I and II). Arnold Publishers (India) Pvt. Ltd., AB/9 Safdarjung Enclave, New Delhi.
3. Raghuwamsi B S. 1996. A Course in Workshop Technology (Vol. I and II). Dhanpat Rai and Sons, 1682 NaiDarak, New Delhi.
4. Jayan P.R and Vaishak J. 2011. Workshop Practice-Vol-I, Practice Manual, Dept. of FPME, KCAET, Kerala Agricultural University Press, Mannuthy
5. Jayan P.R and Vaishak J. 2011. Workshop Practice-Vol-II, Practice Manual, Dept. of FPME, KCAET, Kerala Agricultural University Press, Mannuthy


## Fpme. 1202 Theory of Machines 2(2+0)

**Objectives**

- To provide knowledge on kinematics of selected mechanisms.
- To provide knowledge on theory and analysis of gears, Gear Trains and Synthesis of Mechanisms.
- To provide knowledge on different types of governors.

**Theory**

**Module I** **(8 Hours)**

Elements, links, pairs, kinematics chain, and mechanisms. Classification of pairs and mechanisms. Lower and higher pairs. Four bar chain, slider crank chain and their inversions. Determination of velocity and acceleration using graphical (relative velocity and acceleration) method. Instantaneous centers.

**Module II** **(8 Hours)**

Types of gears. Law of gearing, velocity of sliding between two teeth in mesh. Involute and cycloidal profile for gear teeth.Spur gear, nomenclature, interference and undercutting. Introduction to helical, spiral, bevel and worm gear. Simple, compound, reverted, and epicyclic trains. Determining velocity ratio by tabular method.

**Module III** **(8 Hours)**

Turning moment diagrams, coefficient of fluctuation of speed and energy, weight of flywheel, flywheel applications. Belt drives, types of drives, belt materials. Length of belt, power transmitted, velocity ratio, belt size for flat and V belts. Effect of centrifugal tension, creep and slip on power transmission, Chain drives. Types of friction,.laws of dry friction. Friction of pivots and collars. Single disc, multiple disc, and cone clutches. Rolling friction, anti-friction bearings.

**Module IV** **(8 Hours)**

Types of governors. Constructional details and analysis of Watt, Porter, Proell governors. Effect of friction, controlling force curves. Sensitiveness, stability, hunting, iso-chronism, power and effort of a governor.Static and dynamic balancing. Balancing of rotating masses in one and different planes.

**Lecture Schedule**

1. Introduction
2. Elements, links and pairs

3. Kinematic chain and mechanism
4. Classification of pairs and mechanism
5. Lower pair and Higher pair
6. Four bar chain
7. Slider crank chain and their inversions
8. Determination of velocity and acceleration using graphical method (relative velocity and acceleration)
9. Instantaneous centers.
10. Types of gears and law of gearing
11. Velocity of sliding between two teeth in mesh
12. Involute and cycloidal profile for gear teeth
13. Spur gear nomenclature. Interference and undercutting
14. Introduction to helical, spiral, bevel and worm gear
15. Simple and compound gear train
16. Reverted and epicyclic gear trains
17. Determining velocity ratio by tabular method
18. Turning moment diagrams
19. Coefficient of fluctuation of speed and energy
20. Weight of flywheel. Flywheel applications
21. Belt drives, types of drives, belt materials. Length of belt, power transmitted, velocity ratio, belt size for flat and V belts
22. Effect of centrifugal tension, creep and slip on power transmission
23. Chain drives
24. Types of friction, laws of dry friction
25. Friction of pivots and collars
26. Single disc, multiple disc, and cone clutches
27. Rolling friction, anti-friction bearings.
28. Types of governors. Constructional details and analysis of Watt, Porter, Proell governors
29. Effect of friction, controlling force curves
30. Sensitiveness, stability, hunting, isochronism, power and effort of a governor
31. Static and dynamic balancing
32. Balancing of rotating masses in one and different planes.

**Suggested Readings**


1. Rattan S B. 1993. Theory of Machines. Tata McGraw Hill Publishing Co. Ltd., 12/4 Asaf Ali Road, New Delhi.
2. Bevan Thomas. 1984. Theory of Machines. CBS Publishers and Distributors, Delhi.
3. Ballaney P L. 1985. Theory of Machines. Khanna Publishers, 2-B Nath Market, NaiSarak, New Delhi.
4. Rao J S and Dukkipatti R V. 1990. Mechanisms and Machine Theory. Wiley Eastern Ltd., New Delhi.
5. LalJagdish. 1991. Theory of Mechanisms and Machines. Metropolitan Book Co. Pvt.Ltd., 1 NetajiSubashMarg, New Delhi..
6. Khurmi R S and Gupta J K. 1994. Theory of Machines. Eurasia Publishing House Pvt. Ltd., Ram Nagar, New Delhi.

## Fpme. 1203 Machine Drawing 1(0+1)

**Objectives**

- To understand the fundamental concepts of machine drawing
- To generate orthographic drawing of different machine parts
- To generate sectional drawing of simple machine parts

**Practical**

**Module I** **(8 Hours)**

Introduction to Machine Drawing, Types of lines, Dimensioning, Different methods of dimensioning. Free hand sketching in machine drawing- Machine components, assembly and manufacturing drawing. Sectional drawing of simple machine parts. Types of rivet heads and riveted joints. Processes for producing leak proof joints. Symbols for different types of welded joints.

**Module II** **(8 Hours)**

Threaded fasteners -Nomenclature, Thread profiles, multi start threads, left and right hand threads, representation of threads, ISO metric thread and squarethread forms. Square and hexagonalheaded nuts and bolts. Different types of lock nuts, studs, machine screws, cap screws and wood screws. Different types of keys-types, taper, rank taper, hollow saddle etc. Types of cotter and pin joints, Socket and spigot joint, sleeve and cotter joint and knuckle joint.

**Practical Schedule**

1. Dimensioning, Different Methods of dimensioning
2. Free hand sketching of machine components
3. Sectional drawing of simple machine parts
4. Introduction to riveted joints, forms of rivet heads, leak proof joints
5. Symbols for different types of welded joints
6. Forms of screw threads- Drawing of BSW, Square and Metric threads
7. Drawing of square headed nuts and bolts
8. Drawing of hexagonal headed nuts and bolts
9. Drawing of Different types of lock nuts
10. Drawing of machine screws, cap screws and wood screws
11. Drawing of Different types of keys
12. Assembly drawing of simple machine parts
13. Introduction to cotter and pin joints
14. Drawing of Socket and spigot joint
15. Drawing sleeve and cotter joint
16. Drawing of knuckle joint

**Suggested Readings**


1. Bhat. N.D.2010. Elementary Engineering Drawing. Charotar Publishing House Pvt.Ltd. Anand.
2. Anilkumar. K.N. 2005.Engineering Graphics. Adhyuthnarayan Publishers, Kottayam.
3. Bhatt. N.D and Panchal. V.M. 2013.Machine Drawing. Charotar Publishing House Pvt. Ltd.Anand.
4. Narayana. K L and Kannaiah. P. 2010. Machine Drawing. Scitech Publications (India) Pvt. Ltd. Chennai.

## Fpme. 2104 Machine Design 2(2+0)

**Objective**

- To provide basic knowledge on the design consideration and methodology of various machine elements.

**Theory**

**Module I** **(10 Hours)**

Meaning of design, Phases of design, design considerations. Common engineering materials and their mechanical properties. Types of loads and stresses, theories of failure, factor of safety, selection of allowable stress. Stress concentration. Elementary fatigue and creep aspects.

**Module II** **(7 Hours)**

Cotter joints, knuckle joint and pinned joints, turnbuckle. Design of welded joints subjected to static loads. Design of threaded fasteners subjected to direct static loads, bolted joints loaded in shear and bolted joints subjected to eccentric loading.

**Module III** **(9 Hours)**

Design of shafts under torsion and combined bending and torsion. Design of keys. Design of muff, sleeve, and rigid flange couplings. Design of helical and leaf springs.

**Module IV** **(6 Hours)**

Design of flat belt, V-belt drives and pulleys. Design of gears. Design of screw motion mechanisms like screw jack, lead screw, etc. Selection of anti-friction bearings.

**Lecture schedule**

1. Meaning of design
2. Phases of design
3. Design consideration
4. Common engineering materials
5. Mechanical properties of engineering materials.
6. Types of loads and stresses
7. Theories of failure
8. Factor of safety, selection of allowable stress
9. Stress concentration
10. Elementary fatigue and creep aspects
11. Design of cotter joint
12. Design of knuckle joint
13. Design of pinned joints
14. Design of welded joints subjected to static loads
15. Design of threaded fasteners subjected to direct static loads
16. Design of bolted joints loaded in shear
17. Design of bolted joints subjected to eccentric loading
18. Design of shafts under torsion, bending moment and combined bending and torsion
19. Types of Keys
20. Design of keys
21. Types of keys
22. Design of sleeve or muff coupling
23. Design of flanged coupling
24. Types of springs

25. Design of helical springs
26. Design of leaf springs
27. Design of flat belt drives
28. Design of V-belt drives
29. Design of gears
30. Design of screw jack
31. Design of lead screw
32. Selection of anti-friction bearings

**Suggested Readings**


1. Anonymous. 1984. Design data Hand book. PSG, Coimbatore.
2. K Mahadevan and K Balaveera Reddy. 2013. Design Data Handbook for Mechanical Engineering in SI and Metric Units. CBS publications,New Delhi.
3. Jain. R.K. 2013. Machine Design. Khanna Publishers, 2-B Nath Market, NaiSarak, New Delhi.
4. Khurmi. R.S and Gupta. J.K. 2014. A Text Book of Machine Design. S. Chand & Company Ltd., New Delhi.
5. Shigley. J.E and C.R. Mischke. Mechanical Engineering Design. 2004. Tata McGraw Hill India Ltd., New Delhi.
6. Maleev and Hartman. 1978. Mechanical Design of Machines. CBS Publications, New Delhi.
7. Norton. R.L. 1991. Machine Design. Pearson Education, New Delhi.
8. Pandya. N.C and Shah. C.S. 1981. Machine design.Charotar Book Stall, Anand.


## Fpme. 2105 Electrical Machines and Power Utilization 3(2+1)

**Objective**

- To impart basic knowledge in Electrical Machines by understanding the Fundamental Concepts and develop analytical skills, conceptual understanding of basic laws and improve the solving problem skills related electrical Machines and power utilization

**Theory**

**Module I** **(8 Hours)**

Electro motive force, reluctance, laws of magnetic circuits, determination of ampere-turns for series and parallel magnetic circuits, Transformer: principle of working, construction of single phase transformer, EMF equation, phasor diagram, Equivalent circuit, transformer on no load, Transformer under load, leakage reactance, voltage regulation, open circuit and short circuit tests, Transformer losses and efficiency.

**Module II** **(9 Hours)**

Operation and performance of DC machine (generator and motor), Construction, EMF and torque equations, armature reaction, commutation, excitation of DC generator and their characteristics, DC motor characteristics, starting of shunt and series motors, speed control methods-field and armature control.

**Module III** **(9 Hours)**

Polyphase induction motor: construction and principle of operation, starting and running torques, equivalent circuit, effect of rotor resistance, torque equation, starting and speed control methods, single phase induction motor: double field revolving theory, equivalent circuit, characteristics, phase split, capacitor start and shaded pole motors.

**Module IV** **(6 Hours)**

Various methods of three phase power measurement; power factor, disadvantages of low power factor and power factor improvement. Concept and analysis of balanced poly-phase circuits. Series and parallel resonance in RLC Circuits.

**Practical**

To get familiar with AC and DC Machines and measuring instruments, Polarity test on single-phase two winding transformer, Measurement of Coupling Coefficient of Transformer coil, Open Circuit and Short Circuit tests on single phase two winding transformer, Sumpner's test or back to back test on single phase two winding transformer, Load test on single-phase two winding transformer, Parallel operation of two single phase two winding transformers, Load test on 3 phase squirrel cage induction motor, Separation of losses in 3 phase squirrel cage induction motor, Speed control of 3 phase slip ring induction motor, Load test on single phase induction motor, To study characteristics of DC shunt and series motors, To obtain load characteristics of DC shunt, series and compound generators, To Plot OCC of DC Shunt Generator, Three phase power measurement using 2 wattmeter method, To study power consumed in a three-phase circuit; two lights in series controlled by one switch; two lights in parallel controlled by one switch.

**Lecture Schedule**

1. Magnetic circuit concepts, MMF, Reluctance, Flux Density, Permeability.
2. Analogy with electrical circuits, laws of magnetic circuits
3. Determination of ampere-turns for series and parallel magnetic circuits.
4. Transformer : Principle of working, construction of single phase transformer
5. Emf equation derivation, Phasor diagrams, Ideal transformer, transformer on no load.
6. Transformer under load, Transformer losses, Hysteresis and eddy current losses.
7. Efficiency, condition for maximum efficiency and voltage Regulation.
8. Open circuit and short circuit tests on single phase transformer.
9. D.C. Machine (generator and motor): Types and Constructional details.
10. Armature windings, Lap and wave windings-comparison.
11. Principle of operation, generation of induced emf, emf equation derivation.
12. Armature reaction, demagnetizing and cross-magnetizing effect.
13. Ampere turns calculations, compensating windings, additional field ampere turns.
14. Effect of armature reaction on commutation of DC Generator.
15. Commutation of D.C. generator, Methods of improving commutation.
16. Losses in DC generator, power stages, different stage efficiencies.
17. D.C. generator operating characteristics.
18. Determination of OCC, process of voltage build up and condition necessary for voltage build up.
19. D.C. Motor, principle of operation, voltage equation.
20. Production of electromagnetic torque, Power stages and stage efficiencies.
21. Starting of DC motors, 3 point and 4 point starters, Speed control methods- field and armature control.
22. Poly-phase induction motor: Construction and principle of operation.
23. Slip ring and Squirrel cage rotor construction. Slip, frequency of rotor currents, Torque developed.
24. Torque at standstill condition, running torque and effect of rotor resistance.
25. Equivalent circuit of rotor, complete equivalent circuit.
26. Theory of rotating magnetic field, Torque versus Slip Characteristics.
27. Losses and power stages, starting of 3 phase induction motors.
28. Single phase induction motor: principle of operation, double field revolving theory.

29. Characteristics of phase split, capacitor start and shaded pole motors.
30. Various methods of three phase power measurement.
31. Power factor, disadvantages of low power factor. Methods for power factor improvement.
32. Concept and analysis of balanced poly-phase circuits. Series and parallel resonance in RLC Circuits.

**Practical Schedule**

1. To get familiar with AC and DC Machines and measuring instruments.
2. Polarity test on single-phase two winding transformer.
3. Measurement of Coupling Coefficient of Transformer coil.
4. Open Circuit and Short Circuit tests on single phase two winding transformer.
5. Sumpner's test or back to back test on single phase two winding transformer.
6. Load test on single-phase two winding transformer.
7. Parallel operation of two single phase two winding transformers.
8. Load test on 3 phase squirrel cage induction motor.
9. Separation of losses in 3 phase squirrel cage induction motor.
10. Speed control of 3 phase slip ring induction motor.
11. Load test on single phase induction motor.
12. To study characteristics of DC shunt and series motors
13. To obtain load characteristics of DC shunt, series and compound generators
14. To Plot OCC of DC Shunt Generator.
15. Three phase power measurement using 2 wattmeter method.
16. To study power consumed in a three-phase circuit; two lights in series controlled by one switch; two lights in parallel controlled by one switch.

**Suggested Readings**


1. Thareja BL &Theraja AK. 2005. A text book of Electrical Technology. Vol. I S. Chand & Company LTD., New Delhi.
2. Thareja BL &Theraja AK 2005. A text book of Electrical Technology. Vol. II S.Chand& Company LTD., New Delhi.
3. Dr.P.S.Bimbhra. 2004. Electrical Machinery, Khanna Publications, New Delhi.
4. Vincent Del Toro. 2000. Electrical Engineering Fundamentals. Prentice-Hall of India Private LTD., New Delhi.
5. Anwani M L. 1997. Basic Electrical Engineering. DhanpatRai& Co.(P) LTD. New Delhi.


## Fpme. 2106 Auto CAD Applications 2(0+2)

**Objective**

- To introduce modern techniques and trends in computer aided design and drafting to students and to equip them in preparing technical drawings in standard CAD software.

**Practical**

Application of computers for drafting and design. Standard and commercially available packages, hardware and software requirements, input – output devices, graphic file formats. Familiarization of CAD window. Study of different co-ordinate systems, various input methods, drafting settings and preferences. Practice on draw, edit and format commands and methods. Practice on dimensioning and adding text to drawing. Organizing the drawing with layers, line width, colours etc. Creating 2D drawing, dimensioning and plotting the drawing.

Creating orthographic views of simple models from pictorial views. Preparing drawings of standard machine elements. Introduction to 3D modelling and practice on basic 3D commands. Demonstration of CNC machine.

**Practical Schedule**

1. Introduction to the use computers in drafting and design, hardware and software requirements, input – output devices, graphic file formats.
2. Familiarizing CAD window and working with menus and files.
3. Practice on setting up of drawing – SNAP, GRID, LIMITS, UNITS etc.
4. Practice on drawing basic entities – Line, Circle, Arc, Rectangle, Ellipse etc.
5. Study of OSNAP, input methods and display commands.
6. Study of coordinate systems.
7. Practice on drawing basic entities – Polyline, Polygon, Spline etc.
8. Practice on edit / modify commands – Copy, Move etc.
9. Practice on edit / modify commands– Mirror, Rotate, Scale etc.
10. Practice on PEDIT, Explode etc.
11. Practice on trim, extend, lengthen.
12. Practice on edit / modify commands –Fillet, Chamfer, Array etc.
13. Study on Layers, line width, colour etc.
14. Practice on Hatch, Boundary, Region etc.
15. Practice on dimensioning and adding text to drawing.
16. Creating orthographic views of simple models from pictorial views.
17. Creating orthographic views of simple models from pictorial views.
18. Creating orthographic views of simple models from pictorial views.
19. Creating orthographic views of simple models from pictorial views.
20. Preparing drawings with dimensions of machine elements – nuts, bolts etc.
21. Preparing drawings with dimensions of machine elements – nuts, bolts etc.
22. Preparing drawing of machine parts with all dimensions and allowances - Foot step bearing and knuckle joint
23. Preparing drawing of machine parts with all dimensions and allowances - Foot step bearing and knuckle joint
24. Preparing drawing of machine parts with all dimensions and allowances - Foot step bearing and knuckle joint
25. Creating different view ports, setting up of drawing for printout and plotting.
26. Introduction to 3D modelling, UCS orientation and options.
27. Practice on 3D commands extrude, revolve.
28. Practice on 3D commands sweep, loft etc.
29. Creating 3D models of simple objects.
30. Creating 3D models of simple objects.
31. Introduction to creating complex 3D models.
32. Demonstration of CNC machine.

**Suggested Readings**


1. Finkelstein,E., and Ambrosius, L. 2014. AutoCAD 2015 and AutoCAD LT 2015. Wiley India Pvt. Ltd, New Delhi.
2. Lee, K. 1999. Principles of CAD/CAM/CAE Systems. Prentice-Hall, USA.
3. Rao, P.N. 2002. CAD/CAM Principles and Applications. McGraw-Hill Education Pvt. Ltd., New Delhi.

4. SareenKuldeep and Chandan Deep Grewal. 2010. CAD/CAM Theory and Practice. S.Chand& Company Ltd., New Delhi.
5. Varghese, P. I., and John, K.C. 2013. Machine Drawing including AutoCAD, VIP Publishers, Thrissur.

## Fpme. 2207 Thermodynamics and Automotive Engines 3(2+1)

**Objectives**

- To acquaint with the basis of energy transfer (thermodynamics) and its application to farm power and agricultural processing techniques
- To understand the constructional details of IC engines and its working principles, particularly of diesel and petrol engines of tractors and power tillers.

**Theory**

**Module I** **(6 Hours)**

Thermodynamics –macroscopic and microscopic approach- closed and open system, properties, flow and non-flow processes, cycles, equilibrium, temperature, pressure, gas laws, laws of thermodynamics, internal energy. Application of first law in heating and expansion of gases in non-flow processes. First law applied to steady flow processes. Carnot cycle, Carnot theorem. Entropy, physical concept of entropy, Otto, diesel and dual cycles.

**Module II** **(8 Hours)**

Study of engine components their construction, operating principles and functions. Study of engine strokes and comparison of 2-stroke and 4-stroke engine cycles and CI and SI engines.Study of mechanical, thermal and volumetric efficiencies. Study of Engine valve systems, valve mechanism, Valve timing diagrams.

**Module III** **(8 Hours)**

Study of fuel supply system. Study of fuels, properties of fuels, minimum quantity of air and oxygen required for complete combustion of liquid fuels-calculation of air-fuel ratio. Fuel tests for SI and CI engines. Study of detonation of petrol engine and diesel knock IC engines. Study of a simple carburettor and compensatingtype carburettors- main functional components, working, air-fuel ratios- Study of fuel injection system of diesel engine – fuel pump and injectors, their types, working principles. Engine governing – need of governors, governor types and governor characteristics.

**Module IV** **(10 Hours)**

Study of lubrication system – need, types, functional components. Study of lubricants – physical properties, additives and their application. Engine cooling system – need, cooling methods and main functional components. Additives in the coolant. Study of ignition system of SI engines- Battery Ignition and Magneto Ignition systems. Study of electrical system including battery, starting motor, battery charging, cut-out, etc. Familiarization with the basics of engine testing.

**Practical**

Tutorials on thermodynamic air cycles. Tools and measuring instruments-Engine parts and functions, working principles etc. Valve system – study, construction and adjustments; Oil & Fuel – determination of physical properties; Fuel supply system of CI and SI engine; Cooling system, Lubricating system & adjustments; Starting and electrical system; Ignition system; Tractor engine heat balance and engine performance curves; Visit to engine manufacturer/ assembler/ spare parts agency.

**Lecture Schedule**

1. Thermodynamics – macroscopic and microscopic approach
2. Thermodynamic systems-homogeneous and heterogeneous- boundary- surroundings- properties- intensive and extensive-equilibriums-chemical, mechanical and thermodynamic equilibriums
3. Temperature NTP,STP and pressure –atmospheric and absolute– problems
4. Enthalpy, thermodynamic functions- point and path-flow and non-flow processes
5. Vapour and gas – perfect gas - gas laws – Boyl's and Charl's laws- Characteristic and Universal Gas constants- relation between Cp and Cv, R,and J- problems
6. Joule's and Avagadro's law- Laws of thermodynamics- Zeroth law
7. First law of thermodynamics- problem - limitations- Second law- Kelvin Plank and Clausius Statements
8. Heating and expansion of gases in non-flow processes- five methods – Constant pressure, volume, temperature,adiabatic and poly tropic processes- expressions for work done and internal energy – problems
9. Representation of these processes on PV diagrams- problems- contd.
10. Clausius theorm – concept of entropy – representation of the processes on on TS diagrams- Carnot theorem and Carnot cycle-efficiency derivation-problem- TS diagrams
11. Otto and diesel and dual cycles –efficiency derivations- TS diagrams
12. Otto and diesel and dual cycles –problems - TS diagrams
13. Study of IC engine components their construction- terminologies- mechanical, thermal and volumetric efficiencies -problems
14. Operating principles diesel and petrol engines
15. Comparison of 2-stroke and 4-stroke engine cycles and CI and SI engines
16. Study of engine valve systems types and valve mechanism
17. Valve timing diagram- typical valve timing diagrams of diesel and petrol engines
18. Properties of IC engine fuels, fuel supply system of petrol engine – air-fuel ratios- working of a simple and compensating type carburettors
19. Study diesel fuel supply system- working of fuel pump and fuel injectors
20. Fuel tests – calorific value and viscosity of SI and CI engine fuels - minimum quantity of air and oxygen required for complete combustion of liquid fuels - derivation
21. Study of detonation of petrol engine and diesel knock in diesel engines- remedies.
22. Engine governing –mechanical governor- need of governors and governor characteristics
23. Study of lubrication systems – types and working
24. Study of lubricants – physical properties, SAE grades and API scales- additives and their application
25. Engine cooling system – need and types- air and water cooling methods and main functional components
26. Study of ignition system of SI and CI engines
27. Battery ignition system- components and working- problems and remedies
28. Magneto ignition systems- components and working – problems and remedies
29. Study of electrical system including starting motor, battery charging, cut-out, etc.
30. Tractor engine heat balance - problems
31. Engine performance curves- torque reserve
32. Familiarization with the basics of engine testing.

**Practical schedule**

1. Study of tools and measuring instruments used in Heat Engine Laboratory and steam engine
2. To study the constructional details & working principles of Internal Combustion Engines.
3. To study the constructional details & working principles of 4-stroke petrol Engine.
4. To study the constructional details & working principles of 2- stroke petrol Engine.
5. To determine the calorific value of the given solid fuel or liquid fuel using Oxygen Bomb Calorimeter.
6. To determine the kinematic viscosity and absolute viscosity of the given lubricating oil at different temperatures using Redwood Viscometer.
7. To determine flash point and fire point of the given lubricating oil using Pensky Marten's apparatus.
8. To study the valve timing
9. To study the fuel system of diesel engine- fuel pump and injectors
10. Study of a carburettor.
11. To study the constructional details & working principles of air cooling systems
12. To study the constructional details & working principles of water cooling systems
13. To study the constructional details & working principles of lubricating system.
14. To study the constructional details & working principles of battery ignition system
15. To study the constructional details & working principles of magneto ignition system
16. Visit to IC engine manufacturing industries

**Suggested Readings**


1. Kothandaraman C P Khajuria P R and Arora S C. 1992. A Course in Thermodynamics and Heat Engines. DhanpetRai and Sons, 1682 NaiSarak, New Delhi.
2. Khurmi R S. 1992. Engineering Thermodynamics. S Chand and Co. Ltd., Ram Nagar, New Delhi.
3. Mathur M L and Mehta F S. 1992. Thermodynamics and Heat Power Engineering. DhanpatRai and Sons 1682 NaiSarak, New Delhi.
4. Ballney P. L. 1994. Thermal Engineering. Khanna Publishers, New Delhi.
5. Nag P K.1995. Engineering Thermodynamics. Tata McGraw Hill Publishing Co.Ltd.,4/12Asaf Ali Raod, New Delhi.
6. Ganesan,V.1994.Internal Combustion Engines. Tata McGraw Hill Publishing Co.Ltd.4/12Asaf Ali Raod, New Delhi
7. Pandya, N.C and Shah,C.S. 1990. Elements of Heat Engines.Charotar Publishing House, Court Road, Anand 388 001.


## Fpme. 2208 Fundamentals of Renewable Energy Sources 3(2+1)

**Objective**

- To make the student aware on the various basic aspects of energy use, its environmental impact, different classifications of energy sources and on major renewable energy sources and technologies.

**Theory**

**Module I** **(5 Hours)**

Introduction to energy- Classification-Energy and environment- Concept of Renewable Energy Sources (RES)-Clean Development Mechanism-Role of renewable energy for mitigation of Global warming, Classification of RES, Energy inputs for agricultural production.

**Module II** **(12 Hours)**

Solar Energy: Fundamentals and basic principles- Solar radiation measurement, Basic Principles of Solar thermal energy conversion, Flat plate and Concentrating collectors, different solar thermal devices, Applications and gadgets- Solar drying, Solar still

Solar Photo voltaic electricity production: Principles of Photo voltaic energy production-p-n junctions, Solar cells, PV Systems- Cell characteristics

**Module III** **(5 Hours)**

Wind Energy: Energy available in wind, General formula, Lift and drag. Basics of Wind energy conversion, Power coefficient- Betz limit-Operational parameters of wind turbines-torque coefficient-tip speed ratio. Types of wind turbine rotors

**Module IV** **(10 Hours)**

Bio-energy: Thermo-chemical energy conversion of biomass – Biomass combustion- Combustion of Biomass and stoves -Biomass gasification, Types of gasifiers. Biochemical energy conversion of biomass: Anaerobic digestion process-types of biogas plants- Basic design aspects of Biogas plants-operational and environmental parameters affecting biogas generation. Liquid bio-fuels. Basic principles for production of alcohol and biodiesel.

**Practical**

Study of solar cookers, solar water heating system, solar dryer, biogas plants and improved biomass stoves, Estimation of thermal efficiency of biomass stove, solar photovoltaic cell characteristics.

**Lecture schedule**

1. Introduction to energy- basic thermodynamics- Exergy and Anergy
2. Classification of energy sources- concept of renewable energy
3. Energy and environment – Global warming and related hazards- Role of renewable energy for mitigation
4. Clean development Mechanism
5. Energy inputs for agricultural production- Equivalent energy coefficients
6. Solar Energy: Fundamentals and basic principles
7. Solar radiation measurement
8. Basic Principles of Solar thermal energy conversion
9. Flat plate and Concentrating collectors
10. Different solar thermal devices: Solar water heater
11. Principles of Solar drying
12. Solar pond, solar still and solar chimney
13. Thermal energy utilization using concentrated collectors
14. Solar cooker
15. Basics principles of Solar Photo voltaic electricity production
16. Photo voltaic energy production using p-n junctions, Solar cells
17. PV Systems
18. Solar Cell characteristics
19. Wind Energy: Energy available in wind, General formula
20. Principle of operation of wind turbines, Lift and drag.
21. Basics of Wind energy conversion, Power coefficient- Betz limit
22. Operational parameters of wind turbines-torque coefficient- tip speed ratio.
23. Types of wind turbine rotors and their salient features
24. Bio-energy: Thermo-chemical energy conversion of biomass
25. Biomass combustion- Combustion of Biomass and stoves

26. Biomass gasification, Types of gasifiers.
27. Biochemical energy conversion of biomass: Anaerobic digestion process
28. Types of biogas plants. Basic design aspects of Biogas plants
29. Operational and environmental parameters affecting biogas generation
30. Liquid bio-fuels and their relevance
31. Basic principles for production of alcohol
32. Vegetable oil as fuel- Biodiesel production and use

**Practical Schedule**

1. Estimation of energy input in agricultural production
2. Study of carbon foot print estimation
3. Estimation of calorific value of fuels
4. Study of solar water heating system
5. Study of solar cookers
6. Study of different types of solar dryers
7. Solar drying experiment
8. Study of a lab scale floating gas holder type biogas plan
9. Study of a lab scale floating gas holder type biogas plant
10. Design of biogas plant
11. Study of an improved biomass stove
12. Study of a biomass gasifier
13. Study of solar photovoltaic cell characteristics
14. Study of solar photovoltaic cell characteristics
15. Estimation of solar energy availability at a locality
16. Visit to renewable energy power production facilities

**Suggested Readings**


1. Chawla, O.P. 1986. Advances in biogas Technology, IARI, New Delhi.
2. Chakraverty, A. 1989. Bio-technology and other alternative technologies for utilization of Biomass/Agrl. Wastes. Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi.
3. Mathur, A.N. and Rathore N.S. 1992. Biogas production, management and utilization. Himanshu Publication. Delhi.
4. Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.
5. Sukhatme, S.P. and Nayak, J.K. 2012. Solar Energy: Principles of Thermal Collection and Storage, Tata Mc-Graw Hill Education Pvt. Ltd., New Delhi
6. Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Non Conventional Energy Sources, Himanshu Publications.
7. Tiwari, G.N. and Ghoshal, M.K. 2005. Renewable Energy Resources: Basic Principles and Applications. Narosa Pub. House. Delhi.
8. Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Renewable Energy, Theory and Practice, Himanshu Publications.
9. FAO 1992. Biogas processes for sustainable development. Food and Agrl. Organisation of the U.N. Rome.

## Fpme. 3109 Tractor Systems and Controls 3(2+1)

**Objectives**

- To equip the student with sufficient knowledge about tractor and its various systems, their principles of operation and types, components etc.;
- To impart knowledge on the concept of traction and mechanics of tractor;
- To introduce the ergonomic and safety considerations in tractors; and tractor testing

**Theory**

**Module I** **(3 Hours)**

Introduction to Tractors - Review of engine parts and their functions- Introduction to transmission system in a tractor – components - functioning

**Module II** **(17 Hours)**

Study of clutch – need, types, functional requirements, construction and principle of operation; Familiarization with single plate, multi-plate, centrifugal and dual clutch systems; Study of Gear Box – gear terminology – types of gears - principle of operation; Gear box types - functional requirements; Calculation for speed ratio; Study of differential system – need, functional components, construction; Calculation for speed reduction; Study of final drive – need, types ; Study of brake system – types, principle of operation, construction; Calculation for braking torque; Study of steering system – requirements, functional components; Steering geometry characteristics Calculation for turning radius; Familiarization with Ackerman steering - Steering systems in track type tractors; Introduction to hydraulic system - principle of operation; Types of hydraulic system, main functional components, functional requirements; Familiarization with the hydraulic system adjustments and ADDC; Introduction to tractor power outlets – PTO, PTO standards, types and functions; Study of power tiller transmission system and clutches – components and functions

**Module III** **(10 Hours)**

Introduction to traction - Traction terminology; Theoretical calculation of shear force and rolling resistance on traction device; Study of wheels and tyres – Solid tyres and pneumatic tyres; Tyre construction and tyre specifications; Study of traction aids; Study of tractor mechanics – forces acting on the tractor; Determination of CG of a tractor; Weight transfer in a tractor; Determination and importance of moment of inertia of a tractor; Study of tractor static equilibrium, tractor stability especially at turns; Determination of maximum drawbar pull; Familiarization with tractor as a spring-mass system

**Module IV** **(2 Hours)**

Ergonomic considerations and operational safety; Introduction to tractor testing - Deciphering the test codes.

**Practical**

Introduction to transmission systems and components; Study of clutch functioning, parts and design problem on clutch system; Study of different types of gear box, calculation of speed ratios, design problems on gear box; Study on differential and final drive and planetary gears; Study of brake systems and some design problems; Steering geometry and adjustments; Study of hydraulic systems in a tractor, hydraulic trainer and some design problems; Appraisal of various controls in different makes tractors in relation to anthropometric measurements. Determination of location of CG of a tractor, Moment of Inertia of a tractor. Traction performance of a traction wheel.

**Lecture Schedule**

1. Introduction to Tractors- Line diagram
2. Review of engine parts and their functions

3. Introduction to transmission system in a tractor –components - functioning
4. Study of clutch – need, types, functional requirements, construction and principle of operation
5. Familiarization with single plate, multi-plate, centrifugal and dual clutch systems
6. Study of Gear Box – gear terminology – types of gears - principle of operation
7. Gear box types - functional requirements. Calculation for speed ratio
8. Study of differential system – need, functional components, construction
9. Calculation for speed reduction
10. Study of final drive –need, types
11. Study of brake system – types, principle of operation, construction
12. Calculation for braking torque
13. Study of steering system – requirements, functional components
14. Steering geometry characteristics. Calculation for turning radius
15. Familiarization with Ackerman steering - Steering systems in track type tractors
16. Introduction to hydraulic system-principle of operation
17. Types of hydraulic system, main functional components, functional requirements
18. Familiarization with the hydraulic system adjustments and ADDC
19. Introduction to tractor power outlets – PTO, PTO standards, types and functions
20. Study of power tiller transmission system and clutches – components and functions
21. Introduction to traction - Traction terminology
22. Theoretical calculation of shear force and rolling resistance on traction device
23. Study of wheels and tyres – Solid tyres and pneumatic tyres
24. Tyre construction and tyre specifications
25. Study of traction aids. Study of tractor mechanics – forces acting on the tractor
26. Determination of CG of a tractor. Weight transfer in a tractor.
27. Determination and importance of moment of inertia of a tractor
28. Study of tractor static equilibrium, tractor stability especially at turns
29. Determination of maximum drawbar pull
30. Familiarization with tractor as a spring-mass system
31. Ergonomic considerations and operational safety
32. Introduction to tractor testing - Deciphering the engine test codes

**Practical Schedule**

1. Introduction to transmission systems and components
2. Study of clutch - functioning, parts
3. Design problem on clutch system
4. Study of different types of gear box
5. Calculation of speed ratios - design problems on gear box
6. Study on differential & study of final drive and planetary gears
7. Study of brake systems
8. Steering geometry and adjustments
9. Study of hydraulic systems in a tractor
10. Traction performance of a tractor wheel
11. Appraisal of various controls in different makes of tractors in relation to anthropometric measurements.
12. Finding C.G of a tractor by weighing technique
13. Finding C.G of a tractor using suspension/balancing techniques
14. Finding moment of inertia of a tractor
15. Problems in weight transfer.
16. Study of power tiller

**Suggested Readings**


1. Liljedahl, J. B., Turnquist, P. K., Smith, D. W., and Hokey, M. 2004. Tractors and Their Power Units. CBS Publishers and Distributers Pvt. Ltd, New Delhi
2. Jain, S. C., and Rai, C. R. 2013. Farm Tractor Maintenance and Repair. Standard Publishers Distributors, Delhi
3. Kirpal Singh. 2013. Automobile Engineering Vol. I. Standard Publishers Distributors, Delhi
4. Singh, S., and Verma, S. R. 2009. Farm Machinery Maintenance and Management. Indian Council of Agricultural Research, New Delhi
5. Relevant BIS Test Codes for Tractors.


## Fpme. 3110 Farm Machinery and Equipment-I 3(2+1)

**Objectives**

- To familiarize the students with the relevance of farm machinery and its economic analysis.
- To impart knowledge about the various implements for primary, secondary tillage, seeding and planting, its components, construction, working and force analysis.

**Theory**

**Module I** **(10 Hours)**

Introduction to farm mechanization – Scope, Merits, Limitations, Status of mechanization in the country and state - History of farm mechanization - Research and developments in farm machinery - Classification of farm machines based on operation, power source, in relation to power unit etc. - Unit operation in crop production and related implements / machines - Power units / sources for farm machinery / implements, hitching systems and controls on farm machinery - Field capacities, field efficiency, different ploughing methods - Calculation of field capacity and field efficiency - Economics of machinery usage, fixed cost, variable cost - Methods for calculating depreciation - Estimation of cost of operation - Break even analysis – small, large and own, hired machine - Economic considerations in selection of farm implements and machinery.

**Module II** **(10 Hours)**

Land reclamation and earth moving equipment - Seed bed preparation operations and its classification - Concepts of deep tillage, rotary tillage and minimum tillage - Introduction to machines / implements used for primary and secondary tillage operations - Mould-board plough, disc plough: Functional components, type, constructional details, accessories and attachments - Chisel plough, sub-soiler: Functional components, type, constructional details, accessories and attachments - Horizontal suction, Vertical Suction of MB plough and Disc geometry of disc plough - Forces acting on tillage implements - Draft measurement of tillage implements and calculation of power requirement for the tillage implements - Study of cultivator - Study of harrows - Study of rotary tillers - Study of leveling and puddling implements.

**Module III** **(7 Hours)**

Introduction to sowing, planting & transplanting equipment - Introduction to seed drills, no-till drills, and strip-till drills - Introduction to planters, bed-planters and other planting equipment - Rice transplanters - Study of types of furrow openers - Study of metering systems in drills and planters - Calibration of seed-drills/ planters and adjustments.

**Module IV** **(5 Hours)**

Introduction to materials used in construction of farm machines - Heat treatment processes and their requirement in farm machines - Properties of materials used for critical and functional components of agricultural machines - Introduction to steels and alloys for agricultural application - Identification of heat treatment processes specially for the agricultural machinery components.

**Practical**

Familiarization with different farm implements and tools. Study of hitching systems, Problems on machinery management. Study of primary and secondary tillage machinery – construction, operation, adjustments and calculations of power and draft requirements. Study of sowing and planting equipment – construction, types, calculation for calibration and adjustments. Study of transplanters – paddy, vegetable, etc. Identification of materials of construction in agricultural machinery and study of material properties. Study of heat treatment processes subjected to critical components of agricultural machinery.

**Lecture Schedule**

1. Introduction to farm mechanization – Scope, Merits, Limitations, Status of mechanization in the country and state
2. History of farm mechanization - Research and developments in farm machinery
3. Classification of farm machines based on operation, power source, in relation to power unit etc.
4. Unit operation in crop production and related implements / machines
5. Power units / sources for farm machinery / implements, hitching systems and controls on farm machinery
6. Field capacities, field efficiency, different ploughing methods
7. Economics of machinery usage, fixed cost, variable cost
8. Methods for calculating depreciation
9. Estimation of cost of operation
10. Break even analysis – small, large and own, hired machine
11. Economic considerations in selection of farm implements and machinery
12. Land reclamation and earth moving equipment
13. Seed bed preparation operations and its classification - Concepts of deep tillage, rotary tillage and minimum tillage
14. Introduction to machines / implements used for primary and secondary tillage operations
15. Mould-board plough, disc plough: Functional components, type, constructional details, accessories and attachments.
16. Chisel plough, sub-soiler: Functional components, type, constructional details, accessories and attachments
17. Horizontal suction, Vertical Suction of MB plough and Disc geometry of disc plough
18. Forces acting on tillage implements
19. Draft measurement of tillage implements and calculation of power requirement for the tillage implements
20. Study of cultivator and harrows
21. Study of rotary tillers
22. Study of leveling and puddling implements
23. Introduction to sowing, planting & transplanting equipment
24. Introduction to seed drills, no-till drills, and strip-till drills
25. Introduction to planters, bed-planters and other planting equipment - Rice transplanters
26. Study of types of furrow openers

27. Study of metering systems in drills and planters, Calibration of seed-drills/ planters and adjustments
28. Introduction to materials used in construction of farm machines
29. Heat treatment processes and their requirement in farm machines
30. Properties of materials used for critical and functional components of agricultural machines
31. Introduction to steels and alloys for agricultural application
32. Identification of heat treatment processes specially for the agricultural machinery components.

**Practical Schedule**

1. Familiarization with different farm implements and tools
2. Study on hitching systems
3. Estimating field capacities, field efficiencies and related problems
4. Calculation of cost of operation of farm implements and machinery
5. Problems on selection of farm machinery – economic considerations
6. Study of MB plough
7. Study of Disc plough
8. Calculations of power and draft requirements
9. Study of secondary tillage implements
10. Measurement of draft
11. Study on seed drill
12. Study on planters
13. Study on transplanters
14. Calibration of seed drill
15. Identification of materials of construction in agricultural machinery and study of material properties.
16. Study of heat treatment processes subjected to critical components of agricultural machinery.

**Suggested Readings**


1. Kepner, R. A., Bainer, R., and Barger, E. L. 2005. Principles of Farm Machinery. CBS Publishers and Distributors Pvt. Ltd., New Delhi
2. Sahay, J. 2015. Elements of Agricultural Engineering. Standard Publishers and Distributors, New Delhi
3. Ojha, T. P. and Michael, A. M. 2011. Principles of Agricultural Engineering Vol. I. Jain Brothers, New Delhi
4. Jain S. C., and Grace Philip. 2012. Farm Machinery – An Approach. Standard Publishers Distributors., New Delhi
5. Yadav, R., and Solanki, H. B. 2009. Numericals and Short Questions in Farm Machinery, Power and Energy in Agriculture. New India Publishing Agency, New Delhi.

## Fpme. 3111 Bio-Energy Systems: Design and Applications 2(1+1)

**Objectives**

- To provide in depth knowledge on basic principles of Bio-energy systems.
- To provide skills in design and operation of major bio-energy systems like, improved biomass stoves, biomass furnaces, biogas plants, biomass gasifiers etc. and related appliances.

**Theory**

**Module I** **(4 Hours)**

Environmental aspects of bio-energy, assessment of greenhouse gas mitigation potential. Energy and biomass availability in Indian farms – Introduction to Bio energy - Biomass – Photosynthesis - Energetics of photosynthesis - Energy farms, energy plantation- Processing of biomass for energy production- Physical and chemical properties of biomass relevant in energy conversion- proximate and ultimate analysis-HHV and LHV- estimation of calorific value- Briquetting of biomass. Classification of bioenergy processes- Thermo-chemical and Bio-chemical energy conversion processes.

**Module II** **(4 Hours)**

An overview of anaerobic processes for energy production – Biomethanation process – Biogas plant design, operation, fault checking, maintenance. Biogas appliances, engines - Clean-up of biogas - Developments in anaerobic waste management - Design of commercial biogas plants., Principles of high rate biogas systems- Different types of high rate bio-reactors like UASB, Anaerobic filter, fluidised bed and hybrid bioreactors. Energy production from MSW and landfills.

**Module III** **(4 Hours)**

Use of vegetable oils as fuel - Bio-diesel - general principles of the technology- production and use. Alcohol for fuel purpose- production processes and technology. Hydrogen as fuel – Hydrogen production by bio-photolysis – Biogas Fuel cells.

**Module IV** **(4 Hours)**

Combustion, gasification and pyrolysis of biomass - Basic principles. Technology and equipment for biomass combustion- Chemistry of gasification- Different types of gasifiers– Thermal applications of producer gas- Use of producer gas in engines.

**Practical**

Study of biomass characteristics, Study of anaerobic fermentation systems and systems for application of biogas, Study of gasification for industrial process heat, Study of biodiesel production, biomass densification technique, Use of biofuels for thermal applications and mechanical/electrical power

**Lecture schedule**

1. Basic concepts of bioenergy and its environmental aspects -Greenhouse gas emission- emission reduction
2. Biomass – Photosynthesis - Energetics of photosynthesis-Energy farms, energy plantation
3. Classification of bioenergy processes- Thermo-chemical and Bio-chemical energy conversion processes.
4. Processing of biomass for energy production- Briquetting of biomass-Physical and chemical properties of biomass relevant in energy conversion- proximate and ultimate analysisHHV and LHV- BOD and COD
5. An overview of anaerobic processes for energy production – Biomethanation process
6. Operation, Fault checking and maintenance of biogas systems
7. Biogas appliances, engines - Clean-up of biogas

8. Principles of high rate biogas systems like UASB, Anaerobic filter, fluidised bed and hybrid bioreactors.
9. Energy production from MSW and landfills.
10. Use of vegetable oils as fuel - Bio-diesel production and use
11. Alcohol for fuel purpose- production processes and technology.
12. Hydrogen as fuel – Hydrogen production by bio-photolysis- Biogas Fuel cells
13. Combustion, gasification and pyrolysis of biomass - Basic principles.
14. Biomass Combustion - Equipment for biomass combustion
15. Gasifier technology- Chemistry of gasification- Different types of gasifiers
16. Use of producer gas in engines

**Practical schedule**

1. Study of biomass characteristics like TS, VS, Proximate analysis and their estimation
2. Design of biogas system for a dairy unit
3. Assessment of portable biogas plants
4. Estimation of efficiency of biogas stove
5. Study of biogas engine
6. Study of biogas engine
7. Study of anaerobic waste water treatment systems
8. Study of operation parameters of anaerobic high rate bioreactor
9. Study of operation parameters of anaerobic high rate bioreactor
10. Design of biomass gasifier
11. Study of biomass gasifier system used for energy production
12. Study of biomass gasifier system used for energy production
13. Production procedure for biodiesel
14. Study and operation of a briquetting machine
15. Estimation of BOD of an organic waste water sample
16. Estimation of BOD of an organic waste water sample

**Suggested Readings**


1. Chawla, O.P. 1986. Advances in biogas Technology, IARI, New Delhi.
2. Chakraverty, A. 1989. Bio-technology and other alternative technologies for utilization of Biomass/Agrl. Wastes. Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi.
3. Mathur, A.N. and Rathore N.S. 1992. Biogas production, management and utilization. Himanshu Publication. Delhi.
4. Rai G.D. 1989. Non-conventional Sources of energy. Khanna Publishers. Delhi.
5. FAO 1983. Biomass Energy profiles. Food and Agrl. Organisation of the U.N. Rome.
6. FAO 1992. Biogas processes for sustainable development. Food and Agrl. Organisation of the U.N. Rome.
7. FAO 1997. Renewable biological systems for alternative sustainable energy production. Food and Agrl. Organisation of the U.N. Rome.
8. Sims, Ralph. 2002. The Brilliance of Bioenergy - In Business and In Practice, James & James (Science Publishers) Ltd, EustonRai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.
9. Mital, K.M., 1996, Biogas systems; Principles and applications, New Age International (P) ltd. Publishers, New Delhi.
10. Sims, Ralph. 2002. The Brilliance of Bioenergy - In Business and In Practice, James & James (Science Publishers) Ltd., Euston.

## Fpme. 3112 Tractor and Farm Machinery Operation and Maintenance-I 1(0+1)

**Objective**

- To familiarize the students with agricultural tractors and power tillers, its systems, operation, maintenance and safety precautions.

**Practical**

Familiarization with different makes and models of agricultural tractors and Power Tillers. Identification of functional systems and controls of tractors. Safety rules and precautions. Maintenance and trouble shooting. Driving practice of tractor and Power tiller. Familiarization with tools for general and special maintenance.

**Practical Schedule**

1. Familiarization with different makes and models of agricultural tractors and Power Tillers
2. Identification of functional systems including fuels system, cooling system, transmission system, steering and hydraulic systems.
3. Familiarization with controls on a tractor, Safety rules and precautions to be observed while driving a tractor.
4. Study of maintenance points to be checked before starting a tractor.
5. Starting and stopping practice of tractor and Power tiller
6. Driving practice of tractor
7. Driving practice of tractor
8. Driving practice of tractor
9. Driving practice of power tiller
10. Driving practice of power tiller
11. Introduction to tractor maintenance – precautionary and break-down maintenance.
12. Tractor starting with low battery charge.
13. Introduction to trouble shooting in tractors.
14. Familiarization with tools for general and special maintenance.
15. Introduction to scheduled maintenance after 10, 100, 300, 600, 900 and 1200 hours of operation.
16. Fuel saving tips. Preparing tractor for storage.

**Suggested Readings**


1. Jain, S. C., and Rai, C. R. 2013. Farm Tractor Maintenance and Repair. Standard Publishers Distributors., New Delhi.
2. Ghosh, R. K., Swan, S. 1993. Practical Agricultural Engineering. Kolkata Naya Prakosh.
3. Surendra Singh, Verma, S. R. 2009. Farm Machinery Maintenance and Management. India Council of Agricultural Research, New Delhi.
4. Operators Manuals of Tractors.
5. Service manuals provided by manufacturers.

## Fpme. 3213 Farm Machinery and Equipment-II 3(2+1)

**Objective**

- To impart knowledge about machines / implements for plant protection, intercultural operation, harvesting and threshing.

**Theory**

**Module I** **(8 Hours)**

Introduction to plant protection equipment – sprayers and dusters, Classification of sprayers, Types of nozzles – components and function, Calculations for calibration of sprayers and chemical application rates. Introduction to interculture equipment - Use of weeders – manual and powered. Study of functional requirements of weeders and main components. Familiarization of fertilizer application equipment.

**Module II** **(8 Hours)**

Introduction to harvesting - Principles and types of cutting mechanisms. Study of harvesting operation – harvesting methods, harvesting terminology. Study of mowers – types, constructional details, working and adjustments. Study of shear type harvesting devices – cutter bar, inertial forces, counter balancing, terminology, cutting pattern. Study of reapers, binders and windrowers – principle of operation and constructional details. Importance of hay conditioning, methods of hay conditioning, and calculation of moisture content of hay.

**Module II** **(8 Hours)**

Introduction to threshing systems – manual and mechanical systems. Types of threshing drums and their applications. Types of threshers- tangential and axial, their constructional details and cleaning systems. Study of factors affecting thresher performance. Study of grain combines, combine terminology, classification of grain combines, study of material flow in combines. Computation of combine losses, study of combine troubles and troubleshooting. Study of chaff cutters and capacity calculations. Study of straw combines – working principle and constructional details.

**Module III** **(8 Hours)**

Study of root crop diggers – principle of operation, blade adjustment and approach angle, and calculation of material handled. Study of Cotton harvesting – Cotton harvesting mechanisms, study of cotton pickers and strippers, functional components. Study of maize harvesting combines. Study of tree climbers - coconut climbers. Study of tools for rubber tapping, tea harvesting. Introduction to vegetables and fruit harvesting equipment and tools. Testing of farm machinery – types of tests, test code and procedure. Ergonomic considerations in designing farm machinery.

**Practical**

Familiarization with plant protection and interculture equipment. Study of sprayers, types, functional components. Study of dusters, types and functional components. Calculations for chemical application rates. Study of nozzle types and spread pattern using patternator. Familiarization with manual and powered weeding equipment and identification of functional components. Study of fertilizer application equipment including manure spreaders and fertilizer broadcasters. Study of various types of mowers, reaper, reaper binder. Study of functional components of mowers and reapers. Familiarization with threshing systems, cleaning systems in threshers. Calculations of losses in threshers. Familiarization with functional units of Grain combines and their types. Calculations for grain losses in a combine. Study of root crop diggers and familiarization with the functional units and attachments.

Familiarization with the working of cotton and maize harvesters. Familiarization with vegetable and fruit harvesters.

**Lecture Schedule**

1. Introduction to plant protection equipment – sprayers and dusters.
2. Classification of sprayers
3. Types of nozzles – components and function
4. Calculations for calibration of sprayers and chemical application rates
5. Introduction to interculture equipments
6. Study of weeders – manual and powered
7. Study of functional requirements of weeders and main components
8. Familiarization of fertilizer application equipment
9. Introduction to harvesting - Principles and types of cutting mechanisms
10. Study of harvesting operation – harvesting methods, harvesting terminology
11. Study of mowers – types, constructional details, working and adjustments
12. Study of shear type harvesting devices – cutter bar, inertial forces, counter balancing, terminology, cutting pattern
13. Study of reapers, binders and windrowers – principle of operation and constructional details
14. Importance of hay conditioning, methods of hay conditioning, and calculation of moisture content of hay
15. Introduction to threshing systems – manual and mechanical systems
16. Types of threshing drums and their applications
17. Types of threshers- tangential and axial, their constructional details and cleaning systems
18. Study of factors affecting thresher performance
19. Study of grain combines, combine terminology
20. classification of grain combines, study of material flow in combines
21. Computation of combine losses
22. study of combine troubles and troubleshooting
23. Study of chaff cutters and capacity calculations
24. Study of straw combines – working principle and constructional details
25. Study of root crop diggers – principle of operation, blade adjustment and approach angle, and calculation of material handled
26. Study of Cotton harvesting – Cotton harvesting mechanisms, study of cotton pickers and strippers, functional components
27. Study of maize harvesting combines
28. Study of tree climbers - coconut climbers
29. Study of tools for rubber tapping, tea harvesting
30. Introduction to vegetables and fruit harvesting equipment and tools
31. Testing of farm machinery – types of tests, test code and procedure.
32. Ergonomic considerations in designing farm machinery.

**Practical Schedule**

1. Study of sprayers, types, functional components.
2. Study of nozzle types and spray pattern using patternator.
3. Calibration of sprayers.
4. Study of dusters, types and functional components
5. Familiarization with manual and powered weeding equipmentsand identification of its functional components.

6. Study of fertilizer application equipments including manure spreaders and fertilizer broadcasters.
7. Study of various types of mowers, reaper, reaper binder.
8. Study of cutter bar mechanism of reapers and mowers.
9. Harvesting with reapers.
10. Familiarization with threshing systems and cleaning systems in threshers.
11. Practical of paddy threshing.
12. Calculations of losses, efficiencies in threshers.
13. Familiarization with functional units of Grain combines and their types.
14. Calculations for grain losses in a combine.
15. Familiarization with coconut climbing devices.
16. Familiarization with vegetable and fruit harvesters.

**Suggested Readings**


1. Kepner, R. A., Bainer, R., and Barger, E. L. 2005. Principles of Farm Machinery. CBS Publishers and Distributors Pvt. Ltd., New Delhi
2. Sahay, J. 2015. Elements of Agricultural Engineering. Standard Publishers and Distributors, New Delhi
3. Ojha, T. P. and Michael, A. M. 2011. Principles of Agricultural Engineering Vol. I. Jain Brothers, New Delhi
4. Jain S. C., and Grace Philip. 2012. Farm Machinery – An Approach. Standard Publishers Distributors., New Delhi
5. Yadav, R., and Solanki, H. B. 2009. Numericals and Short Questions in Farm Machinery, Power and Energy in Agriculture. New India Publishing Agency, New Delhi.


## Fpme. 3214 Tractor and Farm Machinery Operation and Maintenance-II 1(0+1)

**Objective**

- To familiarize the students with agricultural tractors and power tillers, its systems, operation, maintenance and safety precautions.

**Practical**

Familiarization with different makes and models of agricultural tractors and Power Tillers. Identification of functional systems and controls of tractors. Safety rules and precautions. Maintenance and trouble shooting. Driving practice of tractor and Power tiller. Familiarization with tools for general and special maintenance.

**Practical Schedule**

1. Hitching & De-hitching of mounted type implement.
2. Hitching & De-hitching of trailed type implement.
3. Study of field patterns while operating a tillage implement.
4. Practice of operating tillage tool (mould-board plough/ disc plough) and their adjustment in the field.
5. Practice of operating tillage tool (mould-board plough/ disc plough) and their adjustment in the field.
6. Driving practice with a trail type trolley – forward and in reverse direction.
7. Driving practice with a trail type trolley – forward and in reverse direction.
8. Driving practice with a trail type trolley – forward and in reverse direction.
9. Care and maintenance procedure of agricultural machinery during operation and off-season.

10. Repair and maintenance of implements – adjustment of functional parameters in tillage implements.
11. Replacement of broken components in tillage implements.
12. Replacement of furrow openers and change of blades of rotavators.
13. Maintenance of cutter bar in a reaper.
14. Adjustments in a thresher for different crops.
15. Replacement of V-belts on implements.
16. Setting of agricultural machinery workshop.

**Suggested Readings**


1. Jain, S. C., and Rai, C. R. 2013. Farm Tractor Maintenance and Repair. Standard Publishers Distributors., New Delhi.
2. Ghosh, R. K., Swan, S. 1993. Practical Agricultural Engineering. Kolkata NayaPrakosh.
3. Surendra Singh, Verma, S. R. 2009. Farm Machinery Maintenance and Management. India Council of Agricultural Research, New Delhi.
4. Operators Manuals of Tractors.
5. Service manuals provided by manufacturers.


## Fpme. 3215 Energy Technology for Renewable Power production 2(2+0)

**Objectives**

- To make the student competent to deal with fundamental issues related to power production from renewable resources.
- To enable him with technical knowhow on the state of the art technology for nourishing his future capabilities in energy sector.

**Theory**

**Module I** **(8 Hours)**

Energy consumption pattern & energy resources in India. Renewable energy options, potential and present status. Basic principles of fuels- solid, liquid and gaseous fuels- principles of combustion- Design considerations for combustion equipment- stoichiometric air requirement- oil burners and gas burners.

**Module II** **(8 Hours)**

Principles of operation of a steam power plant, Basics of different types of steam turbines- impulse and reaction turbines, Basics of nuclear energy, basic components of a nuclear power reactor, Hydro-electric power generation- basic principles-classification based on hydraulic characteristics and head - Mini and micro hydel plants.

**Module III** **(8 Hours)**

Tidal power- components-operation methods, Principles of OTEC system, wave energy systems, utilization of geo-thermal resources for power production, Fuel cells and hydrogen energy, Magneto hydro dynamic (MHD) power generation- Open cycle and closed cycle MHD. Fuel cell power plants. Estimation of solar energy, Solar thermal and photovoltaic Systems for power generation. Central receiver type solar power plant.

**Module IV** **(8 Hours)**

Wind farms. Estimation of wind energy, Velocity- duration curve, Power – duration curve, frequency – duration curve, Aero-generators, Wind power generation systems. Biogas technology for power production, Power generation from urban, municipal and industrial waste, Energy from landfills- Combustion of biomass- Basic principles for design of combustion equipment.

**Lecture schedule**

1. Energy consumption pattern & energy resources in India.
2. Renewable energy options, potential and present status.
3. Basic principles of fuels- solid, liquid and gaseous fuels,
4. Principles of combustion - Design considerations for combustion equipment- –
5. Stoichiometric air requirement
6. Estimation of flue gas quantity
7. Oil burners and Gas burners
8. Principles of operation of a steam power plant
9. Different types of steam turbines- impulse and reaction turbines
10. Nuclear energy, basic components of a nuclear power reactor
11. Hydro-electric power generation - Classification based on hydraulic characteristics and head
12. Mini and micro hydel plants – Characteristics
13. Tidal power- principles
14. Components and operation of tidal power systems
15. Principles of OTEC system
16. Wave energy systems
17. Geo-thermal resources for power production
18. Hydrogen energy
19. Fuel cell Technology
20. Fuel cell power plants
21. Magneto hydro dynamic (MHD) power generation
22. Open cycle and closed cycle MHD
23. Photovoltaic Systems for power generation
24. Estimation of solar energy
25. Solar thermal Systems for power generation -Central receiver type solar power plant
26. Wind farms- Estimation of wind energy- Important field parameters
27. Velocity- duration curve, Power – duration curve, Frequency –duration curve
28. Aero-generators, Wind power generation systems.
29. Biogas technology for power production
30. Power generation from urban, municipal and industrial waste
31. Energy from land fills
32. Combustion of biomass- Principles for design of combustion equipment.

**Suggested Readings**


1. Garg H.P. 1990. Advances in Solar Energy Technology; D. Publishing Company, Tokyo.
2. Bansal N.K., Kleemann M. and Meliss Michael. 1990. Renewable Energy Sources & Conversion Technology; Tata Mecgrow Publishing Company, New Delhi.
3. Rao, S. and Parulekar B.B. 2005. Energy Technology, Khanna Publishers, Delhi
4. Sukhatme, S.P. and Nayak, J.K. 2012. Solar Energy: Principles of Thermal Collection and Storage, Tata Mc-Graw Hill Education Pvt. Ltd., New Delhi
5. Rathore N. S., Kurchania A. K. & N.L. Panwar. 2007. Non Conventional Energy Sources, Himanshu Publications.

6. Rai, G.D.,2010. An introduction to Power Plant Technology, Khanna Publishers, Delhi
7. Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.
8. Sims, Ralph. 2002. The Brilliance of Bioenergy - In Business and In Practice, James & James (Science Publishers) Ltd., Euston.

## Fpme. 3216 Ergonomics in Farm Machinery 1(1+0)

**Objectives**

- To impart basic knowledge in Ergonomics by understanding the Fundamental Concepts
- To acquaint and equip with the ergonomic aspects in the design of farm machinery for more output and safety of human beings.

**Theory**

**Module I** **(8 Hours)**

Importance of ergonomics and its application in agriculture; Energy liberation in human body; Assessment of energy expenditure- direct calorimetry, Indirect calorimetry- Assessment by oxygen consumption; Techniques of measuring oxygen consumption; Assessment by heart rate and calibration; Assessment by subjective rating of perceived effort- Overall discomfort score and BPDS; Basal metabolism and work metabolism; Assessment of work load;Assessment of Individual's maximal work capacity.

**Module II** **(5 Hours)**

Anthropometry; Anthropometric data and measurement techniques; Anthropometric dimensions and strength parameters; Causes of variability of anthropometric data; Analysis of anthropometric data and use of percentiles

**Module III** **(3 Hours)**

Biomechanics of motion. Vibration- hand arm vibration and whole body vibration, physiological effects; Noise and its physiological effects.

**Lecture schedule**

1. Importance of ergonomics and its application in agriculture
2. Energy liberation in human body
3. Assessment of energy expenditure- direct calorimetry, Indirect calorimetry
4. Assessment by oxygen consumption; Techniques of measuring oxygen consumption
5. Assessment by heart rate and calibration
6. Assessment by subjective rating of perceived effort- Overall discomfort score and BPDS
7. Basal metabolism and work metabolism
8. Assessment of work load;Assessment of Individual's maximal work capacity
9. Introduction to Anthropometry
10. Anthropometric data and measurement techniques
11. Anthropometric dimensions and strength parameters
12. Causes of variability of anthropometric data
13. Analysis of anthropometric data and use of percentiles
14. Introduction to Biomechanics of motion
15. Vibration- hand arm vibration and whole body vibration, physiological effects
16. Noise and its physiological effects.

**Suggested Readings**


1. Astrand, P.O and Rodahl, K.1977. Text book of work physiology, McGraw Hill, New York
2. Bridger, R.S,1995. Introduction to Ergonomics, McGraw Hill, New York
3. Dul J and Weerdmeester B.1993.Ergonomics for Beginners. A Quick Reference Guide. Taylor and Francis, London.
4. Kroemer, K.H.E., Kroemer,H.J. and K.E.Kroemer-Elbert. 1997. Engineering Physiology: bases of human factors/ergonomics, VAN NOSTRAND REINHOLD, New York.
5. Rodal, K.1989.The Physiology of work, Taylor and Francis, London.

## Department of Farm Power Machinery and Energy-Electives

### Elfm. 4201 Mechanics of Tillage and Traction 3(2+1)

**Objective:**
To impart basic knowledge in mechanics of tillage and traction by understanding the fundamental concepts and to develop analytical and practical skills in farm machinery.

**Module I** **(8 Hours)**
Introduction to mechanics of tillage tools, engineering properties of soil, principles and concepts, stress strain relationship.

**Module II** **(8 Hours)**
Design of tillage tools principles of soil cutting, design equation, force analysis.

**Module III** **(8 Hours)**
Application of dimensional analysis in soil dynamics and traction prediction equation.

**Module IV** **(8 Hours)**
Introduction to traction and mechanics, off road traction and mobility, traction model, traction improvement, tyre size, tyre lug geometry and their effects, tyre testing. Soil compaction and plant growth, variability and application of GIS in soil dynamics.

**Practical**
Measurement of static and dynamic soil parameters related to tillage, soil parameters related to puddling and floatation, draft for passive rotary and oscillating tools, slip and sinkage under dry and wet soil conditions and load and fuel consumption for different farm operations; Weight transfer and tractor loading including placement and traction aids; Studies on tyres, tracks and treads under different conditions, and soil compaction and number of operations.

**Lecture schedule**

1. Study of tillage operations- forces acting on a tillage implement- draft
2. Physical properties of soils
3. Engineering properties of soil- consistency limits – shear strength
4. Mohr's circle – shear failure- Coulomb's equation- general model of shear failure
5. Tri-axial compression test- stress strain theory- relationship
6. Force analysis of tillage implements
7. Dimensional Analysis- units and dimensions - definition- systems of measurements
8. Dimensional Analysis- Dimension of entities- Dimensionless numbers –
9. complete set of dimensionless products
10. Methods of determining dimensionless products- Rayleigh's method
11. Buckingham Pi theorem and method –problems
12. Systematic analysis methods of DA-problems
13. Development of prediction equation through dimensional analysis
14. Mechanics of tillage tools-tractive performance of wheeled vehicles- off road traction mechanics- objectives
15. Rolling resistance at different soil and tyre conditions
16. Prediction of sinkage- Bekker'sand Columb'sequations – plate test

17. Mobility number- Wheel numeric- Weismer and Luth Equation- Analysis of soil-machine dynamics in tillage
18. Relation between tractive force and slip.
19. Mechanical properties of soils- strength determining factors and floatation
20. Penetration resistance and mobility number approach for predicting field performance of tyres-typical values of cone penetrometer resistances
21. Traction - tractive efficiency and coefficient of traction at varying slips
22. Draw bar power – its variation w.r.to various pull and slip conditions
23. Design of tillage tools- active and passive tools
24. Application of dimensional analysis in soil dynamics
25. Traction mechanics
26. Traction models
27. Traction improvement methods
28. Cone index and its determination
29. Tyres for agricultural tractors
30. Tyre and track terminology and selection of tyres
31. Soil compaction studies – compaction measurement
32. Application of GIS in soil dynamics

**Practical Schedule**

1. Measurement of static and dynamic soil parameters related to tillage
2. Measurement of Soil parameters related to puddling and floatation
3. Draft measurement of tractor attached implements
4. Draft measurement for passive tools
5. Draft measurement for activetools
6. Measurement of Slip
7. Measurement sinkage under wet soil conditions
8. Load and fuel consumptiontests fortractor engines.
9. Study of weight transfer of a tractor
10. Study of tractor tyres and traction aids
11. Visibility test for tractors
12. Measurement of puddling index of wet soils
13. Measurement of turbidity index
14. Study of different methods of ballasting
15. Determination of cone index
16. Visit to R&D organizations dealing with tillage studies

**Suggested Readings**


1. Gill William, R. and Glen E. Vanden Berg. 1968. Soil Dynamics in Tillage and Traction. Scientific Publishers (India), Reprint 2013.
2. Liljedahl, J. B., Turnquist, P. K., Smith, D. W. and Hoki, M. 2004.Tractors and their Power Units. CBS Publishers Pvt. Ltd.
3. Daniel Hillel. 1980 Fundamentals of Soil Physics. Academic Press, Inc. Ltd. New York
4. Kumar,V.J.F and Durairaj,C.D.2003. Dimensional Analysis and Similitude (Through worked examples). New Age International Pvt. Ltd., New Delhi.( ISBN-8122414868).
5. Mehta, M.L, Verma,S.R., Misra, S.K and Sharma, V.K. 1995. Testing and evaluation of Agricultural Machinery. National Agricultural Technology Information Centre.89,I Block Sarabha Nagar, Ludhiana 141 001

6. Langhaar, H.L.1951. Dimensional Analysis and Theory of Models. Robert E. Krieger Publishing Company, Malabar,Florida.
7. Bosoi,E.S,Verniaev,O.V.,Smirnov,I.I and Sultan Shakh. 1990. Theory,Construction and Calculations of Agricultural Machines. Vol. I. Oxonian press Pvt. Ltd.,New Delhi.
8. Kuipers, H and Koolen, A.J. 1983. Agricultural Soil Mechanics. Sringer-Verlag New York

## Elfm. 4202 Farm Machinery Design and Production 3(2+1)

**Objective**

To impart basic knowledge in Farm Machinery Design and Production by understanding the Fundamental Concepts and develop analytical and practical skills in that field.

**Module I** **(8 Hours)**

Introduction to design parameters of agricultural machines & design procedure. Characteristics of farm machinery design. Research and development aspects of farm machinery.

**Module II** **(8 Hours)**

Design of standard power transmission components used in agricultural machines: mechanical & hydraulic units. Introduction to safety in power transmission. Application of design principles to the systems of selected farm machines.

**Module III** **(8 Hours)**

Critical appraisal in production of Agricultural Machinery; Advances in material used for agricultural machinery. Cutting tools including CNC tools and finishing tools. Advanced manufacturing techniques including powder metallurgy, EDM (Electro-Discharge Machining).

**Module IV** **(8 Hours)**

Heat Treatment of steels including pack carburizing, shot pining process, etc.Limits, Fits & Tolerances, Jigs & Fixtures. Industrial lay-out planning. Quality production management. Reliability. Economics of process selection. Familiarization with Project Report.

**Practical**

Familiarization with different design aspects of farm machinery and selected components. Solving design problems on farm machines & equipment Visit to Agricultural machinery manufacturing industry, Tractor manufacturing industry Jigs and Fixtures – study in relation to agricultural machinery. Fits, tolerances and limits; Layout planning of a small scale industry; Problems on Economics of process selection; Preparation of a project report; Case study for manufacturing of simple agricultural machinery.

**Lecture schedule**

1. Introduction to design parameters of agricultural machines
2. Introduction to design procedure of agricultural machines
3. Characteristics of farm machinery design.
4. Research and development aspects of farm machinery.
5. Introduction to standard power transmission components
6. Design of power transmission components used in agricultural machines
7. Components of Power Transmission - mechanical
8. Components of Power Transmission - hydraulic
9. Introduction to safety in power transmission

10. Application of design principles to the systems of selected farm machines
11. Application of design principles to the systems of selected farm machines
12. Application of design principles to the systems of selected farm machines
13. Critical appraisal in production of Agricultural Machinery;
14. Advances in material used for agricultural machinery.
15. Cutting tools including CNC tools and finishing tools.
16. Advanced manufacturing techniques
17. Powder metallurgy,
18. EDM (Electro-Discharge Machining),
19. Heat Treatment of steels including
20. Pack carburizing,
21. Shot pining process,.
22. Limits, Fits & Tolerances,
23. Jigs & Fixtures.
24. Industrial lay-out planning,
25. Industrial lay-out planning,
26. Industrial lay-out planning
27. Quality production management.
28. Reliability.
29. Economics of process selection.
30. Familiarization with Project Report.
31. Familiarization with Project Report.
32. Familiarization with Project Report.

**Practical Schedule**

1. Familiarization with different design aspects of farm machinery and selected components.
2. Solving design problems on farm machines & equipment
3. Visit to Agricultural machinery manufacturing industry,
4. Visit to Agricultural machinery manufacturing industry,
5. Visit to Tractor manufacturing industry
6. Visit to Tractor manufacturing industry
7. Jigs and Fixtures – study in relation to agricultural machinery.
8. Jigs and Fixtures – study in relation to agricultural machinery.
9. Fits, tolerances and limits;
10. Fits, tolerances and limits;
11. Layout planning of a small scale industry;
12. Layout planning of a small scale industry;
13. Problems on Economics of process selection
14. Problems on Economics of process selection;
15. Preparation of a project report
16. Case study for manufacturing of simple agricultural machinery.

**Suggested Readings**

1. Khurmi, R. S. and Gupta, J. K. 2012. Text Book of Machine Design. S Chand Publications.
2. Sharma, D. N. and Mukesh, S. 2012. Design of Agricultural Tractor.2nd edition. LP, New Delhi.

3. Sharma, D. N. and Mukesh, 2010. S., Farm Machinery Design. 2nd edition. LP, New Delhi.

## Elfm. 4203 Human Engineering and Safety 3(2+1)

**Objective**

To impart basic knowledge in Human Engineering by understanding the Fundamental Concepts and to acquaint and equip with the human factors in the design of farm machinery and tractors for safety of human beings.

**Theory**

**Module I** **(8 Hours)**

Human factors in system development – concept of systems; basic processes in system development; performance reliability, human performance; Metabolic system, human energy machine, Human metabolism and work; Energy liberation in human body; Energy for muscle work; Assessment of energy expenditure- direct calorimetry, Indirect calorimetry; Techniques of measuring oxygen consumption; Assessment of work load; Information input process, visual displays, major types and use of displays, auditory and factual displays. Speech communications.

**Module II** **(8 Hours)**

Biomechanics of motion, types of movements, Range of movements, strength and endurance, speed and accuracy, human control of systems. Human motor activities, controls, tools and related devices. Analysis of arm lifting, Types of body joints, Mobility- Maximal displacement of body joints.

**Module III** **(8 Hours)**

Introduction to Anthropometry; Equipments for measuring anthropometric data; Identification of anthropometric dimensions and strength parameters for the design of Agro Machinery and equipment; arrangement and utilization of work space; Use of anthropometric dimensions for the functional components of farm Machinery and equipment; functional Anthropometry; causes of variability of anthropometric data-; Inter-individual variations, Intra-individual variations, Secular changes, Poor data; Designing to fit the body; Normality, variability, correlations and use of percentiles

**Module IV** **(8 Hours)**

Fundamentals of human thermoregulation, thermal balance, measuring the thermal environment-dry bulb temperature, relative humidity and wet bulb temperature, globe temperature, air movement and wind chill; heat stress ;Work in hot climates- heat stroke, relative humidity, heat acclimatization; personal factors affecting heat tolerance, Heat stress management; work in cold climates- core temperature, acclimatization to cold, perception to cold, Skin temperature; Air pollution. Dangerous machine (Regulation) act, Rehabilitation and compensation to accident victims, Safety gadgets for spraying, threshing, Chaff cutting and tractor & trailer operation etc.

**Practical schedule**

Calibration of the subject in the laboratory using bi-cycle ergo-meter. Study and calibration of the subject in the laboratory using mechanical treadmill; Use of respiration gas meter from human energy point of view. Use of Heart Rate Monitor. Study of general fatigue of the subject using Blink ratio method, Familiarization with electro-myograph equipment, anthropometric measurements of a selected subjects. Optimum work space layout and locations of controls for

different tractors. Familiarization with the noise and vibration equipment. Familiarization with safety gadgets for various farm machines.

**Lecture schedule**

1. Introduction to human factors in system development, concept of systems, basic processes in system development
2. Performance reliability and human performance
3. Metabolic system; human energy machine
4. Human metabolism and work; Energy liberation in human body; Energy for muscle work;
5. Assessment of energy expenditure- direct calorimetry, Indirect calorimetry;
6. Techniques of measuring oxygen consumption; Assessment of work load
7. Introduction to visual displays, Major types and use of displays
8. Auditory and factual displays, Speech communications
9. Introduction to Biomechanics of motion
10. Stress and strain, Newton's laws
11. Types of movements. Range of movements
12. Strength and endurance, speed and accuracy
13. Human control of systems
14. Human motor activities, tools and related devices
15. Analysis of arm lifting. Types of body joints
16. Mobility- Maximal displacement of body joints
17. Introduction to Anthropometry. Equipments for measuring anthropometric data
18. Identification of anthropometric dimensions and strength parameters for the design of Agro Machinery and equipment
19. Use of anthropoemetric dimensions for the functional components of farm Machinery and equipment, arrangement and utilization of work space
20. Functional Anthropometry
21. Causes of variability of anthropometric data-; Inter-individual variations, Intra-individual variations, Secular changes, Poor data. Designing to fit the body
22. Normality, variability, correlations and use of percentiles
23. Fundamentals of human thermoregulation, thermal balance
24. Measuring the thermal environment- dry bulb temperature, relative humidity and wet bulb temperature, globe temperature,
25. Air movement and wind chill, Heat stress
26. Work in hot climates- heat stroke, relative humidity, heat acclimatization
27. Personal factors affecting heat tolerance, Heat stress management
28. Work in cold climates- core temperature, acclimatization to cold, perception to cold,
29. Skin temperature; Air pollution.
30. Dangerous machine (Regulation) act , Rehabilitation and compensation to accident victims
31. Safety gadgets for spraying, threshing, Chaff cutting
32. Safety gadgets for tractor & trailer operation etc.

**Practical schedule**

1. Measurement of Basal Metabolic Rate of subjects
2. Calibration of the subject in the laboratory using bi-cycle ergo-meter
3. Calibration of the subject in the laboratory using mechanical treadmill
4. Use of respiration gas meter

5. Use of Heart Rate Monitor
6. Measurement of heart rate of subjects while using sprayers
7. Measurement of heart rate of subjects while using sprayers
8. Measurement of heart rate of subjects while using weeders
9. Measurement of heart rate of subjects while using weeders
10. Study of general fatigue of the subject using Blink ratio method
11. Familiarization with electro-myograph equipment
12. Anthropometric measurements of selected subjects
13. Measurement of strength parameters of selected subjects
14. Optimum work space layout and locations of controls for different tractors
15. Familiarization with the noise and vibration equipment
16. Familiarization with safety gadgets for various farm machines

**Suggested Readings**


1. Chapanis A. 1996. Human Factors in System Engineering. John Wiley & Sons, New York.
2. Dul J. and Weerdmeester B.1993. Ergonomics for Beginners. A Quick Reference Guide. Taylor and Francis, London.
3. Mathews J. and Knight A. A. 1971. Ergonomics in Agricultural Equipment Design. National Institute of Agricultural Engineering.
4. Astrand P. And andRodahl K. 1977. Textbook of Work Physiology. Mc Hill Corporation, New York.
5. Mark S. Sanders and Ernest James McCormick. 1993. Human Factors in Engineering and Design. Mc Hill Corporation, New York.
6. Keegan J J, Radke AO. 1964. Designing vehicle seats for greater comfort. SAE Journal; 72:50~5.
7. Yadav R, Tewari V.K. 1998. Tractor operator workplace design-a review. Journal of Terra mechanics 35: 41-53.


## Elfm. 4204 Tractor Design and Testing 3(2+1)

**Objectives**

- To impart knowledge about the mechanics of traction of tractors and the factors affecting traction including different traction aids.
- To familiarize the students with the relevance and basics of design of an agricultural tractor and its components such as engine, transmission system, fuel system, lubrication system, cooling system, hydraulic system and controls and the ergonomics in tractor design.
- To impart knowledge in the problem solving skills related to tractor stability.
- To impart basic knowledge in testing and evaluation of tractor.

**Theory**

**Module I** **(13 Hours)**

Introduction to procedure for design and development of agricultural tractors. Traction theory-Traction mechanism. mechanics of traction devices. Kinematics and dynamic aspects of Rolling elements. Tire selection. Traction devices for wet lands.Mechanics of traction-Traction

performance. Tread design- traction improvements. Mechanics of tractor chassis – Static equilibrium analysis. Centre of gravity & moment of inertia.

**Module II** **(8 Hours)**

Tractor Engine - Parameters affecting design of tractor engine-General design considerations. Design of engine components. Design of fuel injection system, lubrication system, cooling system and ignition system. Design of mechanical power transmission in agricultural tractors. Friction brakes and clutches.

Design of Ackerman Steering and tractor hydraulic steering. Mechanics of steering & front suspension.

**Module III** **(4 Hours)**

Hydraulic systems & controls – basic principles, components and symbols. Flow and circuit analysis, motors, actuators, valves, hydraulic fluids and controls. Draft sensing, automatic control, power steering. Hydraulic circuit design. Hitches, hitching and weight transfer. Force and moment relations for a tractor when pulling an implement, control of hitches.

**Module IV** **(7 Hours)**

Human factors in tractor design - environmental factors, noise, vibration. Operator – machine interface, Design aspects of foot and hand controls, rollover protection, thermal comfort and safety. Operator's seat. Pollution control technologies.

Tractor Testing: Types, test procedure, national and international codes. Types of tests. Tractor performance criteria- Power measurement methods – types of dynamometers. Drawbar, PTO and three point hitch performances. Power losses in dynamometers and hydraulic test equipment. Review and interpretation of test reports. Case studies.

**Practical**

Design problem of tractor clutch – (Single/ Multiple disc clutch). Design of gear box(synchromesh/constant mesh), variable speed constant mesh drive; Selection of tractor tires – Problem solving. Problem on design of governor. Design and selection of hydraulic pump. Engine testing as per BIS code. Drawbar performance in the lab; PTO test and measure the tractor power in the lab/field; Determining the turning space, turning radius and brake test, hydraulic pump performance test and air cleaner and noise measurement test; Visit to tractor testing centre/industry.

**Lecture schedule**

1. Introduction to procedure for design and development of agricultural tractors. Technical specifications of tractors available in India.
2. Modern trends in tractor design and development. Special design features of tractors in relation to Indian agriculture.
3. Introduction to CAD and its application in agricultural tractors.
4. Traction theory: Co-efficient of traction, Deflection between traction devices and soil, slippage and sinkage of wheels.
5. Evaluation and prediction of traction performance, design of traction and transport devices.
6. Traction mechanism: Introduction of traction devices. Tires-types function & size, their selection.

7. Mechanics of traction devices. Off road traction mechanics, Trafficability.
8. Performance evaluation, design considerations traction devices. Kinematics and dynamic aspects of rolling elements.
9. Tire selection. Traction devices for wet lands- Tracks, cage wheels, cage rollers.
10. Mechanics of traction: Traction performance equation, performance of tires, tire size, load & air pressure relationship.
11. Tread design- effect of lug spacing, traction improvements.
12. Mechanics of tractor chasis – assumptions, equations of motion. Static equilibrium analysis, longitudinal stability, Lateral stability.
13. Determination of Centre of gravity & moment of inertia. Problems
14. Tractor Engine - Parameters affecting design of tractor engine and their selection, General considerations in engine design.
15. Design of engines - Stroke-bore ratio, crankshaft & firing order, valve design, valve timing, cam shaft.
16. Combustion chamber design, piston, flywheels, balancing of engines.
17. Design of fuel injection system, lubrication system, cooling system and ignition system.
18. Design of mechanical power transmission in agricultural tractors: Tractor transmission and drive chains – complete drive train, transmission types, gears for power transmission.
19. Differentials, transmission drive shafts. Friction brakes and clutches- single disc, multi disc and cone clutches. Rolling friction and anti-friction bearings.
20. Design of Ackerman Steering and tractor hydraulic steering.
21. Mechanics of steering & front suspension of farm tractor.
22. Hydraulic systems & controls – basic principles of hydraulics, components and symbols.
23. Basics of hydraulic flow and hydraulic circuit analysis motor performance, actuators, valves, hydraulic fluids and controls.
24. Draft sensing, automatic control, power steering. Hydraulic circuit design.
25. Hitches – types, principles, hitching and weight transfer, force and moment relations for a tractor when pulling an implement, control of hitches.
26. Human factors in tractor design – operator exposure to environmental factors, noise, and vibration. Operator – machine interface.
27. Design aspects of foot and hand controls on tractors, rollover protection, thermal comfort and safety.
28. Design of operator's seat for tractors and agricultural equipment. Pollution control technologies.
29. Tractor Testing: Types of tests; test procedure, national and international codes.
30. Test equipment- usage and limitations. Types of tests – compulsory tests, optional tests, static & dynamic tests, noise test.
31. Tractor performance criteria – Power measurement methods – types of dynamometers. Drawbar, PTO and three point hitch performances.
32. Power losses in dynamometers and hydraulic test equipment. Review and interpretation of test reports. Case studies.

**Practical schedule**

1. Determination of Slip, Rolling resistance and pull of a tractor.
2. Determination of Centre of gravity of Tractor.
3. Determination of Co-efficient of Rolling resistance, Co-efficient of Traction and Tractive efficiency.
4. Measurement of diametric parameters of tyres.
5. Determination of turning space and turning radius.

6. Problems on Mechanics of Traction.
7. Measurement of Tractive parameter by two tractor method.
8. Design problem of tractor engine. Design problem of tractor clutch.
9. Design problem of tractor gear box.
10. Design problem of Fuel injection pump for tractor engine.
11. Design problem of Lubrication system of Tractor
12. Design problem of cooling system of Tractor.Selection of tractor tires – Problem solving.
13. Design and selection of hydraulic pump.
14. Engine testing as per BIS code.
15. Drawbar and PTO performance in the lab/field.
16. Visit to tractor testing centre/industry.

**Suggested Readings**


1. Liljedahl J B, Turnquist P K, SmithD W, and Hoki M.(1996), Tractors and Their Power Units, CBS Publishers & Distributers.
2. Raymond N Y, EEzzat A F and Nicolas Skiadas.(1984), Vehicle Traction Mechanics, Elsevier Science Publishers B V, New York.
3. Sharma, D N and Mukesh, S.(2010), Design of Agricultural Tractor- Principles and problems,Jain brothers, New Delhi.
4. William R G and Vanden Berg G E. (1968), Soil Dynamics in Tillage and Traction, Agricultural Research Service, USA.
5. Pandey, M M& Others.(2013), Handbook of Agricultural Engineering, Indian Council of Agricultural Engineering, New Delhi.
6. Mehta ML, SR Verma, SK Mishra, VK Sharma.(2010), Testing & Evaluation of Agricultural Machinery.


## Elfm. 4205 Hydraulic Drives and Controls 3(2+1)

**Objective:**

To impart basic knowledge in Hydraulic systems by understanding the Fundamental Concepts, understanding of basic laws, system components, application in agricultural engineering and improvethe related problem solving skills.

**Theory**

**Module I** **(8 Hours)**

Basics of Hydraulic: Pascal's Law, Flow, Energy, Work, and Power. Hydraulic Systems, Colour Coding, Reservoirs, Strainers and Filters, Filtering Material and Elements. Accumulators, Pressure Gauges and Volume Meters, Hydraulic Circuit, Fittings and Connectors.

**Module II** **(8 Hours)**

Pumps, Pump Classifications, operation, performance, Displacement, Design ofGear Pumps, Vane Pumps, Piston Pumps.

**Module III** **(8 Hours)**

Hydraulic Actuators, Cylinders, Construction and Applications, Maintenance, Hydraulic Motors. Valves, Pressure-Control Valves, Directional- Control Valves, Flow-Control Valves, Valve. Installation, Valve Failures and Remedies, Valve Assembly, Troubleshooting of Valves.

**Module IV** **(8 Hours)**

Hydraulic Circuit Diagrams and Troubleshooting, United States of American Standards Institute USASI Graphical Symbols Tractor hydraulics, nudging system, ADDC. Pneumatics: Air services, logic units, Fail safe and safety systems Robotics: Application of Hydraulics and Pneumatics drives in agricultural systems, Programmable Logic Controls (PLCs).

**Practical**

Introduction to hydraulic systems. Study of hydraulic pumps, hydraulic actuators. Study of hydraulic motors, hydraulic valves, colour codes and circuits. Building simple hydraulic circuits, hydraulics in tractors. Introduction to pneumatics, pneumatics devices, pneumatics in agriculture; Use of hydraulics and pneumatics for robotics.

**Lecture schedule**

1. Basics of Hydraulic: Pascal's Law, Flow, Hydraulic Energy, Work, and Power.
2. Hydraulic Systems.
3. Colour Coding, Reservoirs.
4. Strainers and Filters, Filtering Material and Elements.
5. Accumulators.
6. Pressure Gauges and Volume Meters.
7. Hydraulic Circuit, Fittings and Connectors.
8. Pumps, Pump Classifications, operation.
9. Performance, Displacement.
10. Design of Gear Pumps
11. Design of Vane Pumps
12. Design of Piston Pumps
13. Hydraulic Actuators, Cylinders
14. Construction and Applications, Maintenance
15. Hydraulic Motors.
16. Valves, Pressure-Control Valves.
17. Construction, Applications and Maintenance of valves.
18. Directional- Control Valves, Flow-Control Valves, Valve.
19. Installation, Valve Failures and Remedies
20. Valve Assembly, Troubleshooting of Valves.
21. Hydraulic Circuit Diagrams and Troubleshooting.
22. United States of American Standards Institute USASI Graphical Symbols.
23. Tractor hydraulics.
24. Working and typical settings of tractor hydraulic system.
25. Working and typical settings of tractor hydraulic system.
26. Maintenance of tractor hydraulics system.
27. Nudging system, ADDC.
28. Pneumatics: Air services, logic units, Fail safe and safety systems.
29. Pneumatics: Air services, logic units, Fail safe and safety systems.
30. Robotics: Application of Hydraulics and Pneumatics drives in agricultural systems

31. Robotics: Application of Hydraulics and Pneumatics drives in agricultural systems
32. Programmable Logic Controls (PLCs).

**Practical schedule**

1. Introduction to hydraulic systems.
2. Study of hydraulic pumps.
3. Study of hydraulic actuators.
4. Study of hydraulic motors.
5. Study of hydraulic valves.
6. Study of colour codes and circuits.
7. Building simple hydraulic circuits.
8. Hydraulics in tractors.
9. Working and typical settings of tractor hydraulic system
10. Care and Periodic maintenance of tractor hydraulics system
11. Troubleshooting in tractor hydraulics
12. Introduction to pneumatics
13. Pneumaticsdevices
14. Pneumaticsin agriculture
15. Use of hydraulics for robotics.
16. Use of pneumatics for robotics

**Suggested Readings**


1. Kepner RA, Roy Bainer and Barger E. L. 2005. Principles of Farm Machinery. 3rd edition.CBS Publications and Distributors Pvt. Ltd.
2. Khurmi, R. S. and Khurmi, N. 2014.Hydraulics, Fluid Mechanics and Hydraulic Machines. S Chand Publications and Company Pvt. Ltd.
3. Er. R. K. Rajput. 2013. Text Book of Fluid Mechanics and Hydraulic Machines. S Chand Publications and Company Pvt. Ltd.


## Elfm. 4206 Precision Agriculture and Management 3(2+1)

**Objective:**

To impart basic knowledge in Precision Agriculture, use of GIS based or sensor based modern equipment for precision farming, system approach in machinery selection and improve the related problem solving skills.

**Theory**

**Module I** **(6 Hours)**

Precision Agriculture – need and functional requirements. Familiarization with issues relating to natural resources.

**Module II** **(10 Hours)**

Familiarization with equipment for precision agriculture including sowing and planting machines, power sprayers, land clearing machines, laser guided land levellers, straw-chopper, straw-balers, grain combines, etc.

**Module III** **(8 Hours)**

Introduction to GIS based precision agriculture and its applications. Introduction to sensors and application of sensors for data generation. Database management.

**Module IV** **(8 Hours)**

System concept. System approach in farm machinery management, problems on machinery selection, maintenance and scheduling of operations. Application to PERT and CPM for machinery system management

**Practical**

Familiarization with precision agriculture problems and issues. Familiarization with various machines for resource conservation. Solving problems related to various capacities, pattern efficiency, system limitation, etc. Problems related to cost analysis and inflation and problems related to selection of equipment, replacement, break-even analysis, time value of money etc.

**Lecture schedule**

1. Introduction to Precision Agriculture
2. Precision Agriculture: Need and functional requirements.
3. Concept of Protected Cultivation
4. Climate control in protected cultivation
5. Familiarization with natural resources.
6. Issues relating to natural resources.
7. Familiarization with equipment for precision agriculture.
8. Sowing machines
9. Planting machines
10. Sprayers and power sprayers
11. Land clearing machines
12. Laser guided land levellers
13. Straw-chopper
14. Straw-balers
15. Grain combines
16. Machines for Intercultural operations
17. Horticultural tools, etc.
18. Introduction to GIS based precision agriculture
19. Methods of Remote Sensing
20. Applications of GIS in precision agriculture.
21. Introduction to sensors.
22. Application of sensors for data generation.
23. Integrated electronic communications for Tractor and equipments
24. Variable Rate Technology
25. Familiarization with image processing and data interpretation
26. Database management.
27. System concept.
28. System approach in farm machinery management

29. Problems on machinery selection.
30. Farm machinery maintenance.
31. Scheduling of operations.
32. Application to PERT and CPM for machinery system management.

**Practical schedule**

1. Familiarization with precision agriculture.
2. Familiarization with problems and issues of precision agriculture.
3. Familiarization with various machines for resource conservation.
4. Familiarization with protected cultivation – Greenhouse, Glasshouse etc.
5. Problem solving on GIS.
6. Integrated electronic communications for Tractor and equipments
7. Variable Rate Technology
8. Familiarization with image processing and data interpretation
9. Solving problems related to system limitation.
10. Problems related to cost analysis.
11. Problems related to inflation
12. Problems related to selection of equipment.
13. Problems related to replacement of equipment.
14. Problems related to break-even analysis.
15. Problems related to time value of money etc.
16. Problems related to PERT and CPM.

**Suggested Readings**


1. Jana, B. L., 2008. Precision Farming. AgroTech Publishing Academy.
2. Brahma Singh, Balraj Singh, Naved Sabir and Murtaza Hasan, 2014. Advances in Protected Cultivation. New India Publishing Agency, New Delhi.
3. Donell Hunt, 2013.Farm Power and Machinery Management. 10th edition. MedTec Publishers, New Delhi.
4. Kali Charan Sahu, 2008. Text Book of Remote Sensing and Geographical Information Systems. Atlantic Publishers and Distributors Pvt Ltd.
5. K. Radha Manohar and C. Ignathinathane. 2015. Greenhouse Technology and Management. 2nd edition. B. S. Publications.
6. Zelenin, A. N., Balovnev, V. I. and Kerov, I. P. 1986. Machines for Moving the Earth. Oxian Press, New Delhi.
7. Robert *et.al.* 2011. Precision Farming Tools: Variable-Rate Application. Virginia Cooperative Extension. Publ. 442-505. Online Address : https://pubs.ext.vt.edu/442/442-505/442-505_PDF.pdf


## Elfm. 4207 Photovoltaic Technology and Systems 3(2+1)

**Objective**

To impart basic knowledge in Solar PV Technology, its effective use, commercial installation, components and improve the related problem solving skills.

**Theory**

**Module I** **(8 Hours)**

Solar PV Technology: Advantages, Limitations, Current Status of PV technology, SWOT analysis of PV technology. Types of Solar Cell, Wafer based Silicon Cell, Thin film amorphous silicon cell Thin Cadmium Telluride (CdTe) Cell, Copper Indium Gallium Selenide (CiGS) Cell, Thin film crystalline silicon solar cell.

**Module II** **(8 Hours)**

Solar Photo Voltaic Module: Solar cell, solar module, solar array, series & parallel connections of cell, mismatch in cell, fill factor, effect of solar radiation and temperature on power output of module, I-V and power curve of module.

**Module III** **(8 Hours)**

Balance of Solar PV system: Introduction to batteries, battery classification, lead acid battery, Nickel Cadmium battery, comparison of batteries, battery parameters, and Charge controller: types of charge controllers, function of charge controller, PWM type, MPPT type charge controller, Converters: DC to DC converter and DC to AC converter.

**Module IV** **(8 Hours)**

Application of Solar PV system. Solar home lighting system, solar lantern, solar fencing, solar street light, solar water pumping system, Roof top solar photovoltaic power plant and smart grid.

**Practical**

Study of V-I characteristics of solar PV system, smart grid technology and application, manufacturing technique of solar array, different DC to DC and DC to AC converter, domestic solar lighting system, various solar module technologies, safe measurement of PV modules electrical characteristics and Commissioning procedure for complete solar PV system.

**Lecture Schedule**

1. Solar PV Technology.
2. Solar PV Technology: Advantages, Limitations, Current Status of PV technology
3. SWOT analysis of PV technology.
4. Types of Solar Cell, Wafer based Silicon Cell,
5. Thin film amorphous silicon cell and Thin Cadmium Telluride (CdTe) Cell.
6. Copper Indium Gallium Selenide (CiGS) Cell, Thin film crystalline silicon solar cell.
7. Solar Photo-Voltaic Module: Solar cell.
8. Solar module, solar array.
9. Series and parallel connections of cell.
10. Mismatch in cell, fill factor.
11. Effect of solar radiation and temperature on power output of module
12. Effect of solar radiation and temperature on power output of module
13. I-V and power curve of module.
14. I-V and power curve of module.
15. Balance of Solar PV system: Introduction to batteries.
16. Battery classification,
17. Lead acid battery,
18. Nickel Cadmium battery
19. Comparison of batteries and battery parameters.

20. Charge controller: types of charge controllers
21. Functions of charge controller, PWM type.
22. MPPT type charge controller.
23. Converters: DC to DC converter.
24. DC to AC type converter.
25. Applications of Solar PV system
26. Solar home lighting system
27. Solar lantern, solar street light.
28. Solar fencing.
29. Solar water pumping system.
30. Roof top solar photovoltaic power plant
31. Smart grid.
32. Smart grid.

**Practical schedule**

1. Estimation of energy demand by a load.
2. Study of I-V characteristics of solar PV system.
3. PV cell manufacturing technology.
4. Efficiency of PV system.
5. Smart grid technology and its applications.
6. Procedure for building a solar cell array.
7. Procedure for maintaining optimum system voltage.
8. Construction and operation of DC to AC converters.
9. Construction and operation of solar pumping system.
10. Troubleshooting of PV modules.
11. Troubleshooting of PV modules.
12. Safety precautions for PV modules and solar array.
13. Switching and relays for PV system.
14. Switching and relays for PV system.
15. Electrical characteristics of solar PV system.
16. Commissioning procedure for complete solar PV system.

**Suggested Readings**


1. Rai GD. 1998. Non-conventional Sources of Energy. Khanna Pub.
2. Rathore N.S., Kurchania A.K., Panwar N.L. 2006. Renewable Energy: Theory & Practice, Himanshu Publications.
3. Solanki C.S. 2011. Solar Photovoltaic: Fundamentals, Technologies and Applications, PHI Learning Private Ltd.
4. Meinel & Meinel. Applied Solar Energy.
5. Derrick, Francis and Bokalders, Solar Photo-voltaic Products.
6. Buresch, Mathew. 1983. Photo-voltaic energy systems : Design and Installation. McGraw-Hill Book Company, New York.


## Elfm. 4208 Mechatronics 3(2+1)

**Objective**

To impart basic knowledge in mechatronics, different control systems associated, sensors and output signals, modelling, robotics and improve the related problem solving skills.

**Theory**

**Module I** **(8 Hours)**

Definition of mechatronics, measurement system, control systems, microprocessor based controllers, mechatronics approach. Sensors and transducers, performance terminology, Displacement, Position & Proximity Sensors, photo-electric transducers, flow transducers, optical sensors and transducers.

**Module II** **(8 Hours)**

Actuators, Mechanical Actuation Systems, Hydraulic & Pneumatic Actuation Systems, Electrical Actuation Systems, A.C. Motor, D.C. Motor, Stepper Motor. Signal conditioning process, filtering digital signal, multiplexers, data acquisition, digital signal processing, measurement system, pulse modulation, data presentation systems.

**Module III** **(8 Hours)**

System modelling & control, Mathematical Models, Engineering Systems, Electro-mechanical & Hydraulic-mechanical Systems, Modelling Dynamic Systems, Transfer Functions, Control Modes, PID Controller. Micro-processor & computer, Computer and Interfacing, Micro-computer Structure, Micro-controllers, Application of Microcontrollers, PLC.

**Module IV** **(8 Hours)**

Robotics, Robot components, robot classification and specification, Work envelopes, other basic parameters of robots. Robot applications, Robot applications in manufacturing, Material transfer and machine loading/unloading, Processing operations like Welding & painting, Assembly operations, Inspection automation, Future applications.

**Practical**

Selection of sensor for a particular application from Catalogue/Internet. Design a mechatronics product/system and incorporate application of mechatronics for enhancing product values. To study the hardware and software of mechatronics kit. To move a table in X-direction within the range of proximity sensors using Control-X software. To run a motor with PLC. To run a conveyor with computer. To study the movement of actuating cylinders and sensors.

**Lecture Schedule**

1. Definition of mechatronics, measurement system.
2. Control systems, Microprocessor based controllers, mechatronics approach.
3. Sensors and transducers, performance terminology.
4. Displacement, Position & Proximity Sensors.
5. Photo-electric transducers and Flow transducers.
6. Optical sensors and transducers.
7. Actuators, Mechanical Actuation Systems.
8. Hydraulic & Pneumatic Actuation Systems
9. Electrical Actuation Systems, A.C. Motor, D.C. Motor, Stepper Motor.
10. Signal conditioning process, Filtering digital signal, multiplexers, data acquisition.
11. Digital signal processing, measurement system.
12. Pulse modulation,
13. Data presentation systems.
14. System modelling & control.
15. Mathematical Models.

16. Engineering Systems.
17. Electro-mechanical Systems.
18. Hydraulic-mechanical Systems
19. Modelling Dynamic Systems, Transfer Functions,
20. Control Modes, PID Controller.
21. Micro-processor & computer
22. Computer and Interfacing.
23. Micro-computer Structure
24. Micro-controllers.
25. Application of Microcontrollers, PLC.
26. Robotics, Robot components.
27. Robot classification and specification,
28. Work envelopes, other basic parameters of robots.
29. Robot applications, Robot applications in manufacturing.
30. Material transfer and machine loading/unloading.
31. Processing operations like Welding & painting.
32. Assembly operations, Inspection automation, Future applications.

**Practical Schedule**

1. Selection of sensor for a particular application from Catalogue/Internet.
2. Design a mechatronics product/system.
3. Design a mechatronics product/system.
4. Incorporation of application on mechatronics product for enhancing product values.
5. Incorporation of application on mechatronics product for enhancing product values.
6. Working of A.C. Motor, D.C. Motor, Stepper Motor
7. To study on Mathematical Models.
8. To study the hardware of mechatronics kit.
9. To study the software of mechatronics kit.
10. To study Engineering Systems.
11. Modelling Dynamic Systems.
12. To move a table in X-direction within the range of proximity sensors using Control-X software.
13. To run a motor with PLC.
14. To run a conveyor with computer.
15. To run a conveyor with computer
16. To study the movement of actuating cylinders and sensors.

**Suggested Readings**


1. Bolton, W. 2004.Mechatronics. Pearson Education Asia.
2. Wolfram, Stadler. 1995. Analytical Robotics and Mechatronics. Mc-Graw Hill.
3. Doeblin E.O. 2004. Measurement Systems. Mc-Graw Hill.
4. Mahind, A.P. 1992. Introduction to Digital Computer Electronics. TMH.
5. Niku, S.Y. 2009.Introduction to Robotics: Analysis, systems and applications", Pearson Education Asia.
6. Craig, J.J. 2008.Introduction to Robotics. Pearson Education Asia.

## Department of Irrigation and Drainage Engineering- Core Courses

### Iden. 1101 Engineering Mechanics 3(2+1)

**Objectives**

- To apply the principles of mechanics to practical engineering problems, identify the structural system, develop a simple mathematical model and carry out its analysis.
- To provide basic concepts and principles of strength of materials.

**Theory**

**Module I** **(5 Hours)**

Basic concepts of Engineering Mechanics. Force systems, Resultant of forces, Moment of a force, Varignon's theorem, Parallel force and couples, Free body diagram and equilibrium of forces.

**Module II** **(8 Hours)**

Centroid, Moment of inertia, Frictional forces and its application, Analysis of simple framed structures using methods of joints, methods of sections and graphical method.

**Module III** **(8 Hours)**

Simple stresses and strains: Elastic constants, Analysis of plane and complex stresses.

**Module IV** **(11 Hours)**

Shear force and bending moment diagrams for determinate structures. Stresses in beams, Torsion, Helical springs.

**Practical**

Numerical problems on composition and resolution of forces, Magnitude and direction of the resultant force graphically, Position of the resultant force by Varignon's theorem, Problems relating to resultant of force systems, Equilibrium of concurrent – co-planar and non concurrent – co-planar force systems; Numerical problems on centroids of plane figures, symmetrical and unsymmetrical sections; Numerical problems on moment of inertia, section modulus, polar moment of inertia, radius of gyration, Numerical problems on frictional forces, ladder and wedge friction; Analysis of simple trusses by method of joints and method of sections; Analysis of simple trusses by graphical method; Numerical problems on simple stresses and strains; Mohr's Circle for two-dimensional stress systems; Numerical problems on shear force and bending moments; Numerical problems on bending and shearing stresses in beams; Problems on torsion of shafts and helical springs.

**Lecture Schedule**

1. Fundamentals of engineering mechanics – Force – Effects of a force – Characteristics of a force. Particle, Rigid body. Systems of forces. Principle of physical independence of forces. Principle of transmissibility of forces.
2. Resultant of a system of forces, Method of resolution. Resolved components and resolved parts of a force. Theorem of resolved parts and its applications. Numerical problems.
3. Moments and its applications – Moment of a force. Geometrical representation of moment of a force. Varignon's theorem and its applications. Corollaries of Varignon's theorem. Position of resultant force. Numerical problems.

4. Parallel forces – Resultant of two like and two unlike parallel forces. Centre of parallel forces, Couple – Types of couples, moment of a couple characteristics of a couple. Theorems for couples.
5. Equilibrium of forces – Resultant and equilibrant conditions of equilibrium – Principles of equilibrium. Lami's theorem and its applications. Numerical problems. Stable, unstable and neutral equilibrium.
6. Centre of gravity – Centre of gravity of plane sections from geometrical considerations. Centre of gravity of geometrical sections. Reference axes and axes of symmetry. Centre of gravity by the method of moments. Centre of gravity of sections with cut out holes. Numerical problems.
7. Moment of inertia – Units of M.I, Radius of gyration and Modulus of section. M.I. of plane sections by Routhe's rule. M.I. by the method of integration. M.I. of a rectangular section. Perpendicular axis theorem. M.I. of a circular section. M.I. of hollow rectangular and circular section. Numerical problems.
8. Parallel axis theorem and its applications. M.I. of a triangular section about its base, centre of gravity and vertex. M.I. of a semicircular section. Numerical problems.
9. Friction – Types of friction – Limiting friction. Laws of static and dynamic friction. Angle of friction, cone of friction. Friction of bodies on inclined planes -various cases. Numerical problems.
10. Ladder, Wedge and screw jack friction. Numerical problems.
11. Analysis of perfect frames – Types of frames. Assumptions for the analysis of frames. Equation for a perfect frame. Analytical methods – Method of joints and method of sections.
12. Analysis of perfect frames by method of joints. Numerical Problems.
13. Analysis of perfect frames by the method of sections. Numerical problems.
14. Simple stresses and strains – elasticity – stress – strain relationship – types of stresses – Hooke's law – Young's modulus – problems.
15. Elongation in a bar due to its own weight, varying sections – problems.
16. Linear strain – lateral strain – Poisson's ratio – Volumetric strain of a body subjected to three mutually perpendicular stresses – problems.
17. Stress on inclined sections of a bar under tension or compression – state of simple shear – linear strain of the diagonal.
18. Bulk modulus – relation between elastic constants E, K and N – problems.
19. Principal planes – principal stresses – derivation.
20. Mohr's circle – problems.
21. Shear force and bending moment diagrams for cantilever beams – problems.
22. Shear force and bending moment diagrams for simply supported beams – problems
23. SFD and BMD for overhanging beams – problems.
24. Relation between SF, BM and intensity of load – derivation of the equation.
25. Bending stresses in beams – theory of simple bending – neutral axis – moment of resistance – assumptions for bending analysis.
26. Bending stresses in beams of various sections – strength of a section – problems.
27. Shear stress in beams – derivation of the equation for shear stress.
28. Shear stresses in beams of various sections – problems.
29. Torsion-derivation of the torsional equations
30. Power transmitted by a shaft.
31. Strength of a solid shaft and a hollow shaft – problems in the design of shaft.
32. Close and open coiled springs – derivation – problems.

**Practical Schedule**

1. Resultant of forces in magnitude and direction
2. Graphical study of equilibrium of forces
3. Graphical study of wedge friction
4. Determination of position of resultant force (numerical problems)
5. Numerical problems on centroids and moment of inertia of plane figures, radius of gyration, section modulus and polar moment of inertia, for plane figures, symmetrical and unsymmetrical sections
6. Numerical problems on frictional forces, ladder and wedge friction
7. Analysis of simple trusses by method of joints
8. Analysis of simple trusses by method of sections
9. Analysis of simple trusses by graphical method
10. Numerical problems on simple stresses and strains
11. Determination of resultant stresses for one-dimensional and two-dimensional stress systems
12. Determination of principal stresses and maximum shear stress for two-dimensional stress systems
13. Numerical problems on shear force and bending moments
14. Numerical problems on bending and shearing stresses in cantilever beams
15. Numerical problems on bending and shearing stresses in simply supported beams
16. Problems on torsion of shafts and springs.

**References**


1. Khurmi R.S. 2001. Strength of Materials S. Chand & Co., Ltd., New Delhi.
2. Sundarajan V 2002.Engineering Mechanics and Dynamics.Tata McGraw Hill Publishing Co. Ltd., New Delhi.
3. Timoshenko S and Young D H 2003. Engineering Mechanics. McGraw Hill Book Co., New Delhi.
4. Prasad I B 2004.Applied Mechanics.Khanna Publishers, New Delhi.
5. Prasad I B 2004.Applied Mechanics and Strength of Materials.Khanna Publishers, New Delhi.
6. Bansal R K 2005.A Text Book of Engineering Mechanics.Laxmi Publishers, New Delhi.
7. Khurmi, R. S. 2014 A Text Book of Engineering Mechanics, S. Chand and Co. New Delhi.
8. Ramamrutham, S.A 2015 Text Book of Applied Mechanics, DhanpatRai and Sons, New Delhi.
9. Ramachandra. 2013 Applied Mechanics, Standard Publishers and Distributors, New Delhi.
10. Prasad, I. B. 2012 A Text Book of Applied Mechanics, Khanna Publishers, New Delhi.
11. Bansal, R. K.2014 Engineering Mechanics and Strength of Materials, Laxmi Publications, New Delhi.
12. Kumar, K. L. 2010 Engineering Mechanics, Tata McGraw Hill Publishing Company, New Delhi.
13. Timoshenko, 2010 Strength of Materials Vol .I & II, CBS Publishers &Distributers, New Delhi

## Iden. 1202 Fluid Mechanics and Open Channel Hydraulics 3(2+1)

**Objectives**

- To understand the basic principles, fundamental concepts and theories of fluid mechanics
- To familiarize the behavior of the fluids at rest as well as in motion
- To impart knowledge on static, kinematics and dynamic aspects of fluids

**Theory**

**Module I** **(9 Hours)**

Properties of fluids: Ideal and real fluid. Pressure and its measurement, Pascal's law, pressure forces on plane and curved surfaces, centre of pressure, buoyancy, meta centre and meta centric height, condition of floatation and stability of submerged and floating bodies.

**Module II** **(8 Hours)**

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

**Module III** **(8 Hours)**

Laminar and turbulent flow in pipes, general equation for head loss, Darcy Equation, Minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic gradient and energy gradient; Flow through orifices (Measurement of Discharge, Measurement of Time), Flow through Mouthpieces, Flow over Notches, Flow over weirs, Chezy's formula for loss of head in pipes, Flow through simple and compound pipes.

**Module IV** **(7 Hours)**

Open channel design and hydraulics: Chezy's formula, Bazin's formula, Kutter's Manning's formula, Velocity and Pressure profiles in open channels, Hydraulic jump; Dimensional analysis and similitude: Rayleigh's method and Buckingham's 'Pi' theorem, types of similarities, dimensional analysis, and dimensionless numbers.

**Practical**

Study of manometers and pressure gauges; Verification of Bernoulli's theorem; Determination of coefficient of discharge of venturi-meter and orifice meter; Determination of coefficient of friction in pipeline; Determination of coefficient of discharge for rectangular and triangular notch; Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice; Determination of coefficient of discharge for mouth piece; Determination of meta-centric height, Study of current meter; Velocity distribution in open channels and determination of Manning's coefficient of rugosity.

**Lecture Schedule.**

1. Definition and classification of fluid, properties of fluid – mass density, specific weight, specific volume and specific gravity
2. Viscosity, Newton's law of viscosity, Surface tension and capillarity
3. Fluid pressure at a point, Pascal's law, Pressure variation in a fluid at a point, absolute, gauge, atmospheric and vacuum pressure
4. Measurement of pressure-manometers. Differential manometers and mechanical gauges

5. Hydrostatistics – total pressure and centre of pressure
6. Pressure on immersed surfaces-vertical plane surface, inclined surface
7. Curved surface and pressure diagrams
8. Buoyancy and flotation-expression for buoyant force and centre of buoyancy
9. Metacentre and determination of metacentric height-experimental and analytical method
10. Principle of flotation and stability of floating and submerged bodies
11. Kinematics-types of fluid flow-steady, unsteady, uniform and non-uniform flows, Laminar and turbulent flows, compressible and incompressible flows
12. Rotational and irrotational flows, one, two and three dimensional flows, vorticity, vortex motion-free vortex and forced vortex
13. Lagrangin and Eulirian description of fluid motion-continuity equation-continuity equation in three dimensions, velocity and acceleration
14. Path lines, streak lines and stream lines, velocity potential function and stream function
15. Dynamics of fluid flow – Eulers and Bernoulli's equation of motion, application of Bernoulli's equation-venturimeter,
16. Orifice meter, nozzle meter and pitot tube
17. Flow measuring devices-orifices and mouthpieces, notches and weirs classification and flow through them.
18. Flow through pipes – laminar and turbulent flow, head loss in pipes-major and minor losses
19. Hydraulic gradient and total energy line, flow through net work of pipes
20. Power transmission through pipes,
21. Dimensional analysis and similitude – units and dimensions, dimensional homogeneity
22. Rayleigh's method, example problems
23. Buckingham's method, example problems
24. Types of similarities and similitude
25. Dimensionless numbers-Reynold's number, Froude number, Euler's number, Weber's number and Mach's number.
26. Open channel flow-types of flow in channels, velocity distribution
27. Measurement of velocity in channels
28. Current meter, parshall flumes, cut throat flumes and venturiflumes,
29. Chezy's and Manning's equation
30. Most economical section of channels-Rectangular and trapezoidal.
31. Triangular and circular channel.
32. Specific energy , critical depth and hydraulic jump

**Practical Schedule**

1. Determination of viscosity
2. Study of manometers and pressure gauges;
3. Verification of pascal's law
4. Determination of hydrostatic forces on plane surface
5. Verification of Archimedes law
6. Determination of meta-centric height;
7. Verification of Bernoulli's theorem;
8. Determination of coefficient of discharge of venturi-meter and orifice meter;
9. Determination of coefficient of friction in pipeline;
10. Determination of minor losses
11. Determination of coefficient of discharge for rectangular and triangular notch;

12. Calibration of rectangular and triangular notch
13. Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice;
14. Determination of coefficient of discharge for mouth piece;
15. Determination of Manning's and chezy'sconstant in open channels.
16. Study of current meter, parshall flumes, cut throat flumes and venturiflumes,

**Suggested Readings**


1. Khurmi R .S. 1970. A Text Book of Hydraulics, Fluid Mechanics and Hydraulic Machines S. Chand & Company Limited, New Delhi.
2. Modi P M and Seth S.M.1973.Hydraulics and Fluid Mechanics. Standard Book House, Delhi.
3. Chow V T 1983. Open Channel Hydraulics. Mc Graw Hill Book Co., New Delhi.
4. Lal Jagadish 1985. Fluid Mechanics and Hydraulics. Metropolitan Book Co. Pvt. Ltd., New Delhi.
5. Bansal, R K. 2010 A text book of fluid mechanics and Hydraulic machines. Laxmi Publications (P) Ltd. New Delhi.


## Iden. 1203 Strength of Materials 2(1+1)

**Objectives**

- To equip the students with the comprehensive methods of structural analysis with emphasis on analysis of elementary structures.
- To give an ability to apply the knowledge of strength of materials on engineering application and design problems.

**Theory**

**Module I** **(8 Hours)**

Slope and deflection of beams using double integration method, Macaulay's method, moment area method and conjugate beam method.

**Module II** **(3 Hours)**

Columns and Struts. Rankines formula, Combined bending and axial stresses, Stability of masonry dams.

**Module III** **(5 Hours)**

Analysis of statically intermediate beams. Propped beams. Fixed and continuous beam analysis using superposition, three moment equation and moment distribution methods.

**Practical**

To perform the tension test on M. S. and TMT specimens, to observe the behaviour of materials under load, to calculate the value of E, ultimate stress, permissible stress, percentage elongation etc. and to study its fracture; To perform the compression test on; concrete cylinders &cubes; To perform the bending test on the specimens; M.S. girder, timber beam, R.C.C. beam, and to determine the various physical and mechanical properties; To determine modulus of elasticity of beam using Maxwell's reciprocal theorem; Determination of Modulus of Rigidity of M.S. specimen (torsion test); To study load deflection and other physical properties of closely coiled helical spring in tension and compression; To perform the Rockwell and Brinell's Hardness tests on the given specimens; To perform the Drop Hammer Test, Izod Test and Charpy's impact tests on the given

specimens; To measure workability of concrete by slump test and compaction factor test; To write detail report emphasizing engineering importance of performing tension, compression, bending, torsion, impact and hardness tests on the materials.

**Lecture Schedule**

1. Deflections of beams – relation between slope, deflection and radius of curvature.
2. Deflection of cantilever beams –Problems.
3. Deflection of simply supported beams –Problems
4. Deflection by Macaulay's method – Problems.
5. Deflection by moment area method – Mohr's theorem –cantilever beams – Problems.
6. Deflection by moment area method – Mohr's theorem – simply supported beams – Problems.
7. Deflection by conjugate beam method, cantilever beams – Problems
8. Deflection by conjugate beam method, simply supported beams – Problems
9. Combined bending and direct stresses – eccentric loading – limit of eccentricity – middle third rule for rectangular and other sections.
10. Condition for no tension in the sections – Problems.
11. Stability of masonry dams.
12. Columns and struts – assumptions for Euler's column theory – derivation for buckling load for four cases of long columns.
13. Rankine's formula for long columns – Problems.
14. Statically indeterminate beams – Analysis of fixed beams – problems
15. Analysis of continuous beams by Clapeyron's three moment theorem – problems
16. Analysis of continuous beams by Clapeyron's three moment theorem – problems

**Practical Schedule**

1. To perform the tension test on M. S. and TMT specimens, to observe the behaviour of materials under load, to calculate the value of E, ultimate stress, permissible stress, percentage elongation etc. and to study its fracture
2. To perform the compression test on concrete cylinders &cubes
3. To perform the bending test on the specimens M.S. Girder, Timber beam, R.C.C. beam, and to determine the various physical and mechanical properties
4. To determine modulus of elasticity of beam using Maxwell's reciprocal theorem
5. Determination of Modulus of Rigidity of M.S. specimen (torsion test)
6. To study load deflection and other physical properties of closely coiled helical spring in tension and compression
7. To perform the Rockwell and Brinell's Hardness tests on the given specimens
8. To perform the Drop Hammer Test, Izod Test and Charpay's impact tests on the given specimens
9. To measure workability of concrete by slump test and compaction factor test
10. To determine the initial and final setting time for cement.
11. Numerical Problems on slope and deflection by using double integration method.
12. Numerical Problems on slope and deflection by Macaulay's method
13. Numerical Problems on slope and deflection by moment area method and conjugate beam method.
14. Numerical Problems on fixed beam for the construction of BMD and SFD
15. Numerical Problems on continuous beam by Clapeyrons, three moment equation
16. Numerical Problems on continuous beam by moment distribution methods.

**Suggested Readings**


1. Khurmi R.S. 2001. Strength of Materials S. Chand & Co., Ltd., New Delhi.
2. Junarkar S.B. 2001.Mechanics of Structures (Vo-I& II). Choratar Publishing House, Anand.
3. Ramamrutham S. 2003. Strengths of Materials.DhanpatRai and Sons, NaiSarak, New Delhi.
4. S.Ramamrutham&R.Narayan, 2011. Theory of Structures, DhanpatRaiPublishing Company (P) Ltd.
5. Khurmi, R.S. 2010. Theory of Structures, S. Chand & Co., Ltd., New Delhi.


## Iden. 2104 Building Construction and Cost Estimation 2(2+0)

**Objective**

- To study the properties of building materials, the fundamentals of building construction, building components and the basics of estimation and valuation

**Theory**

**Module I** **(11 Hours)**

Building Materials: Rocks, Stones, Bricks; Tiles, Lime, Cement, Concrete, Sand. Glass, Rubber, Plastics, Iron, Steel, Aluminium &Timber – types, properties and uses.

**Module II** **(5 Hours)**

Building construction: Stone masonry, Brick masonry
Building components: Lintels, Arches, stair cases

Mid-term Examination

**Module III** **(6 Hours)**

Doors and windows, Roofs, Different types of floors and floorings, Damp proofing and water proofing, Plastering, pointing, white washing, distempering and painting,
Functional requirements of a building, important building components, building construction, Types of agricultural buildings and related needs.

**Module IV** **(10 Hours)**

Estimating principle: Methods of estimating, Main items of work, Types of estimates– Preliminary estimates, Detailed Estimates of Buildings, estimate of a small building, Schedule of rates, Analysis of rate, Valuation.

**Lecture Schedule.**

1. Stone-classification of rocks – Natural bed of stone and its importance. Qualities of good building stone. Common building stones in India. Artificial stones. ISI tests for stones. Uses of stones.
2. Brick-Composition of good brick earth-Harmful ingredients in brick earth - classification of brick according to shape. IS classification – Qualities of good bricks.
3. Manufacture of bricks-Preparation of clay, Moulding, drying and burning. Burning in Hoffman's kiln.
4. Fire clay bricks. Substitute for bricks-concrete blocks, sand lime bricks and fly ash bricks. Qualities of good brick. ISI tests for bricks.
5. Tiles - Common types. Drain tiles, floor tiles and roof tiles. Lime-classification of lime-ISI classification. Uses of lime.

6. Cement-Properties of cement. Composition of cement, Functions of cement ingredients. Setting action of cement, ISI tests for cement -Uses of cement-Different types of cement.
7. Manufacture of cement-Mixing of raw materials-Dry and wet processes. Burning in rotary kiln. Grinding in ball mills and tube mills.
8. Cement concrete-Properties, materials required for C.C and R.C.C. Properties of concrete – W/c. ratio and its importance. Workability of concrete and its measurement. Mixing, transportation and placing of concrete. – curing of concrete – Mortar-types of mortar.
9. Sand, Glass – Types, properties and uses, Rubber, Plastics – Uses of plastics in buildings – P V C pipes and fiber glass reinforced plastics.
10. Iron – Steel – Market forms of steel – Properties of mild steel and hard steel – Uses of steel – Aluminium – Properties of aluminium – Evaluation as a building material – Economy of using aluminium
11. Timber – Qualities of good timber – Seasoning of timber– Preservation of timber – Market forms of timber – Industrial forms of Timber
12. Stone masonry – technical terms – classification of stone masonry –
13. Brick masonry – technical terms – Bonds in brickwork – Features of English bond and Flemish bond
14. Plan and elevation of English bond and Flemish bond for various wall thicknesses.
15. Arches – technical terms – Classification of Arches – Lintels – Types of lintels
16. Stairs – Technical terms used – Types of Stairs
17. Doors and Windows – Technical terms used – Types of Doors and Windows
18. Roofs – Classification of Roofs – Roofing materials – Different types of A C sheets, G I sheets and FRP sheets.
19. Floors and floorings – Types – Damp Proofing and water proofing – methods
20. Plastering, pointing, white washing distempering and painting,
21. Functional requirements of a building, important building components,
22. Types of agricultural buildings and related needs
23. Estimating principle, main items of work, deductions for openings
24. Earthwork calculations
25. R.C.C. work, Estimation for Flooring, Roofing, Plastering, Doors, Windows, Wood Work, Iron Work, Aluminum work and Lump sum items
26. Types of estimates, Detailed and abstract estimate
27. Method of building estimate – separate or individual wall method
28. Centre line method
29. Detailed estimate of a small building
30. Detailed estimate of a small building
31. Schedule of rates – Analysis of rates, Purpose and factors affecting the rate of items
32. Valuation, methods of valuation, book value, market value, scrap and salvage value

**Suggested Readings**


1. Rangwala S C. 1994. Engineering Materials.Charotar Publishing House, Anand
2. Rangwala, S. C. 2012. Building Construction, Charotar Publishing House, Anand.
3. Dutta, B. N. 2014. Estimating and Costing in Civil Engineering, UBS Publishers Pvt. Ltd., New Delhi.
4. Punmia, B.C., Ashok Kumar Jain and Arun Kumar Jain. 2012. Building Construction.Laxmi Publications (P) Ltd., New Delhi.
5. Duggal, S K. Building materials.New Age International Publishers.
6. Sane Y.S. Planning and Designing of Buildings.
7. Sharma, S. K. Building Construction, S. Chand & Co., Delhi.

8. Punmia, B. C. Building Construction, A. Sauraby and Company Pvt. Ltd., Delhi.
9. Sushil Kumar, Engineering Materials, Metropolitan Book Company, New Delhi.
10. Parbin Singh. Civil Engineering Materials, S. K. Kataria and Sons, Delhi
11. Chakrabrti, M. 2002. Estimating, Costing, Specification and Valuation on Civil Engineering. Calcutta.
12. I. S. 1200 – Methods of Measurement of Buildings and Civil Engineering Works.
13. I. S. I. – National Building Code of India.

## Iden. 2205 Design of Structures 2(1+1)

**Objectives**

- To learn the basic concepts of design and perform analysis and design of structural steel members and its connections.
- To understand the concepts of working stress method and to analyse and design reinforced concrete structural elements.

**Theory**

**Module I** **(6 Hours)**

Loads and use of BIS Codes. Design of riveted and welded connections. Design of structural steel members in tension, compression and bending.

**Module II** **(5 Hours)**

Analysis and design of singly and doubly reinforced sections, Shear, Bond and Torsion. Design of T Beams.

Mid-term Examination

**Module III** **(5 Hours)**

Slabs, Columns, Footings, Retaining walls and Silos.

**Practical**

Different types of steel sections for beams, tension members, compression members and built-up compression members– Different types of welded and riveted connections– Design and drawing of singly reinforced beam and doubly reinforced beam–T beams– Design and drawing of one way and two way slabs– Design and drawing of cantilever retaining wall.

**Lecture Schedule**

1. Design of steel structures – Concept of design of steel structures – Structural sections for steel – Use of IS codes and Hand books.
2. Riveted connections – Failures of riveted joints – Strength of a riveted joint – rivet value – Efficiency of the joint – Assumptions for the design of riveted connections – Design of riveted connections – Problems.
3. Welded connections – Parts of weld – Advantages and disadvantages of welded connections – Different types of welds –IS specifications for butt welds and fillet welds– Design of butt welds and fillet welds – Problems.
4. Design aspects of tension members – Effective net sectional area – Design of axially loaded tension members – Design problems.
5. Steel columns and compression members – Euler's crippling load – Merchant-Rankine formula – Slenderness ratio – Design aspects of axially loaded compression members and struts – Problems in axial load computation and design.
6. Analysis of steel beams – Use of relevant tables for the design – Design aspects of laterally unsupported beams only – Check for shear, deflection and bearing.

7. Design of concrete structures – Concept of analysis and design – Working stress method of design – Factor of safety based on stress and load – Grades of concrete and steel – characteristics of concrete and steel – Assumptions for the design of RCC structural elements.
8. Balanced and unbalanced sections – Balanced design – Balanced section as an economical and critical section – Fundamental equations for design – Design constants – Computation of design loads – Use of IS codes.
9. Analysis of singly reinforced beams –Different types of problems -- Design.
10. Analysis of doubly reinforced beams – problems – Revised elastic theory and steel beam theory
11. Analysis of T beams – Different types of problems.
12. Analysis of slabs – one way and two way – Problems – Design of two way slabs by IS code method only.
13. Design aspects of RCC columns – short and long –Problems.
14. Design aspects of RCC footings – Design problems – square footing only.
15. Retaining walls – Types – structural aspects.
16. Bins and silos – Structural aspects of RCC bins and silos.

**Practical**

1. Numerical problems on riveted connections
2. Numerical problems on welded connections
3. Numerical problems on tension members in steel
4. Numerical problems on compression members in steel
5. Numerical problems on simple beams in steel
6. Numerical problems on singly reinforced beam
7. Numerical problems on doubly reinforced beam
8. Design and detailing of singly reinforced beam
9. Numerical problems on T beam
10. Design and detailing of T beam
11. Design and detailing of one way simply supported slabs
12. Design and detailing of unrestrained two way slabs by IS code method
13. Design and detailing of restrained two way slabs by IS code method
14. Numerical problems on short columns in concrete by IS code method
15. Numerical problems on long columns in concrete by IS code method
16. Design and detailing of square column and footing

**Suggested Readings**


1. Ramamrutham, S. and Narayan, R. 2016.Design of Reinforced Concrete Structures, DhanpatRaiPublishing Co Pvt Ltd.
2. Vazirani, V.N.&.Ratwani, M.M. 2013. Design of Reinforced Concrete Structures.KhannaPublishers.
3. Ramamrutham, S.Design Of Steel Structures. DhanpatRai Publishing Company (p) Limited
4. Ramachandra, Design Of Steel Structures Vol. I & II. Scientific Publishers-Jodhpur
5. SushilKumar.2003. Treasure of R.C.C. Design. R.K. Jain. 1705-A, NaiSarak , Delhi-110006, P.B.1074.

## Iden. 2206 Irrigation Engineering 3(2+1)

**Objective**

- To acquaint and equip the students with the basic principles of Soil-Plant Water relations and their interactions and to develop competency to design water conveyance systems and surface irrigation systems in the field.

**Theory**

**Module I** **(5 Hours)**

Water resources utilization & Irrigation development, Major and medium irrigation schemes of India, purpose of irrigation, environmental impact of irrigation projects, source of irrigation water, measurement of irrigation water: weir, flumes, orifices and other methods;

**Module II** **(10 Hours)**

Open channel water conveyance system: design and lining of irrigation field channels. On farm structures for water conveyance, control & distribution; underground pipe conveyance system: components and design; land grading: criteria for land levelling, land levelling design methods, estimation of earth work;

**Module III** **(8 Hours)**

Soil water plant relationship: soil properties influencing irrigation management, soil water movement, infiltration, soil water potential, soil moisture characteristics, soil moisture constants, measurement of soil moisture, moisture stress and plant response; water requirement of crops: concept of evapotranspiration (ET), measurement and estimation of ET.

**Module IV** **(9 Hours)**

Irrigation requirement of crops, depth of irrigation, frequency of irrigation, irrigation efficiencies Surface methods of water application: border, check basin and furrow irrigation – adaptability, specification and design considerations.

**Practical**

Measurement of soil moisture by different soil moisture measuring instruments; Measurement of irrigation water; Measurement of infiltration characteristics; Determination of bulk density, Determination of Field capacity and wilting point; Estimation of evapotranspiration-Direct methods, Estimation of evapotranspiration-In direct methods. Land grading exercises, Design of underground pipeline system; Estimation of irrigation efficiency; Study of advance, recession and computation of infiltration opportunity time; Infiltration by inflow-outflow method; Evaluation of border irrigation method, Evaluation of furrow irrigation method; Evaluation of check basin irrigation method.

**Lecture Schedule**

1. Water resources utilization & Irrigation development – Present status, Irrigation Potential -Created and Utilized, Causes for gap in Potential created and utilized.
2. Irrigation-Definition, Purpose-Sources of irrigation water-Major and medium irrigation schemes of India.
3. Environmental impact of irrigation projects-Environmental Impact Assessment ,Inter Basin Water Transfer.

4. Measurement of irrigation water: Units of measurement – Methods of Water measurement in Open Channels – weir, flumes and orifices and other methods;
5. Flow measurement in pipes. Difference between Pipe Flow and Open Channel Flow
6. Open channel water conveyance system – Types of Open Channels – Types of Open Channel Flow
7. Design of irrigation field channels, Discharge capacity of a channel ,
8. Seepage in canals and field channels, Measurement of seepage in canals ,Materials for lining canals and field channels
9. On farm structures for water conveyance, control &distribution ;Drop Structures Chute Spillways Pipe Drop Spillways, Check Gates , Portable Check Dams ,Turnouts , Siphon Tubes , Flumes , Culverts ,Inverted Siphons
10. Cost analysis of surface Irrigation distribution systems
11. Underground pipe conveyance system: Advantages– Types of pipes for underground pipeline system-Testing of pipes-Discharge capacity, Underground pipeline structures.
12. Design of underground pipe conveyance system-Laying out of Underground Pipeline System – Operation and Maintenance of Underground Pipeline Systems, Cost analysis
13. Land Levelling - Leveling Layout of field for Irrigation and Drainage Systems – Survey and Staking – criteria for land levelling,
14. Land levelling design methods – Plane Method , Profile Method, Plan Inspection Method, Contour Adjustment Method
15. Land levelling design methods-contd, Estimation of earth work-Equipments for Land Grading
16. Soil water plant relationship – soil properties influencing irrigation management,soil Water Relations
17. Kinds of Soil Water, soil water movement-steady and unsteady flow.
18. Infiltration Characteristics of the soil – Infiltration Process – Infiltration Equations
19. Measurement of Infiltration – Factors Affecting Infiltration
20. Soil water potential – Soil Moisture Constants
21. Soil moisture characteristics, Measurement of soil moisture,
22. Water requirement of crops, Concept of evapotranspiration (ET)-Different terminologies-Actual ET, PET, Consumptive use.
23. Estimation and measurement of ET-Direct methods.
24. Indirect methods of estimation of ET.
25. Water and irrigation requirement of crops,Depth of irrigation, frequency of irrigation, Irrigation interval, Irrigation period.
26. Irrigation efficiencies
27. Surface methods of water application-Border – adaptability, specification.
28. Border system – design considerations.
29. Surface methods of water application – Check Basin – adaptability, specification.
30. Check Basin – design considerations.
31. Surface methods of water application-Furrow – adaptability, specification
32. Furrow-design considerations

**Practical**

1. Measurement of soil moisture by different soil moisture measuring instruments;
2. Measurement of soil moisture by different soil moisture measuring instruments;
3. Measurement of irrigation water;
4. Measurement of infiltration characteristics;
5. Determination of bulk density,
6. Determination of Field capacity and wilting point;
7. Estimation of evapotranspiration-Direct methods.

8. Estimation of evapotranspiration-In,Direct methods.
9. Land grading exercises
10. Design of underground pipeline system;
11. Estimation of irrigation efficiency;
12. Study of advance, recession and computation of infiltration opportunity time;
13. Infiltration by inflow-outflow method;
14. Evaluation of border irrigation method;
15. Evaluation of furrow irrigation method;
16. Evaluation of check basin irrigation method.

**Suggested Readings**


1. Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing House New Delhi.
2. MajumdarD. K.2013. IrrigationWater Management Principles.PHI learning Private Limited New Delhi 2nd Edition.
3. Allen R. G., L. S. Pereira, D. Raes, M. Smith. 1998. Crop Evapotranspiration guidelines for computing crop water requirement. Irrigation and drainage Paper 56, FAO of United Nations, Rome.
4. Murthy VVN. 2013. Land and Water Management Engineering. Kalyani Publishers, New Delhi.
5. Israelsen O.W,and Hansen V. E and Stringham G. E. 1980.Irrigation Principles and Practice, John Wiley & Sons, Inc. USA.


**Iden. 3107 Sprinkler and Micro - Irrigation Systems 2(1+1)**

**Objectives**

- To introduce the concept of micro - irrigation
- To design Sprinkler and Drip irrigation systems

**Theory**

**Module I** **(6 Hours)**

Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems; design of sprinkler irrigation system: layout selection, hydraulic design of lateral, sub-main and main pipe line, design steps; selection of pump and power Module for sprinkler irrigation system; performance evaluation of sprinkler irrigation system: uniformity coefficient and pattern efficiency;

**Module II** **(5 Hours)**

Micro Irrigation Systems: types-drip, spray, & bubbler systems, merits and demerits, different components; Design of drip irrigation system: general considerations, wetting patterns, irrigation requirement, emitter selection, hydraulics of drip irrigation system, design steps; necessary steps for proper operation of a drip irrigation system;

**Module III** **(5 Hours)**

Maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment; fertigation: advantages and limitations of fertigation, fertilizers solubility and their compatibility, precautions for successful fertigation system, fertigation frequency, duration and injection rate, methods of fertigation.

**Practical**

Study of different components of sprinkler irrigation system; design and installation of sprinkler irrigation system; determination of precipitation pattern, discharge and uniformity coefficient; cost economics of sprinkler irrigation system; study of different components of drip irrigation; design and installation of drip irrigation system; determination of pressure discharge relationship and emission uniformity for given emitter; study of different types of filters and determination of filtration efficiency; determination of rate of injection and calibration for chemigation/fertigation; design of irrigation and fertigation schedule for crops; field visit to micro irrigation system and evaluation of drip system; cost economics of drip irrigation system.

**Lecture Schedule**

1. Sprinkler irrigation: adaptability, problems and prospects
2. Types of sprinkler irrigation systems
3. – 4.Design of sprinkler irrigation system: layout selection, hydraulic design of lateral, sub-main and main pipe line
5. Design steps; selection of pump and power module for sprinkler irrigation system
6. Performance evaluation of sprinkler irrigation system: uniformity coefficient and pattern efficiency
7. Micro-Irrigation Systems: types-drip, spray, & bubbler systems, merits and demerits
8. Micro Irrigation Systems: different components
9. – 10. Design of drip irrigation system: general considerations, wetting patterns,
11. Design of drip irrigation system: irrigation requirement, emitter selection
12. Hydraulics of drip irrigation system
13. Design steps; necessary steps for proper operation of a drip irrigation system
14. Maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment
15. Fertigation: advantages and limitations of fertigation, fertilizers solubility and their compatibility, precautions for successful fertigation system
16. Fertigation frequency, duration and injection rate. Methods of fertigation.

**Practical Schedule**

1. Study of different components of sprinkler irrigation system
2. -3. Design and installation of sprinkler irrigation system
4. Determination of precipitation pattern, discharge and uniformity coefficient
5. Cost economics of sprinkler irrigation system
6. Study of different components of drip irrigation
7. –8. Design and installation of drip irrigation system
9. Determination of pressure discharge relationship and emission uniformity for given emitter
10. Study of different types of filters
11. Determination of filtration efficiency
12. Determination of rate of injection and calibration for chemigation/fertigation
13. Design of irrigation and fertigation schedule for crops
14. Field visit to micro- irrigation system
15. Evaluation of drip system
16. Cost economics of drip irrigation system.

**Suggested Readings**


1. Keller Jack and Bliesner Ron D. 2001. Sprinkle and Trickle Irrigation. Springer Science+ business Media, New York .
2. Mane M.S. and Ayare B.L.2007. Principles of Sprinkler Irrigation systems, Jain Brothers, New Delhi.
3. Mane M.S and Ayare B.L. and MagarS.S.2006.Principles of Drip Irrigation systems, Jain Brothers, New Delhi.
4. Michael AM, Shrimohan and KR Swaminathan. Design and evaluation of irrigation methods, (IARI Monograph No.1). Water Technology Centre, IARI New Delhi.
5. Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Pub. House New Delhi.
6. Choudhary M.L and Kadam U.S 2006. Micro irrigation for cash crops Westville Publishing House.
7. Suresh, R., 2010"Principles of Micro-Irrigation Engineering", Standard Publishers Distributors, New Delhi.
8. Sivanappan R.K., 1987 "Sprinkler Irrigation", Oxford and IBH Publishing Co., New Delhi.


## Iden. 3108 Drainage Engineering 2(1+1)

**Objectives**

- To understand the basic concepts for planning, design and management of land drainage works in cultivated areas
- To study the various methods of land drainage and its impact on environment

**Theory**

**Module I** **(3 Hours)**

Water logging – causes and impacts; drainage, objectives of drainage, familiarization with the drainage problems of the state;

**Module II** **(5 Hours)**

Surface drainage: Surface drainage coefficient, types of surface drainage, design of surface drains; sub-surface drainage: purpose and benefits, investigations of design parameters-hydraulic conductivity, drainable porosity, water table; derivation of Hooghoudt's and Ernst's drain spacing equations.

**Module III** **(4 Hours)**

Subsurface drainage system: Design of subsurface drainage system; drainage materials, drainage pipes, drain envelope; layout, construction and installation of drains.
Drainage structures.

**Module IV** **(4 Hours)**

Special drainage systems: vertical drainage; bio-drainage; mole drains.
Salt balance, reclamation of saline and alkaline soils, leaching requirements, conjunctive use of fresh and saline water.

**Practical**

*In-situ* measurement of hydraulic conductivity by single auger hole and inverse auger hole method; Estimation of drainage coefficients; installation of piezometer and observation wells; preparation of iso-bath and isobar maps; determination of drainable porosity; design of surface drainage systems; design of gravel envelope; design of

subsurface drainage systems; determination of chemical properties of soil and water; study of drainage tiles and pipes; installation of sub-surface drainage system; cost analysis of surface and sub-surface drainage system.

**Lecture Schedule**

1. Water logging – causes and impacts
2. Drainage, objectives of drainage
3. Familiarization with the drainage problems of the state
4. Surface drainage coefficient
5. Types of surface drainage. Design of surface drains;
6. Sub-surface drainage: purpose and benefits
7. Investigations of design parameters-hydraulic conductivity drainable porosity water table;
8. Derivation of Hooghoudt's and Ernst's drain spacing equations.
9. Design of subsurface drainage system;
10. Drainage materials drainage pipes and drain envelope
11. Layout construction and installation of drains.
12. Drainage structures
13. Special drainage systems: vertical drainage; bio-drainage; mole drains
14. Salt balance- reclamation of saline and alkaline soils
15. Leaching requirements
16. Conjunctive use of fresh and saline water.

**Practical Schedule**

1. -2. *In-situ* measurement of hydraulic conductivity by single auger hole and inverse auger hole method
3. Estimation of drainage coefficients
4. Installation techniquesof piezometer and observation wells
5. Preparation of isobath and isobar maps /water contour maps
6. Determination of drainable porosity
7. – 8. Design of surface drainage systems
9. Design of gravel envelope
10. – 11. Design of subsurface drainage systems
12. – 13. Determination of chemical properties of soil and water
14. Study of drainage tiles and pipes
15. Installation techniques of sub-surface drainage system
16. Cost analysis of surface and sub-surface drainage system.

**Suggested Readings**


1. Bhattacharya AK and Michael AM. 2013. Land Drainage, Principles, Methods and Applications. Vikas Publication House, Noida (UP).
2. Ritzema, H.P., 1994"Drainage Principles and Applications", Publication No. 16, International Institute of Land Reclamation and Improvement, Netherlands.
3. Michael AM. andOjha TP. 2014. Principles of Agricultural Engineering Vol-II 5th Edition. Jain Brothers Publication, New Delhi.
4. Kadam U.S., Thokal R.T., Gorantiwar S.D. and Powar A.G. 2007. Agricultural Drainage-Principles and Practices, Westville Publishing House.
5. FAO Irrigation and Drainage Paper No. 6, 9, 15, 16, 28 and 38. Rome, Italy.

## Iden. 3209 Ground Water, Wells and Pumps 3(2+1)

**Objectives**

- To acquaint and equip the students with the occurrence, development and hydraulics of ground water flow
- To understand the theories and application of wells and pumps
- To impart knowledge in areas of water supply and groundwater development

**Theory**

**Module I** **(4 Hours)**

Occurrence and movement of ground water; aquifer and its types; groundwater exploration techniques; classification of wells, fully penetrating tube wells and open wells, familiarization of various types of bore wells.

**Module II** **(8 Hours)**

Groundwater hydraulics-steady and unsteady state flow to wells – Dupits theory, determination of aquifer parameters by different methods such as Theis, Jacob and Chow's, Theis recovery method; design of open wells; design of tube well and gravel pack, installation of well screen.

**Module III** **(9 Hours)**

Methods of drilling of wells: percussion, rotary, reverse rotary; completion and development of well;well losses and well efficiency, well interference, multiple wells systems, estimation of ground water potential, quality of ground water; artificial groundwater recharge techniques.

**Module IV** **(11 Hours)**

Pumping systems: water lifting devices; different types of pumps, classification of pumps, component parts of centrifugal pumps, priming, pump selection, installation and trouble shooting, performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics; hydraulic ram, propeller pumps, mixed flow pumps and their performance characteristics; deep well turbine pump and submersible pump.

**Practical**

Verification of Darcy's Law; study of different drilling equipments; sieve analysis for gravel and well screens design; estimation of specific yield and specific retention; testing of well screen; estimation of aquifer parameters by Theis method, Coopers-Jacob method, Chow method; Theis Recovery method; well design under confined and unconfined conditions; estimating ground water balance; study of artificial ground water recharge structures; study of radial flow and mixed flow centrifugal pumps, multistage centrifugal pumps, turbine, propeller and other pumps; installation of centrifugal pump; study of hydraulic ram, testing of centrifugal pump and study of cavitations; study and testing of submersible pump.

**Lecture Schedule.**

1. Occurrence and movement of ground water, Aquiferand its types
2. Groundwater exploration techniques
3. Classification of wells, open wells,
4. Fully penetrating tube wells and familiarization of various types of bore wells
5. Hydraulics of flow in wells – steady flow

6. Unsteady flow-determination of aquifer parameters by different methods such as Theis and Jacob
7. Chow's method and Theis recovery method;
8. Design of open well
9. Design of open well continued
10. Design of tubewell
11. Design of tube well continued
12. Gravel pack design and installation of well screen, types and losses in well screen
13. Methods of Construction of wells-open wells
14. Methods of drilling of tube wells-percussion, rotary
15. DTH drilling, core drilling, calyx core drilling and diamond core drilling
16. Development of well-different methods of well development
17. Yield testing, Sanitary protection of tube well
18. Well interference, multiple well systems
19. Estimation of ground water potential, quality of ground water;
20. Artificial groundwater recharge techniques;
21. Pumping systems: Indigenous water lifts-different types
22. Working of Indigenous water lifting devices
23. Types of pumps – principle of pumping and classification
24. Positive displacement and variable displacement pumps
25. Reciprocating pump-principles and working
26. Centrifugal pumps:-components, principles and working
27. Total pumping head, NPSH, maximum suction lift, power requirement in pumping
28. Centrifugal pumps:performance curves
29. Centrifugal pumps: priming, pump selection, installation and trouble shooting,
30. Effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics;
31. Accessories of centrifugal pumps, multistage pumps , Deep well turbine and submersible pumps
32. Mixed flow pumps, propeller pumps, axial flow pumps. Jet and air lift pumps

**Practical schedule**

1. Verification of Darcy's Law
2. Study of different drilling equipments;
3. Sieve analysis for gravel and well screens design;
4. Estimation of specific yield and specific retention;
5. Estimation of aquifer parameters by Theis,
6. Estimation of aquifer parameters – Coopers-Jacob, Chow method
7. Theis Recovery method;
8. Well design under confined and unconfined conditions;
9. Estimating ground water balance;
10. Study of artificial ground water recharge structures;
11. Study of radial flow and mixed flow centrifugal pumps,
12. Multistage centrifugal pumps, turbine, propeller and other pumps;
13. Installation of centrifugal pump;
14. Study of hydraulic ram,
15. Testing of centrifugal pump and study of cavitations;
16. Study and testing of submersible pump.

**Suggested Readings**


1. Michael AM, Khepar SD. and SK Sondhi. 2008. Water Well and Pumps, 2nd Edition, Tata Mc-Graw Hill.
2. Todd David Keith and Larry W. Mays. 2004. Groundwater Hydrology, 3rd Edition, John Wiley & Sons, New York (International Book Distributing Company Lucknow).
3. Michael AM. andOjha TP. 2014. Principles of Agricultural Engineering Vol-II, 5th Edition. Jain Brothers Publication, New Delhi.
4. H.M Reghunath 2003. Ground water, Wiley Eastern Ltd.

## Department of Irrigation and Drainage Engineering- Electives

### Elid. 4201 Management of Canal Irrigation System 3 (2+1)

**Objectives**

- To familiarize the students with the canal irrigation system, its components, alignment and performance indicators.
- To impart knowledge about the estimation of water requirement of crops grown in command areas, to design irrigation canal systems.

**Theory**

**Module I** **(8 Hours)**

Purpose benefits and ill effects of irrigation; typical network of canal irrigation system and its different physical components; canal classification based on source of water, financial output, purpose, discharge and alignment; canal alignment: general considerations for alignment; performance indicators for canal irrigation system evaluation.

**Module II** **(9 Hours)**

Estimation of water requirements for canal command areas and determination of canal capacity; water duty and delta, relationship between duty, base period and delta, factors affecting duty and method of improving duty; silt theory: Kennedy's theory, design of channels by Kennedy's theory, Lacey's regime theory and basic regime equations, design of channels by Lacey's theory, Use of Garrett's diagram

**Module III** **(8 Hours)**

Maintenance of unlined irrigation canals, measurement of discharge in canals, rostering (canal running schedule) and warabandhi, Seepage losses in canals-measurement – necessity of canal lining: advantages and disadvantages, types of canal lining and desirable characteristics for the suitability of lining materials; design of lined canals;

**Module IV** **(7 Hours)**

Functions of distributaries – head and cross regulators; canal falls, their necessity and factors affecting canal fall; sources of surplus water in canals and types of canal escapes; requirements of a good canal outlet and types of outlet.

**Practical**

Estimation of water requirement of canal commands; Determination of canal capacity;

Layout of canal alignments on topographic maps, Drawing of canal sections in cutting, full banking and partial cutting and partial banking; Determination of longitudinal section of canals; Design of irrigation canals based on silt theories; Kennedy's theory

Design of irrigation canals based on Lacey's theory, Use of Garret's diagram, Design of lined canals; Formulation of Warabandhi; Study of canal outlets, Study of canal regulators, Study of canal escapes and canal falls.

**Lecture schedule**

1. Irrigation – Purpose, benefits and ill effects
2. Introduction to Canal irrigation system
3. Canal Irrigation network-Different physical components.
4. Canal classification based on source of water,
5. Financial output-purpose of canal irrigation.
6. Canal Discharge
7. Canal alignment: general considerations for alignment;
8. Performance indicators for canal irrigation system evaluation.
9. Estimation of water requirements for canal command areas
10. Determination of canal capacity;
11. Irrigation terminologies-Water duty, delta and Base period
12. Relationship between duty, base period and delta,
13. Factors affecting duty and method of improving duty
14. Design of channels –Silt Theories.
15. Canal design by Kennedy's theory,
16. Lacey's regime theory and basic regime equations,
17. Design of channels by Lacey's theory-
18. Use of Garrett's diagram
19. Maintenance of unlined irrigation canals
20. Measurement of discharge in canals,
21. Canal water distribution – Rostering
22. Canal running schedule and Warabandhi,
23. Seepage losses in canals-measurement
24. Necessity of canal lining:
25. Advantages and disadvantages of lining
26. Types of canal lining and desirable characteristics for the suitability of lining materials;
27. Design of lined canals;
28. Functions of distributaries – head and cross regulators;
29. Canal falls – their necessity
30. Factors affecting canal fall; Sources of surplus water in canals
31. Types of canal escapes;
32. Requirements of a good canal outlet and types of outlet.

**Practical**

1. Estimation of water requirement of canal commands;
2. Estimation of water requirement of canal commands
3. Determination of canal capacity;
4. Layout of canal alignments on topographic maps,
5. Drawing of canal sections in cutting, full banking and partial cutting and partial banking;
6. Determination of longitudinal section of canals;
7. Design of irrigation canals based on silt theories; Kennedy's theory
8. Design of irrigation canals based on silt theories; Kennedy's theory
9. Design of irrigation canals based on Lacey's theory
10. Design of irrigation canals based on Lacey's theory
11. Use of Garret's diagram
12. Design of lined canals;
13. Formulation of warabandhi;

14. Study of canal outlets,
15. Study of canal regulators
16. Study of canal escapes and canal falls.

**Suggested Readings**


1. Arora, K.R. 2001.Irrigation, Water Power and Water Resources Engineering.Standard Publishers Distributors, Delhi.
2. Garg S. K. 2014. Irrigation Engineering and Hydraulic Structures, Khanna Publishers New Delhi.
3. Sahasrabudhe SR. 2011. Irrigation Engineering and Hydraulic structures.SK Kataria& Sons Reprint 2015.


**Elid. 4202 Minor Irrigation and Command Area Development 3(2+1)**

**Objectives**

- To familiarize students about the basic concepts of Irrigation Management and command area development.
- To impart knowledge about the functioning of Irrigation projects and their performance aspects, activities of command area development authorities and on farm irrigation activities.

**Theory:**

**Module I** **(6 Hours)**
Major, medium and minor irrigation projects -their comparative performance; Factors affecting performance of irrigation projects, Development and utilization of water resources through different minor irrigation schemes.Types of minor irrigation systems in India;

**Module II** **(8 Hours)**
Lift irrigation systems: feasibility, type of pumping stations and their site selection, design of lift irrigation systems; Tank Irrigation: grouping of tanks, storage capacity, supply works and sluices;

**Module III** **(10 Hours)**
Command area development (CAD) programme – components, need, and scope, and development approaches, historicalperspective. Command area development authorities-functions and responsibilities; on farm development works, reclamation works, use of remote sensing techniques for CAD works,

**Module IV** **(8 Hours)**
Water productivity: concepts and measures for enhancing water productivity; Farmers' participation in command area development; Case studies of some selected commands;

**Practical**
Preparation of command area development layout plan; Land Levelling design for a field

Irrigation water requirement of crops; Irrigation water requirement of crops; Preparation of irrigation schedules; Planning and layout of water conveyance system; Design of surplus weir of tanks; Determination of storage capacity of tanks; Design of intake pipe and pump house, Case studies of command areas, Field visits to command areas

**Lecture Schedule**

1. Major,medium and minor irrigation projects
2. Factors affecting performance of irrigation projects-
3, 4.Comparative performances of Irrigation projects
5. Development and utilization of water resources through different minor irrigation schemes
6. Types of minor irrigation systems in India;
7, 8 Lift irrigation systems: feasibility
9.10 Types of pumping stations and their site selection,
11,12Design of lift irrigation systems;
13 Tank Irrigation:
14 Grouping of tanks,
15 Storage capacity,
16 Supply works and sluices;
17 Mid Semester examination
18 Basic concepts of command area-Definitions and terminologies
19 Command area development (CAD) programme – components,
20 Need, scope, and development approaches.
21 Historical perspective,
22 Command area development authorities
23 Functions and responsibilities of CADA
24,25 Planning and execution of on farm developmental activities
26 Reclamation works
27,28 Use of remote sensing techniques for CAD work
29 Water productivity:
30,31 Concepts and measures for enhancing water productivity
32,33Farmers' participation in command area development;
34-36 Case studies of some selected commands;.

**Practical Schedule**

1. Preparation of command area development layout plan;
2. Land Levelling design for a field
3. Land Levelling design for a field
4. Irrigation water requirement of crops;
5. Irrigation water requirement of crops;
6. Preparation of irrigation schedules;
7 .Preparation of irrigation schedules;
8. Planning and layout of water conveyance system;
9. Design of surplus weir of tanks;
10. Determination of storage capacity of tanks;
11. Determination of storage capacity of tanks;
12. Design of intake pipe and pump house.
12.Design of intake pipe and pump house
13. Case studies of command areas
14.Case studies of command areas

15.Field visits to command areas

**Suggested Readings:-**


1. Arora, K.R. 2001.Irrigation, Water Power and Water Resources Engineering.Standard Publishers Distributors, Delhi.
2. Garg S. K. 2014. Irrigation Engineering and Hydraulic Structures, Khanna Publishers New Delhi.
3. Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing VikasPubl.House New Delhi.
4. Sahasrabudhe SR. 2011. Irrigation Engineering and Hydraulic structures.SK Kataria& Sons Reprint 2015.


## Elid. 4203 Water Quality and Management Measures 3 (2+1)

**Objective**

To acquaint and equip the students with different aspects of water quality, standards, analysis, decontamination and management aspects.

**Theory**

**Module I** **(8 Hours)**

Natural factors affecting quality of surface water and groundwater, water quality objectives in relation to domestic, industrial and agricultural activities,

**Module II** **(4 Hours)**

Drinking water quality standards, irrigation water quality classification as per USSL and All Indian Coordinated Research Project (AICRP) criteria.

**Module III** **(5 Hours)**

Point and non-point water pollution sources, water contamination due to inorganic and organic compounds, water contamination related to agricultural chemicals, food industry, hydrocarbon and synthetic organic compounds.Arsenic and fluoride contamination in groundwater and remedial measures

**Module IV** **(15Hours)**

Water decontamination technologies, cultural and management practices for using poor quality water for irrigation.

**Practical**

Water quality analysis and classification according to USSL and AICRP criteria; soil chemical analysis and estimation of lime and gypsum requirements; study of salinity development under shallow and deep water table conditions; study of contamination movement and transport in soil profile; study of different water decontamination techniques; study of different cultural and management practices for using poor quality water for irrigation; field visit to industrial effluent disposal sites.

**Lecture Schedule**

1. Introduction-Natural factors affecting quality of surface water and groundwater-
2. Pollution and Contamination-Definition of terms
3. Sources of surface water pollution
4. Types of water pollution – Physical, Chemical and Bacteriological pollution

5. Quality of ground water – Physical, Chemical and Bacteriological aspects
6. Sources of salinity,
7. Measures of water quality
8. Acid and salt affected soils-Lime and Gypsum requirements for amendment.
9. Water quality criteria – Domestic, Industrial, Agricultural activities
10. Drinking water quality standards
11. Irrigation water quality classification as per USSL and All Indian Coordinated Research Project (AICRP) criteria.
12. Water quality guidelines for irrigation
13. Point and non-point water pollution sources
14. Water contamination due to inorganic and organic compounds
15. Water contamination related to agricultural chemicals
16. Water contamination related to food industry, hydrocarbon and synthetic organic compounds.
17. Arsenic and fluoride contamination in groundwater and remedial measures
18. Water decontamination technologies-Screening
19. Plain sedimentation
20. Sedimentation aided with coagulation
21. Filtration-types of filters
22. Disinfection-methods
23. Water softening
24. Miscellaneous methods of water treatment
25. Irrigation with poor quality water-Improvement of water quality
26. Cultural and management practices for using poor quality water for irrigation-Choice of salt tolerant crops
27. Use of fertilizers. Soil management practices
28. Lime requirement of reclamation of acid soils
29. Irrigation management with poor quality water
30. Special problems in using poor quality irrigation water
31. Irrigation with sewage effluent
32. Environmental legislation on water pollution in India and abroad

**Practical Schedule**

1. Water quality analysis-Physical tests
2. Water quality analysis-Chemical tests
3. Water quality analysis-Chemical tests
4. Bacteriological tests for water
5. Classification according to USSL and AICRP criteria
6. Soil chemical analysis and estimation of lime and gypsum requirements;
7. Study of salinity development under shallow and deep water table conditions;
8. Study of contamination movement and transport in soil profile;
9. Study of different water decontamination techniques;
10. Study of Slow sand, Rapid sand and Pressure filters
11. Study of different cultural and management practices for using poor quality water for irrigation;
12. Fieldvisit to water treatment plants
13. Field visit to industrial effluent disposal sites.

**Suggested Readings**


1. FAO. 1996. Control of water pollution from agriculture – FAO irrigation and drainage paper 55.
2. Gray, N.F. Water Technology. Raj Kamal Electric Press, Kundli, Haryana.
3. Hussain, S.K. 1986. Text Book of Water Supply and Sanitary Engineering. Oxford & IBH Publishing Co. New Delhi.
4. Manahan, S.E. 2009. Fundamentals of Environmental Chemistry. CRC Press, New York.
5. McGauhey, P.H. 1968. Engineering Management of water quality. McGraw Hill Book Company, New York.
6. Minhas, P.S. and Tyagi, N.K. 1998.Guidelines for irrigation with saline and alkali waters. Bull. No, 1/98, CSSRI, Karnal, p. :36.
7. Punmia, B.C. and Lal, P.B.B. 1981. Irrigation and water power engineering. Standard Publishers Distributors, Delhi.
8. Micheal, A.M 2011.Irrigation –Theory and Practice,Vikas Publishing House pvtltd.,New Delhi.


**Elid.4204 Design and Maintenance of Greenhouse 3 (2+1)**

**Objective**

The agricultural production must be increased to guarantee the food demand of the fast growing population. Students will get acquainted with greenhouse technology and the cultivation aspects which will help them to adopt the technology for increasing production.

**Theory**

**Module 1** **(10 Hours)**

History and types of greenhouses; importance, function and features of green house; scope and development of green house technology. Location, Planning and various component of greenhouse; design criteria and calculation; constructional material and methods of construction; covering materials and its characteristics

**Module 2** **(7 Hours)**

Solar heat transfer, steady state analysis of green house, Greenhouse heating, cooling, shedding and ventilation systems; Carbon Dioxide generation and monitoring and lighting systems, instrumentation & computerized environmental Control Systems.

**Module 3** **(10 Hours)**

Green house irrigation system designs. Types of valves and accessories, fertilization, root substrata and its pasteurization, containers and benches, plant nutrition. Alternative cropping systems; plant tissue culture, chemical growth regulation;

**Module 4** **(6 Hours)**

Disease control; integrated pest management; postproduction quality and handling – Cost analysis of greenhouse production; Applications of green house & its repair & maintenance.

**Lecture schedule**

1. History and types of greenhouses
2. Importance, function and features of green house
3. Scope and development of green house technology.

4 & 5.Location, planning and various components of greenhouse

6 & 7. Design criteria and calculation

8 & 9.Constructional material and methods of construction

10. Covering materials and its characteristics

11. Solar heat transfer

12. Steady state analysis of green house

13. Greenhouse heating and cooling

14. Shedding and ventilation systems

15 Carbon Dioxide generation and monitoring and lighting systems

16 & 17 Instrumentation & computerized environmental Control Systems.

18. Mid-exam

19 & 20.Green house irrigation system designs.

21. Types of valves and accessories

22 & 23.Fertigation in greenhouses

24. Root substrata and its pasteurization

25. Containers and benches in polyhouse, plant nutrition.

26 & 27. Alternative cropping systems

28. Plant tissue culture, chemical growth regulation

29. Disease control; integrated pest management

30. Postproduction quality and handling

32. Cost analysis of greenhouse production

33. Applications of green house

34. Greenhouse repair & maintenance

**Practical**

1. Study/visit to a functional green house
2. Planning and layout of green house & associated utilities
3. Material selection for the construction of green house
4. Measurement of temp. using thermistor & thermocouples inside the green house
5. Measurement of humidity, solar radiations & air velocity using various methods
6. Application of psychometric charts
7. Greenhouse irrigation design
8. Estimation of cooling requirements in a green house
9. Estimation of ventilation requirements
10. Thermal performance of green house

11. Application of data loggers for simultaneous estimation & control of different parameters like temp., RH, solar radiations etc.
12. Calculations of environment indices inside a green house
13. Fertigation calculations for greenhouse
14. Structural analysis of green house
15. Economic analysis of green house
16. Visit to a commercial green house
17. Practical examination

**Suggested Reading**


1. Manohar, K.R. and Iga Thinathane. C. *Greenhouse technology and management.* B.S.Publications, Hyderabad.
2. Nelson, P.V. *Greenhouse operation and maintenance.Publisher*: Prentice Hall, 2011. ISBN 10: 0132439360 ISBN 13: 9780132439367.
3. Salokhe, V.M. and Sharma, A.K. 2012.*Greenhouse technology and applications.* GeetaSomaniAgrotech publishing Academy, Udaipur.
4. Prasad and Kumar. 2012. *Greenhouse management for horticulture crops.* Agrobios (India), Jodhpur


**Elid.4205 Landscape Irrigation Design and Management 3 (2+1)**

**Objective**

To acquaint students with the design and management of landscape irrigation systems

**Theory**

**Module I** **(8 Hours)**

Conventional method of landscape irrigation- hose irrigation system, quick release coupling system and portable sprinkler with hose pipes; Modern methods of landscape irrigation- pop-up sprinklers, spray pop-up sprinkler, drip irrigation and bubblers; Merits and demerits of conventional and modern irrigation systems,

**Module II** **(9 Hours)**

Types of landscapes and suitability of different irrigation methods, water requirement for different landscapes, Segments of landscape irrigation systems, Main components of modern landscape irrigation systems and their selection criteria; types of pipes, pressure ratings, sizing and selection criteria;

**Module III** **(8 Hours)**

Automation system for landscape irrigation- main components, types of controllers and their application,

**Module IV** **(9 Hours)**

Design of modern landscape irrigation systems, operation and maintenance of landscape irrigation systems.

**Practical**

Study of irrigation equipments for landscapes; Design and installation of irrigation system for landscape, determination of water requirement.Determination of power requirement, pump selection. Irrigation scheduling of landscapes, Study of irrigation controllers and other equipments, Use of AutoCAD in irrigation design: blocks &

symbols, head layout, zoning and valves layout, pipe sizing, Pressure calculations etc., Visit to landscape irrigation system and its evaluation.

**Lecture Schedule**

1. Conventional method of landscape irrigation- hose irrigation system,
2. Quick release coupling system
3. Portable sprinkler with hose pipes;
4. Modern methods of landscape irrigation- pop-up sprinklers,
5. Modern methods of landscape irrigation- spray pop-up sprinkler,
6. Modern methods of landscape irrigation- drip irrigation
7. Modern methods of landscape irrigation- bubblers;
8. Merits and demerits of conventional and modern irrigation systems,
9. Types of landscapes and suitability of different irrigation methods,
10. -11. Water requirement for different landscapes,
12. Segments of landscape irrigation systems,
13. – 14. Main components of modern landscape irrigation systems
15. Components of modern landscape irrigation systems - their selection criteria;
16. Types of pipes, pressure ratings
17. Pipe sizing and selection criteria;
18. Automation system for landscape irrigation- main components,
19. Types of Automation controllers and their application,
20. Design of modern landscape irrigation systems - Site Survey,
21. – 22. Design of modern landscape irrigation systems - Determining Maximum Flow Rate and Working Pressure,
23. -24. Design of modern landscape irrigation systems - Plant Water Requirements,
25. Design of modern landscape irrigation systems - Zoning
26. Operation and maintenance of landscape irrigation systems - Landscape Irrigation Control Zones,
27. Bubbler/Water Harvesting Irrigation Systems,
28. Turf Sprinkler Irrigation Systems - Sprinkler Patterns,
29. Turf Sprinkler Irrigation Systems - Sprinkler System Evaluation,
30. Turf Sprinkler Irrigation Systems - Efficiency, and Uniformity,
31. -32. Turf Sprinkler Irrigation Systems - System Design,
33. Turf Irrigation Systems - Subsurface Drip Irrigation
34. Turf Sprinkler Irrigation Systems - Maintenance and Economics

**Practical Schedule**

1. Study of irrigation equipment for landscapes
2. -3. Design and installation of irrigation system for landscape
4. -5. Determination of water requirement
6. Determination of power requirement, pump selection.
7. Irrigation scheduling of landscapes
8. Study of irrigation controllers and other equipment
9. Use of AutoCAD in irrigation design: blocks & symbols
10. Use of AutoCAD in irrigation design: head layout
11. Use of AutoCAD in irrigation design: zoning and valves layout
12. Use of AutoCAD in irrigation design: pipe sizing
13. – 15. Use of AutoCAD in irrigation design: Pressure calculations etc.,
16. Visit to landscape irrigation system and its evaluation

**Suggested Readings**


1. Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Publ. House New Delhi.
2. Singh NeerajPartap. 2010. Landscaping Irrigation & Floriculture Terminology, ISBN: 8181895118, 978-8181895110, *Ibdc* Publishers, Bangalore.
3. Stephen W. Smith, 1997. Landscape Irrigation: Design and Management, ISBN: 0471038245, 9780471038245, John Wiley & Sons, N.Y.
4. WALLER, PETER; YITAYEW, MULUNEH.2016.Landscape Irrigation Design and Management. In: WALLER, P.; YITAYEW, M. Irrigation and Drainage Engineering: Springer International Publishing. p. 271--288.
5. Rain Bird Landscape Irrigation Design Manual. 2000. (http://www.rainbird.com/documents/turf/IrrigationDesignManual.pdf). Rain Bird Sprinkler Manufacturing Corporation.


**Elid.4206 Applications of Geospatial techniques in Water Resources 3 (2+1)**

**Objectives:**

i) To introduce the principles and basic concepts of Remote Sensing and GIS
ii) To introduce the remote sensing systems, data products and analysis
iii) To introduce the spatial data models, analysis and presentation techniques
iv) To study the applications of Remote Sensing and GIS in Water Resources – irrigation and drainage.

**Theory**

**Module I Remote Sensing Systems** **(9 Hours)**

Introduction, Basic concepts of remote sensing, Energy sources and radiation principles, Energy interactions with atmosphere and earth surface features, Spectral reflectance curves, Polar orbiting satellites, Spectral, radiometric and spatial resolutions, Multispectral, thermal and hyperspectral sensing.

**Module II Digital Image Processing** **(7 Hours)**

Digital Image Processing - Image restoration, Image enhancement and Information extraction, Image processing software, Digital Elevation Modeling, Sources of digital elevation data, Shuttle Radar Topographic Mission (SRTM) data, DEM for Slope, Aspect, Flow direction, Flow pathways, Flow accumulation, Streams, Catchment area delineation,

**Module III Remote Sensing Applications** **(7 Hours)**

Remote sensing applications for watershed management, Rainfall runoff modeling, Irrigation management, Flood mapping, Drought assessment, Environment and ecology,

**Module IV Geographical Information System** **(8 Hours)**

GIS and basic components, different sources of spatial data, basic spatial entities, major components of spatial data, Basic classes of map projections and their properties, Methods of data input into GIS, Data editing, spatial data models and structures, Attribute data management, integrating data (map overlay) in GIS,

**Module V Advanced Topics** **(3 Hours)**

Advanced Topics - Microwave remote sensing, sources of microwave data, Global positioning System (GPS).

**Practical**

Familiarization with remote sensing and GIS hardware; use of software for image interpretation; interpretation of aerial photographs and satellite imagery; basic GIS operations such as image display; study of various features of GIS software package;

scanning, digitization of maps and data editing; data base query and map algebra. GIS supported case studies in water resources management.

**Lecture schedule**

1. Introduction, Basic concepts of remote sensing, Airborne and space born sensors, Passive and active remote sensing
2. EMR Spectrum, Energy sources and radiation principles
3. Energy interactions in the atmosphere, Energy interactions with earth surface features, Spectral reflectance curves
4. Satellites and orbits, Polar orbiting satellites
5. Spectral, radiometric and spatial resolutions, Temporal resolution of satellites
6. Multispectral, thermal and hyperspectral sensing.
7. Some remote sensing satellites and their features
8. Geometric corrections
9. Co-registration of Data, Ground Control Points (GCP)
10. Atmospheric corrections, Solar illumination corrections
11. Concept of color, Color composites
12. Contrast stretching – linear and non-linear stretching
13. Filtering techniques, Edge enhancement
14. Density slicing, Thresholding, Intensity-Hue-Saturation (IHS) images, Time composite images, Synergetic images.
15. Multispectral classification, Ground truth collection
16. Supervised and unsupervised classification
17. Change detection analysis, Principal component analysis
18. Ratio images, Vegetation indices
19. Image processing software, Multispectral classification algorithms
20. Introduction, Sources of digital elevation data, Types of DEM
21. Radar interferometry, Shuttle Radar Topographic Mission (SRTM) data
22. DEM for Slope, Aspect, Flow direction, Flow pathways, Flow accumulation, Streams, Catchment area delineation
23. Watershed management
24. Rainfall-runoff modeling
25. Irrigation management
26. Flood mapping
27. Drought assessment
28. Environmental monitoring
29. Geographical information system: introduction
30. Components of GIS
31. GIS data models – vector and raster data
32. Coordinate system and geo-referencing
33. Microwave remote sensing, sources of microwave data
34. Global positioning System (GPS), GPS for ground truth collection.

**Practical**

1. Interpretation of FCC for land use mapping
2. Interpretation of FCC for water resources mapping
3. Digital image processing - image enhancement
4. Digital image processing – image filtering
5. Image classification – unsupervised

6. Image classification – supervised
7. Introduction to GIS software
8. Digital elevation model
9. Preparation of slope map
10. Preparation of aspect map
11. Digitisation
12. DEM application
13. Soil erosion modelling using GIS and RS
14. Rainfall runoff modelling using GIS
15. Watershed prioritization using GIS
16. Preparation of water table contour maps
17. Practical Examination

**Suggested Readings**


1. Reddy Anji, M. 2006. Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad.
2. Elangovan, K. 2006. GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi.
3. George Joseph. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad.
4. Jensen, J.R. 2013. Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education Limited, UK.
5. Lillesand, T., R.W. Kiefer and J. Chipman. 2015. Remote Sensing and Image Interpretation. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.
6. Sabins, F.F. 2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA.
7. Sahu, K.C. 2008. Text Book of Remote Sensing and Geographic Information Systems. Atlantic Publishers and Distributors (P) Ltd., New Delhi.
8. Shultz, G.A. and E.T. Engman. 2000. Remote Sensing in Hydrology and Water Management. Springer, New York
9. Burrough and McDonnel. Principles of GIS, Oxford University press.


## Elid.4207 Environmental Engineering 3 (2+1)

**Objective**

To familiarize the students with various water treatment and sanitary engineering principles and applications.

**Theory**

**Module I** **(18 Hours)**

Introduction- Types of water demands. Methods of forecasting population.Water quality – physical, chemical and biological water quality parameters.Analysis of water- physical, chemical and bacteriological tests. Water processing- Sedimentation- types of sedimentation tanks – design aspects. Coagulation- principle and purpose-flocculation- mixing devices – jar test. Filtration- theory- classification of filters- double filtration.Disinfection- theory and necessity- methods. Chlorination – forms. Tests for chlorine.Water softening.Colour, odour and taste removal, Iron and manganese removal, deflouridation. Conveyance of water - intakes- design considerations. Pipes and pipe corrosion. Distribution system- design considerations- methods of distribution. Service reservoirs- purposes and types.Systems of supply of water.Wastage of water and its

prevention.Pipe appurtenances.Water pollution and its control – point sources and distributed sources – types of water pollution – preventive measures – Eutrophication – Cumulative toxins.

**Module II** **(2 Hours)**

Water purification processes in natural systems- physical, chemical and biochemical processes- response of streams to biodegradable organic waste – dissolved oxygen balance – organic discharge and stream ecology.

**Module III** **(9 Hours)**

Introduction to sanitary engineering- collection and conveyance of refuse- methods – systems of sewarage.Quantity of sewage- methods of estimation.Construction of sewers.Design of sewers.Sewer appurtenances. Waste water characteristics- physical, chemical and biological. Waste water treatment objectives- classification of treatment methods, application of treatment methods. Physical unit operations, chemical unit operations and biological unit operations. Facilities for physical and chemical treatment of waste water- screens- grit removal – sedimentation tanks – chemical precipitation. Facilities for the biological treatment of waste water – the activated sludge process – aerated lagoons – trickling filters. Sludge disposal. Other methods of sewage treatment – septic tanks – Imhoff tanks.

**Module IV** **(4 Hours)**

Natural treatment systems- characteristics and objectives- application.

**Practical**

Problems on population estimation, Determination of water quality parameters, Design of sedimentation tanks, Design of flocculation tanks, Design of filters, Problems on disinfection,

Problems on water softening, Design of sewers, Problems on sewage quality, Problems on disposal in natural streams, Design of sewage treatment plant, Field visit to water treatment plant, Field visit to sewage treatment plant.

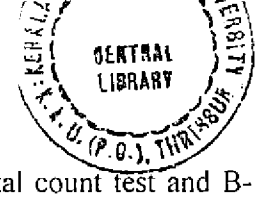
**Lecture Schedule**

1. Introduction- Types of water demands- domestic water demand.

2.-3. Methods of forecasting population – arithmetical increase method, geometrical increase method, incremental increase method, decreasing rate method, simple graphical method, comparative graphical method, mater plan (zoning) method, logistic curve method and apportionment method.

4. - 6. Water quality – physical, chemical and biological water quality parameters, suspended solids, turbidity, colour, temperature, taste and odour, alkalinity, hardness, flouride, total dissolved solids, metals, organics, nutrients, pathogens and pathogen indicator. Water-borne diseases.

7. - 8. Analysis of water- physical, chemical and bacteriological tests, Measurement of colour, taste, odour and temperature, Turbidimeters, measurement of chlorides,




dissolved oxygen, hardness, pH, alkalinity and total solids. Total count test and B-Coli test.

9. Water processing- Sedimentation- theory, purpose and location- types of sedimentation tanks – design aspects.

10. Coagulation- principle and purpose-flocculation-usual coagulants- feeding the coagulants- mixing devices – jar test.

11. - 12. Filtration- theory- classification of filters- slow sand filters- rapid sand filters – pressure filters – double filtration.

13. - 14. Disinfection- theory and necessity- methods – boiling, excess lime treatment, iodine and bromine treatment, U.V. treatment, ozone treatment, potassium permanganate treatment, silver treatment. Chlorination – action of chlorine-application of chlorine – bleaching powder, chloramines and free chlorine gas. Forms of chlorination- plain, pre, post, double, break-point, super and de-chlorination. Tests for chlorine- Orthotolidin and starch-iodide test.

15. Water softening- types of hardness, removal of temporary and permanent hardness- lime-soda process, zeolite process and demineralisation process.

Colour, odour and taste removal, Iron and manganese removal, deflouridation.

16. Conveyance of water- intakes- design considerations. Pipes and pipe corrosion.

17. Distribution system- design considerations- methods of distribution. Service reservoirs- purposes and types.Systems of supply of water.Wastage of water and its prevention.

18. Pipe appurtenances- air valves, bib cocks, fire hydrants, reflux valves, relief valves, scour valves, sluice valves, stop cocks and water meters.

19.Water pollution and its control – point sources and distributed sources -- types of water pollution – preventive measures – Eutrophication – Cumulative toxins.

20. Water purification processes in natural systems- physical, chemical and biochemical processes- response of streams to biodegradable organic waste – dissolved oxygen balance – organic discharge and stream ecology.

21. Introduction to sanitary engineering- collection and conveyance of refuse-methods – systems of sewarage.

Quantity of sewage- dry weather flow and storm water – methods of estimation.

22. Construction of sewers- materials of construction and shapes of sewers.

Design of sewers- principles- minimum and maximum velocities- hydraulic formulas.

23. Sewer appurtenances – catch basins, clean-outs, drop manholes, flushing tanks, grease and oil traps, inlets, inverted siphons, lamp holes, man holes, storm regulators.

24. Waste water characteristics- physical, chemical and biological. Waste water treatment objectives- classification of treatment methods, application of treatment methods.

Physical unit operations, chemical unit operations and biological unit operations.

25.-26. Facilities for physical and chemical treatment of waste water- screens- grit removal – sedimentation tanks – chemical precipitation.

27. - 29. Facilities for the biological treatment of waste water – the activated sludge process – aerated lagoons – trickling filters.

30. Sludge disposal – methods.

31. Natural treatment systems- characteristics and objectives- types- slow rate, rapid infiltration, overland flow, wetlands – constructed and natural, floating aquatic plants. Considerations in application.

32. - 34. Other methods of sewage treatment – septic tanks – Imhoff tanks.

***Practical Schedule***

1. – 2. Problems on population estimation.
3. Determination of water quality parameters.
4. Design of sedimentation tanks.
5. Design of flocculation tanks.
6. Design of filters.
7. Problems on disinfection.
8. Problems on water softening.
9. – 10. Design of sewers.
11. Problems on sewage quality.
12. Problems on disposal in natural streams.
13. to 14. Design of sewage treatment plant.
15. Field visit to water treatment plant.
16. Field visit to sewage treatment plant.
17. Practical Examination

**Suggested Readings**


1. Garg, S. K. (1992) Enviornmental Engineering (Vol. I) Water Supply Engineering. Khanna Publishers, Delhi. pp. 656.
2. Jahne, Johannes (1964) Technical Fundamentals. Construction Practice in Rural Areas, Part I. Construction of Roads and Tracks in Rural Areas. Asia Publishing House. New Delhi. pp. 96.
3. Metcalf and Eddy (1997) Wastewater Engineering - Treatment, Disposal, Reuse. Tata-McGraw-Hill Publishing Co. Ltd. New Delhi. pp. 1334.
4. Peavy, H. S., Rowe, D. R. and Tchobanoglous, G. C. (1986) Environmental Engineering. McGraw-Hill Book Co., New York. pp. 700.
5. Rangwala, S. C. (1992) Water Supply and Sanitary Engineering. Charotar Publishing House, Anand. pp. 783.


## Elid.4208 Numerical Methods In Water Resources 3 (2+1)

**Objective:**

To familiarize the students with the numerical and computational methods for solution of engineering problems in water resources.

**Theory**

**Module I** **(6 Hours)**

Introduction - Methods of computation and computing systems, instability of algorithms and sensitivity of solution techniques - Approximation methods - classical and modern; Numerical quadrature and integration methods; Stability and convergence; Least square approximation; Initial and boundary value problems; Errors and approximation in digital computers – sources of errors- safeguards

**Module II** **(9 Hours)**

Ordinary and partial differential equations, Introduction to differential equations; Differential equations in fluid dynamics; Initial and boundary value problems; difference schemes:- implicit and explicit schemes, accuracy, Consistency, convergence and stability, method of characteristics. Fourier analysis of numerical solutions.Multi-dimensional problems.Diffusion in 2D.

**Module III** **(9 Hours)**

Numerical simulation of hydraulic systems, error analysis, error propagation, solution of non-linear hydraulic equations (graphical, Newton-Raphson and bisection methods), solution of a system of linear equations (Gauss elimination, Gauss-Siedel, Thomas algorithm), linear, polynomial and multiple linear regression, Newton's and Lagrange interpolating polynomials, numerical integration (trapezoidal and Simpson's rule), solution of ordinary differential equations (Euler, Runge-Kutta).

**Module IV** **(5 Hours)**

Finite Difference Methods: Finite differences for ODE's, Finite differences and solution of PDE, classifications, field problems, The advection equation;The diffusion equation-Initial and boundary conditions;The advection-diffusion equation; Unsteady flow and the Method of Characteristics;Unsaturated subsurface flow, Richard's equation;Coupled saturated-unsaturated subsurface flow.

**Module V** (5 Hours)

Introduction to finite element method, variational formulation, Method of Lines, FEM application in Subsurface transport.

Applications in surface and groundwater hydraulics.application to steady and unsteady flows, ground water problems, pollutant dispersion, flood wave propagation, tidal model, application with computer programming.

**Practical**

Problems on errors in numerical computations, Solution of nonlinear hydraulic equations- graphical method, Newton- Raphson method and Bisection method, Solution of linear hydraulic equations- Gauss elimination method,Gauss – Siedel method,Thomas algorithm, Linear polynomial and multiple linear regression, Numerical integration- trapezoidal and Simpson's rule, Solution of ordinary differential equation – Euler, Runge- Kutta method, Finite difference method- Guass- Siedel solution of Laplace's equation, Poisson's equation- drawdown problem, 1D seepage through a dam under Dupuit assumptions, Transient flow- confined aquifer drawdown, Finite element method- solution of Laplace's equation, Finite element method- location of free surface boundary and heads in a dam,Ground water problems, pollutant dispersion, flood wave propagation, tidal model

**Lecture schedule**

1. Introduction - Methods of computation and computing systems,
2. Instability of algorithms and sensitivity of solution techniques
3. Approximation methods - classical and modern;
4. Numerical quadrature and integration methods;
5. Stability and convergence; Least square approximation;
6. Errors and approximation in digital computers – sources of errors- safeguards
7. Ordinary and partial differential equations, Introduction to differential equations
8. Differential equations in fluid dynamics;
9. Initial and boundary value problems;
10. Difference schemes - implicit
11. Eplicit schemes,
12. Accuracy, Consistency,
13. Convergence, stability
14. Method of characteristics
15. Fourier analysis of numerical solutions
16. Multi-dimensional problems
17. Diffusion in 2D.
18. Numerical simulation of hydraulic systems
19. Error analysis, error propagation, solution of non-linear hydraulic equations
20. Graphical method, Newton-Raphson and bisection methods
21. Solution of a system of linear equations
22. Gauss elimination, Gauss-Siedel, Thomas algorithm
23. Linear, polynomial and multiple linear regression
24. Newton's and Lagrange interpolating polynomials
25. Numerical integration - trapezoidal and Simpson's rule
26. Solution of ordinary differential equations – Euler method, Runge-Kutta method
27. Finite Difference Methods: Finite differences for ODE's
28. Finite differences and solution of PDE, classifications, field problems
29. The advection equation;The diffusion equation-initial and boundary conditions
30. The advection-diffusion equation

31. Unsteady flow and the Method of Characteristics, Unsaturated subsurface flow
32. Richard's equation;Coupled saturated-unsaturated subsurface flow.
33. Introduction to finite element method, variational formulation
34. Method of Lines, FEM application in Subsurface transport

**Practical Schedule**

1. Problems on errors in numerical computations
2. Solution of nonlinear hydraulic equations- graphical method
3. Newton- Raphson method and Bisection method
4. Solution of linear hydraulic equations- Gauss elimination method
5. Gauss – Siedel method
6. Thomas algorithm
7. Linear polynomial and multiple linear regression
8. Numerical integration- trapezoidal and Simpson's rule
9. Solution of ordinary differential equation – Euler, Runge- Kutta method
10. Finite difference method- Guass- Siedel solution of Laplace's equation
11. Poisson's equation- drawdown problem
12. 1D seepage through a dam under Dupuit assumptions
13. Transient flow- confined aquifer drawdown
14. Finite element method- solution of Laplace's equation
15. Finite element method- location of free surface boundary and heads in a dam
16. Ground water problems, pollutant dispersion, flood wave propagation, tidal model

**Suggested reading**


1. Fetter, C.W. (1980) Applied Hydrogeology. Merrill, Columbus-Ohio, pp 488.
2. Forsythe, G.E. and Wasow, W. (1960) Finite Difference Methods for Partial Differential Equations. Wiley, New York, pp 444.
3. Huyakorn, P.S. and Pinder, G.F. (1983) Computational Methods in Subsurface Flow. Academic Press, New York.
4. Jain, M.K., Iyengar, S.R.K and Jain R.K. (1991) Numerical Methods for Scientific and Engineering Computation. Wiely Eastern Ltd. New Delhi. Pp 470.
5. Krishnamurthy, E.V., and Sen, S.K, 2000, Numerical Algorithms- computations in science and engineering. Affiliated East- West Press Pvt. Ltd. New Delhi.
6. Pinder, G.F. and Gray, W.G. (1977) Finite Element Simulation in Surface and Subsurface Hydrology, Academic Press, New York, pp 295.
7. Smith, G.D. (1965) Numerical Solution of Partial Differential Equations. OxfordUniversity Press, New York, pp 179.
8. Vedamurthy, V.N. and Iyengar, N. Ch. S. N. (1998) Numerical Methods, Vikas Publishing House Pvt Ltd., New Delhi.
9. Wang, H.F. and Anderson, M.F. (1982) Introduction to groundwater modeling. W. H. Freeman and Co., San Francisco. Pp.237.
10. Zienkiewicz, O.C. (1977) The Finite Element Method. McGraw Hill Inc., New York, pp 787.

## Elid.4209 Irrigation Structures 3 (2+1)

**Theory**

**Module I** **(4 Hours)**

Principles of design – creep theory – seepage force and safety against piping – inverted filter – uplift pressure – design considerations for protection works.

**Module II** **(6 Hours)**

Hydraulic jump as energy dissipater – types – basic characteristics – appurtenances to control jump- stilling basins – standardized designs – SAF and USBR. Channel transitions – structures – principles.

**Module III** **(8 Hours)**

Design of stable, unlined earthen channels, stable earthen channels with unprotected banks – general tractive force design methodology – tractive force concepts. Design of channels in coarse alluviums – Shield's entrainment method for design of channels with protected banks.

**Module IV** **(7 Hours)**

Structures in small canals – conveyance structures - regulating structures – protective structures – water measurement structures – energy dissipating structures – transition and erosion protection structures.

**Module V** **(7 Hours)**

Spillways, Diversion head works, Outlets.

**Practical**

Problems on creep theory, uplift pressure, inverted filter etc., Problems on hydraulic jump.Problems on unlined channel with protected/unprotected banks - tractive force concept. Problems on design of channels in coarse alluvium – Shield's entrainment theory. Design and drawing of : Stilling basins, Drops, Chutes, Flumes, Spillways, Division structures, Turnouts, Culverts.

**Lecture Schedule**

1-3. Principles of design – creep theory – seepage force and safety against piping – inverted filter – uplift pressure – design considerations for protection works.

4-6. Hydraulic jump as energy dissipator – hydraulic jump – types – basic characteristics – control of jump by abrupt drop – stilling basins – standardized designs – SAF and USBR.

7. and 8. Channel transitions – transition structures – principles.

9. to 11. Design of stable, unlined earthen channels – general tractive force design methodology – tractive force concepts. Design procedure for unlined, stable earthen channels with unprotected banks.

12. and 13. Design of channels in coarse alluviums – Shield's entrainment method for design of channels with protected banks.

14. Structures in small canals – conveyance structures - regulating structures – protective structures – water measurement structures – energy dissipating structures – transition and erosion protection structures.

15. to 19. Conveyance structures – aqueduct, structures for canal crossing, drops and chutes.

20. to 22. Regulating structures – concrete/ masonry checks, turnouts, division structures
23. to 26. Water measurement structures – flumes, weirs
27. & 28.Energy dissipators – aprons, stilling wells.
29. & 30.Spillways.
31. Diversion head works- barrage – fish ladder – silt excluder.
32. to 34. Outlets – Non-modular, semi-modular and modular.
Practical
1-3. Problems on creep theory, uplift pressure, inverted filter etc.
4. Problems on hydraulic jump.
5. - 7. Problems on unlined channel with protected/unprotected banks - tractive force concept.
8. Problems on design of channels in coarse alluvium – Shield's entrainment theory.
Design and drawing of :-

9. Stilling basins
10. Drops
11. Chutes
12. Flumes
13. Spillways
14. Division structures
15. Turnouts
16. Culverts
17. Practical Examination

**Suggested Readings**


1. Chow, V. T. (1959) Open-Channel Hydraulics. McGraw Hill Book Co., Singapore. pp. 680.
2. French, R. H. (1994) Open-Channel Hydraulics. McGraw Hill Inc., New York. pp. 739.
3. Garg, S. K. (1987) Irrigation Engineering and Hydraulic Structures. Khanna Publishers. Delhi. pp. 1185.
4. Murthy, C. S. (1997) Water Resources Engineering, Principles and Practice. New Age International (P) Ltd., New Delhi. pp. 260.
5. Robinson, A. R. (1983) Farm Irrigation Structures. Water Management Synthesis Project. Utah State University, Logan, Utah. pp. 503.

## Elid.4210 Climate change and use of Geoinformatics 3 (2+1)

**Objective**

**Theory**

**Module I** **(8 Hours)**

Energy issues and climate change: Climate change, global warming and greenhouse effect, greenhouse gases (GHGs) and their sources, quantifying CO2 and methane emissions, global warming potential (GWP), the radiative balance, earth's carbon reservoirs and carbon cycle. Impacts of climate change in different ecosystem: Models of global and Indian changes including temperature rise, sea level rise, coastal erosion and flooding, positive feedbacks, Climate change refugees.

**Module II** **(8 Hours)**

Controlling carbon dioxide: Efforts to restrict carbon dioxide levels: Kyoto Protocol, recent protocols, methods to increase carbon dioxide absorption in power production, agricultural production, forestry, and industry, the Copenhagen Summit and its implications, future predictions. Carbon Trading: concept of carbon credits.

**Module III** **(8 Hours)**

Introduction, GIS definition and terminology, data types, raster and vector data, GIS database design, spatial database creation – digitization, scanning; processing of data, GIS implementation and project management. Commercially available remote sensing and GIS softwares. Satellite based navigation systems: concepts and applications; map projections and datums, coordinate systems; Survey of India topographical maps types and numbering system. Introduction to the softwares (ArcGIS and Erdas Imagine).

**Module IV** **(8 Hours)**

Climate Change Policy-Mitigation and Adaptation: Carbon storage and sequestration, carbon management through a biotic sequestration- forest ecosystems, wetlands; soil carbon sequestration; bio fuels, carbon farming and carbon trading. Climate change impact assessment – applications for agriculture and water management. Case studies-Projected impact of climate change on India; temperature, rainfall, forests, agriculture, water resources; India's response to climate change

**Practical**

Case studies on effects of climate change: greenhouse gas emissions, sea level rise, crop productivity. Case studies on clean development mechanisms. Comparative evaluation of data from IPCC reports and climate scenarios. Case studies on successful green energy initiatives. Familiarization with remotesensing and GIS hardware;use of software for image interpretation-Preparation of maps; Introduction to GIS softwares–Q-GIS, ERDAS, Arc GIS etc. Visual interpretation of satellite imagery; land use mapping-Digital image processing-Exercises in viewing, editing, overlay-GIS supported case studies in climate change and water management.

**Lecture schedule**

1. Energy issues and climate change
2. Climate change, global warming and greenhouse effect,
3. Greenhouse gases (GHGs) and their sources.
4. Quantifying CO2 and methane emissions, global warming potential (GWP),
5. The radiative balance, earth's carbon reservoirs and carbon cycle.

6. Impacts of climate change in different ecosystems
7, 8. Models of global and Indian changes including temperature rise, sea level rise, coastal erosion and flooding, positive feedbacks, Climate change refugees.
9. Controlling carbon dioxide: Efforts to restrict carbon dioxide levels:
10. Kyoto Protocol, recent protocols.
11,12. Methods to increase carbon dioxide absorption in power production, agricultural production, forestry, and industry
13.Copenhagen Summit and its implications, future predictions.
14. Carbon Trading: concept of carbon credits.
15. Introduction- GIS definition and terminology,
16.Data types, raster and vector data,
17. GIS database design, spatial database creation – digitization, scanning; processing of data, 18. Mid-exam
19. GIS implementation and project management.
20. Commercially available remote sensing and GIS softwares.
21. Satellite based navigation systems: concepts and applications;
22. Map projections and datums, coordinate systems;
23. Survey of India topographical maps types and numbering system.
24, 25, 26. Introduction to ArcGIS 24. and ERDAS Imagine.
27, 28. Climate Change Policy-Mitigation and Adaptation:
29. Carbon storage and sequestration
30, 31. Carbon management through biotic sequestration- forest ecosystems, wetlands; soil carbon sequestration.
32. Climate change impact assessment – applications for agriculture and water management.
33. Case studies- Projected impact of climate change in India; temperature, rainfall, forests, agriculture, water resources; India's response to climate change.

**Practical Schedule**
1. Case studies on effects of climate change: greenhouse gas emissions, sea level rise, crop productivity.
2. Case studies on clean development mechanisms.
3. Comparative evaluation of data from IPCC reports and climate scenarios.
4. Case studies on successful green energy initiatives.
5, 6 Familiarization with remote sensing and GIS hardware; use of software for image interpretation-Preparation of maps;
7, 8 Introduction to GIS software–Q-GIS.
9, 10 Overview of GIS software Arc GIS.
11. Coordinate system, Geo-referencing, Attribute data preparation
12. Digitization and creating maps
13,14 Digital image processing-Exercises in viewing, editing, overlay
15,16 GIS supported case studies in climate change and water management.

**Suggested Reading**


1. AkimasaSuni, Kensuke, F., and Ai, Hiramatsu (2010). Adaptation and mitigation strategies for climate change. Springer.
2. Gautam, P.L. Singh, V. and Melkania, U. (Eds.). (2009). Ecosystem diversity and carbon sequestration: climate change challenge and a way out for ushering in a sustainable future. Daya Publishing House, Delhi.
3. Burroughs, W.J. (2007). Climate change: A multidisciplinary approach (2nd edition.). Cambridge University Press. Dash,
4. Sushil Kumar. (2007). Climate change: An Indian perspective. Cambridge University Press India pvt.ltd. New Delhi.
5. IPCC (2007): Summary for policymakers. In: Climate change 2007: impacts, adaptation and vulnerability. Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 7- 22.
6. Lillisand, Thomas, Ralph W. Kiefer and Jonathan Chipman. 2007. Remote Sensing and Image Interpretation. Wiley India.
7. Lo, C.P., and Albert K.W. Yeung. 2009. Concepts and Techniques of Geographic Information Systems, 2nd Edition. PHI Learning.

## Land and Water Resources and Conservation Engineering- Core Courses

### Lwre. 1101 Engineering Drawing 1(0+1)

**Objective**

To enable the students for making technical drawings of different engineering objects.

**Practical**

Drawing Instruments and their uses, Types of lines, lettering and dimensioning. Introduction of drawing scales, First and third angle methods of projection. Principles of orthographic projections; References planes; Points and lines in space and traces of lines and planes; Auxiliary planes and true shapes of oblique plain surface; True length and inclination of lines; Projections of solids (Change of position method, alteration of ground lines); Section of solids and Interpenetration of solid surfaces; Development of surfaces of geometrical solids; Isometric projection of geometrical solids. Preparation of working drawing from models and isometric views. Drawing of missing views. Concept of sectioning. Revolved and oblique sections.

**Practical Schedule**

1. Acquaintance of drawing instruments, lettering, curves etc.
2. Study of lettering and exercises
3. Different type of scales
4. Projection – orthographic projection views, plane of projection, first and third angle projection
5. Orthographic projections –points
6. Orthographic projections- lines, parallel to and contained by one or both planes, perpendicular to a plane, inclined to one plane and parallel to other
7. Projection of lines – Projection of lines inclined to both plane, True length and inclination of lines, traces of lines
8. Projection of plane- perpendicular to both plane, perpendicular to one and parallel to other, perpendicular to one and inclined to the other, Traces of planes
9. Auxiliary planes and true shapes of oblique plane surface
10. Projections of solids-simple positions
11. Projection of solid-axis inclined to one plane and parallel to other, axis inclined to both planes
12. Section of solids- concept of sectioning, section plane parallel to one plane, section plane perpendicular to one plane and inclined to other
13. Development of surfaces of geometrical solids
14. Isometric projection of geometrical solids.
15. Preparation of working drawing from models and isometric views. Drawing of missing views.
16. Revolved and oblique sections.

**Suggested Readings**


1. Anilkumar K N. 2010 Engineering Graphics. Adhyuth Narayan Publishers, Kottayam
2. Bhatt N D. 2010. Elementary Engineering Drawing. Charotar Publishing House Pvt. Ltd., Anand.
3. Satheesh paul. 2015. Engineering Graphics. Paul and Sheldon Publishing, Kothamangalam
4. Varghese,P.I 2015. Engineering Graphics.VIP publishers, Thrissur.

## Lwre. 1102 Environmental Science and Disaster Management 3(2+1)

**Objectives**

- To understand the natural environment and its relationships with human activities and to characterize and analyze human impacts on the environment.
- Design and evaluate strategies, technologies, and methods for sustainable management of environmental systems and for the remediation or restoration of degraded environments.

**Theory**

**Module I** **(10 Hours)**

Environmental Studies -Scope and importance. Natural Resources: Renewable and non-renewable resources Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

**Module H** **(6 Hours)**

Ecosystems: Concept, Structure, function, Producers, consumers, decomposers, Energy flow, ecological succession, food chains, food webs, ecological pyramids. Introduction, types, characteristic features, structure and function of the forest, grassland, desert and aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity and its conservation:- Introduction, definition, genetic, species & ecosystem diversity and bio-geographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation.Hot-sports 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.

**Module HI** **(10 Hours)**

Environmental Pollution: definition, cause, effects and control measures of a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. 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. Social Issues and the Environment from Unsustainable to Sustainable development, Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. dies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. Human Population and the Environment: 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.

**Module IV** **(6 Hours)**

**Disaster Management**

Natural Disasters and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion. Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents. Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

**Practical**

Case Studies and Field work. Visit to a local area to document environmental assets river/forest/grassland/hill/mountain, Visit to a local polluted site-Urban/ Rural/ Industrial/ Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc. Expected impact of climate change on agricultural production and water resources, Mitigation Strategies, Economics of climate change. Disaster Management introduction, Natural and Manmade Disaster Studies, Informatics for Disaster Management, Quantitative Techniques for Disaster Management Environmental Impact Assessment (EIA) and Disaster Management Disaster Management Policy Environmental Modelling.

**Lecture Schedule**

1. Environmental Studies -Scope and importance. Natural Resources: Renewable and non-renewable resources
2. Natural resources and associated problems. a) Forest resources: Use and over-exploitation Deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.

3-4 b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

5. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

6-7 d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

8 e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.

9-10 f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

11. Ecosystems: Concept, Structure, function, Producers, consumers, decomposers,
12. Energy flow, ecological succession, food chains, food webs, ecological pyramids.
13. Introduction, types, characteristic features, structure and function of the forest, grassland, desert and aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).
14. Biodiversity and its conservation:- Introduction, definition, genetic, species & ecosystem diversity and bio-geographical classification of India.
15. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values.
16. Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-sports of biodiversity.

17. 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.
18. Environmental Pollution: definition, cause, effects and control measures of a. Air pollution
19. b. Water pollution c. Soil pollution
20. d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards.
21. Solid Waste Management: causes, effects and control measures of urban and industrial wastes.
22. Role of an individual in prevention of pollution. Pollution case studies. Social Issues and the Environment from Unsustainable to Sustainable development, Urban problems related to energy. Water conservation, rain water harvesting, watershed management.
23. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. dies. Wasteland reclamation. Consumerism and waste products.
24. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act.
25. Issues involved in enforcement of environmental legislation. Public awareness. Human Population and the Environment: population growth, variation among nations, population explosion.
26. 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.
27. Natural Disasters and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions,
28. Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion.
29. Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution,
30. Road accidents, rail accidents, air accidents, sea accidents. Disaster Management- Effect to migrate natural disaster at national and global levels.
31. International strategy for disaster reduction. Concept of disaster management, national disaster management framework;
32. Financial arrangements; role of NGOs, community-based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations

**Practical Schedule**

1. Case Studies and Field work.
2-3. Visit to a local area to document environmental assets river/forest/grassland/hill/mountain,
4-5. Visit to a local polluted site-Urban/ Rural/ Industrial/ Agricultural,
6. Study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc.
7. Expected impact of climate change on agricultural production and water resources,
8. Mitigation Strategies,
9. Economics of climate change.
10. Disaster Management introduction,
11. Natural and Manmade Disaster Studies,
12. Informatics for Disaster Management,
13. Quantitative Techniques for Disaster Management
14. Environmental Impact Assessment (EIA) and Disaster Management
15. Disaster Management Policy
16. Environmental Modelling.

**Suggested Readings**


1. BharuchaErach. 2005. Text Book of Environmental Studies for Undergraduate Courses. University Grants Commission, University Press, Hyderabad.
2. Sharma J P. 2003. Introduction to Environment Science.Lakshmi Publications.
3. Chary Manohar and Jaya Ram Reddy. 2004. Principles of Environmental Studies. BS Publishers, Hyderabad.
4. Kaul S N, AshuthoshGautam. 2002. Water and Waste Water Analysis. Days Publishing House, Delhi.
5. Gupta P K. 2004. Methods in Environmental Analysis – Water. Soil and Air.Agro bios, Jodhpur.
6. Climate change.1995: Adaptation and mitigation of climate change-Scientific Technical Analysis Cambridge University Press, Cambridge.
7. Sharma, R.K. & Sharma, G. 2005.Natural Disaster. APH Publishing Corporation, New Delhi.
8. Husain Majid. 2013. Environment and Ecology: Biodiversity, Climate Change and Disaster Management. online book.


## Lwre. 1203 Surveying and Levelling 3(1+2)

**Objective**

- To introduce the principle of surveying.
- To impart awareness on the various fields of surveying and types of instruments.
- To understand the various method of surveying and computation required in the field of agriculture.

**Theory**

**Module I** **(5 Hours)**

Surveying – introduction and basic principles – objects and uses of surveying – classification and methods of surveying. Linear measurements – principles in chain surveying – selection of survey stations and lines – types of ranging – direct ranging and indirect ranging – chaining – folding and unfolding of chains – reading the chain – leader and follower and their duties – conventional signs. Types of chains - ranging rod - offsets – types - measurement of offsets – cross staff - optical square. Steps involved in chain survey – reconnaissance - marking stations - reference sketches – running survey lines - booking field notes - plotting a chain survey; Testing of chain - degree of accuracy in chaining – error in length due to incorrect chain - compensating and cumulative errors – mistakes - Chaining on sloping ground – direct and indirect methods – obstacles in chaining - chain and tape corrections. Compass Surveying – Prismatic compass - Surveyor's compass – whole circle and reduced bearings. True and magnetic bearing – dip and declination - local attraction – traversing – plotting.

**Module II** **(4 Hours)**

Plane table Survey – instruments and accessories – setting up – orientation – different methods – radiation – intersection – traversing. Two point problem – three point problem - advantages and disadvantages – errors in plane tabling. Levelling – definitions – types of levels – optical principles – sensitivity of bubble – adjustments of levels – types of bench marks – principles in levelling – booking the reading. Reduction of levels – collimation system – problems. Rise and fall system – problem.

**Module III** **(4 Hours)**

Classification of levelling – profile levelling – cross sectioning – plotting – curvature and refraction – contouring - characteristics – uses – different methods – direct and indirect interpolation. Theodolite Surveying – definitions – parts of a theodolite – adjustment of a theodolite – measurement of angles – horizontal angles – different methods – vertical angle.
Theodolite traverses –traverse computations– adjustment of closed traverse – problems. Tacheometric surveying- stadia system- fixed and movable hair methods - instrument constants- anallatic lens- tangential tacheometry .Areas and volumes - mid ordinate rule – average ordinate rule – trapezoidal rule – Simpson's rule - use of planimeter – volumes – trapezoidal and prismoidal formula.

**Module IV** **(3 Hours)**

Minor instruments – Hand levels – Clinometer. Electronic theodolite. Total station – Introduction to total station survey. GPS survey - Introduction to GPS survey

**Practical**

Chain Surveying, Compass Surveying, Plane Table Surveying – Radiation, Plane Table Surveying – Intersection, Plane Table Surveying – Solving Two Point Problem, Plane Table Surveying - Solving Three Point Problem, Plane Table Surveying- Traversing. Levelling Fly levelling- plane of collimation method, Levelling Fly levelling- rise and fall method, Levelling Longitudinal and Cross sectioning, Levelling Contouring. Theodolite Surveying: Measurement of horizontal angle by repetition method, Theodolite Surveying: Measurement of horizontal angle by reiteration method, Measurement of vertical angle, Theodolite Traversing – closed, Theodolite Traversing – open, Determination of tacheometric constants, Heights and distances by stadia method – line of sight horizontal, Heights and distances by stadia method - line of sight inclined, Heights and distances by tangential method, Heights and distances by tangential method, Heights and distances by solution of triangles, Heights and distances by solution of triangles, Trigonometric levelling- base of the object accessible. Study of minor instruments- hand level – clinometers. Study of electronic theodolite, Total station surveying, GPS surveying.

**Lecture schedule**

1. Surveying – introduction and basic principles – objects and uses of surveying – classification and methods of surveying.
2. Linear measurements – principles in chain surveying – selection of survey stations and lines – types of ranging – direct ranging and indirect ranging – chaining – folding and unfolding of chains – reading the chain – leader and follower and their duties – conventional signs., Types of chains - ranging rod - offsets – types, measurement of offsets – cross staff - optical square.
3. Steps involved in chain survey – reconnaissance - marking stations - reference sketches – running survey lines - booking field notes - plotting a chain survey; Testing of chain - degree of accuracy in chaining – error in length due to incorrect chain - compensating and cumulative errors – mistakes; Chaining on sloping ground – direct and indirect methods – obstacles in chaining - chain and tape corrections.
4. Compass Surveying – Prismatic compass - Surveyor's compass – whole circle and reduced bearings.
5. True and magnetic bearing – dip and declination - local attraction – traversing – plotting.
6. Plane table Survey – instruments and accessories – setting up – orientation - different methods – radiation – intersection – traversing.
7. Two point problem – three point problem - advantages and disadvantages – errors in plane tabling.
8. Levelling – definitions – types of levels – optical principles – sensitivity of bubble – adjustments of levels – types of bench marks – principles in levelling – booking the reading.
9. Reduction of levels – collimation system – problems. Rise and fall system – problems

10. Classification of levelling – profile levelling – cross sectioning – plotting – curvature and refraction – contouring - characteristics – uses – different methods – direct and indirect interpolation.
11. Theodolite Surveying – definitions – parts of a theodolite – adjustment of a theodolite – measurement of angles – horizontal angles – different methods – vertical angle.
12. Theodolite traverses –traverse computations– adjustment of closed traverse – problems.
13. Tacheometric surveying- stadia system- fixed and movable hair methods - instrument constants- analytic lens- tangential tacheometry.
14. Areas and volumes - mid ordinate rule – average ordinate rule – trapezoidal rule – Simpson's rule - use of planimeter – volumes – trapezoidal and prismoidal formula.
15. Minor instruments – Hand levels – Clinometer.Electronic theodolite.
16. Total station – Introduction to total station survey. GPS survey - Introduction to GPS survey.

**Practical Schedule**

1. Chain Surveying – 1
2. Chain Surveying – 2
3. Compass Surveying – 1
4. Compass Surveying – 2
5. Plane Table Surveying – Radiation
6. Plane Table Surveying - Intersection
7. Plane Table Surveying – Solving Two Point Problem
8. Plane Table Surveying - Solving Three Point Problem.
9. Plane Table Surveying- Traversing.
10. Levelling Fly levelling- plane of collimation method.
11. Levelling Fly levelling- rise and fall method
12. Levelling Longitudinal and Cross sectioning.
13. Levelling Contouring - 1
14. Levelling Contouring - 2
15. Theodolite Surveying: Measurement of horizontal angle by repetition method.
16. Theodolite Surveying: Measurement of horizontal angle by reiteration method
17. Measurement of vertical angle
18. Theodolite Traversing – closed
19. Theodolite Traversing – open
20. Determination of tacheometric constants.
21. Heights and distances by stadia method – line of sight horizontal
22. Heights and distances by stadia method - line of sight inclined
23. Heights and distances by tangential method.
24. Heights and distances by solution of triangles.
25. Heights and distances by solution of triangles
26. Trigonometric levelling- base of the object accessible
27. Study of minor instruments- hand level - clinometer
28. Study of electronic theodolite.
29. Total station surveying - 1
30. Total station surveying - 2
31. GPS surveying - 1
32. GPS surveying – 2

**Suggested Readings**


1. Punmia,B C 1987. Surveying (Vol.I). Laxmi Publications, New Delhi.
2. Arora K R 1990.Surveying (Vol.I), Standard Book House, Delhi.
3. Kanetkar T P 1993. Surveying and Levelling. Pune Vidyarthi Griha, Prakashan, Pune.
4. Rangwala 1991. Surveying and levelling. Charotar Publishing House Pvt. Ltd. Gujarat.


## Lwre. 2104 Watershed Hydrology 3(2+1)

**Objective**

- To familiarize the students with the important aspects of watershed hydrology.
- To impart the knowledge about the various hydrologic phenomena and their relevance in the field of soil and water conservation.

**Theory**

**Module I** **(10 Hours)**

Hydrologic cycle, precipitation and its forms, rainfall measurement and estimation of mean rainfall, frequency analysis of point rainfall. Mass curve, hyetograph, depth-area-duration curves and intensity-duration-frequency relationship. Hydrologic processes-interception, infiltration -factors influencing, measurement and indices.

**Module II** **(10 Hours)**

Evaporation - estimation and measurement. Runoff - factors affecting, measurement, stage - discharge rating curve, estimation of peak runoff rate and volume, Rational method, Cook's method and SCS curve number method. Geomorphology of watersheds – Linear, aerial and relief aspects of watersheds- stream order, drainage density and stream frequency. Hydrograph - components, base flow separation, unit hydrograph theory, S-curve, synthetic hydrograph, applications and limitations.

**Module III** **(7 Hours)**

Floods – terms and definitions head water flood control- method. Stream gauging - discharge rating curves, flood peak, design flood and computation of probable flood.

**Module IV** **(5 Hours)**

Flood routing – channel and reservoir routing. Drought – classification causes and impacts, drought management strategy.

**Practical**

Visit to meteorological observatory and study of different instruments. Design of rain gauge network. Exercise on intensity - frequency - duration curves. Exercise on depth - area - duration and double mass curves. Analysis of rainfall data and estimation of mean rainfall by different methods. Exercise on frequency analysis of hydrologic data and estimation of missing data, test for consistency of rainfall records. Exercise on computation of infiltration indices. Computation of peak runoff and runoff volume by Cook's method and rational formula. Computation of runoff volume by SCS curve number method. Study of stream gauging instruments - current meter and stage level recorder. Exercise on geomorphic parameters of watersheds. Exercise on runoff hydrograph. Exercise on unit hydrograph. Exercise on synthetic hydrograph. Exercise on flood routing.

**Lecture schedule**

1. Introduction; Hydrologic events
2. Hydrologic cycle
3. Precipitation and its forms
4. Types of precipitation
5. Rainfall measurement – various types of rain gauges
6. Estimation of mean rainfall
7. Frequency analysis of point rainfall
8. Mass curve and hyetograph
9. Depth-area-duration curves
10. Intensity-duration-frequency relationship
11. Hydrologic processes-Interception
12. Infiltration -factors influencing. Infiltration measurement and indices
13. Evaporation - estimation and measurement
14. Runoff - factors affecting, measurement of runoff
15. Stage - discharge rating curve
16. Estimation of peak runoff rate and volume, Cook's method
17. Rational method of runoff estimation
18. SCS Curve Number method
19. Geomorphology of watersheds
20. Linear, aerial and relief aspects of watersheds - stream order
21. Drainage density and stream frequency
22. Hydrograph - Components, base flow separation
23. Unit hydrograph theory, S-curve
24. Synthetic hydrograph, applications and limitations
25. Floods – terms and definitions
26. Head water flood control- method
27. Stream gauging - discharge rating curves
28. Flood peak - design flood
29. Computation of probable flood
30. Flood routing. Channel routing
31. Reservoir routing
32. Drought – classification causes and impacts. Drought management strategy.

**Practical schedule**

1. Visit to meteorological observatory and study of different instruments
2. Design of rain gauge network
3. Exercise on intensity - frequency - duration curves
4. Exercise on depth - area - duration and double mass curves
5. Analysis of rainfall data and estimation of mean rainfall by different methods
6. Exercise on frequency analysis of hydrologic data and estimation of missing data, test for consistency of rainfall records
7. Exercise on frequency analysis of hydrologic data and estimation of missing data, test for consistency of rainfall records
8. Exercise on computation of infiltration indices
9. Computation of peak runoff and runoff volume by Cook's method and rational formula
10. Computation of peak runoff and runoff volume by Cook's method and rational formula
11. Computation of runoff volume by SCS curve number method
12. Study of stream gauging instruments - current meter and stage level recorder
13. Exercise on geomorphic parameters of watersheds
14. Exercise on runoff hydrograph
15. Exercice on synthetic hydrograph
16. Exercise on flood routing

**Suggested Readings**


1. Chow, V.T., D.R. Maidment and L.W. Mays. 2010. Applied Hydrology, McGraw Hill Publishing Co., New York.
2. Jaya Rami Reddy, P. 2011.A Text Book of Hydrology. University Science Press, New Delhi.
3. Linsley, R.K., M.A. Kohler, and J.L.H. Paulhus. 1984. Hydrology for Engineers. McGraw-Hill Publishing Co., Japan.
4. Mutreja, K.N. 1990. Applied Hydrology. Tata McGraw-Hill Publishing Co., New Delhi.
5. Raghunath, H.M. 2006. Hydrology: Principles Analysis and Design. Revised 2nd Edition, New Age International (P) Limited Publishers, New Delhi.
6. Subramanya, K. 2008. Engineering Hydrology.3rd Edition, Tata McGraw-Hill Publishing Co., New Delhi.
7. Suresh, R. 2005. Watershed Hydrology.Standard Publishers Distributors, Delhi.
   Varshney, R.S. 1986. Engineering Hydrology.Nem Chand and Brothers, Roorkee, U.P.


## Lwre. 2205 Soil Mechanics 3(2+1)

**Objective**

- To impart the students the fundamentals of soil mechanics and to enable the students to understand the basic, index and engineering properties of soil.
- To equip the students to understand the properties and behavior of soil for the design of foundations, earth and earth retaining structures.

**Theory**

**Module I** **(9 Hours)**

**Nature of soil and functional relationships:** Formation of soils - Soil type - 3 phase system -void ratio - specific gravity - dry density - porosity - water content - saturated unit weight -submerged unit weight - degree of saturation – Soil Structure: single grained, honey combed, flocculated and dispersed structure and their effects on the basic soil properties.

**Laboratory and field identification of soils:** Determination of water content by oven drying– Specific gravity using pycnometer and specific gravity bottle - Grain size analysis by sieve analysis, hydrometer analysis and pipette analysis - Atterberg limits and indices – Visual identification by simple field tests – Field density by core cutter, sand replacement and wax coating methods

**Classification of soils:** Necessity - Principles of classification - I.S. classification – Plasticity charts -- Group index.

**Module II** **(9 Hours)**

**Soil water:** Modes of occurrence – adsorbed and capillary water types - Total stress -Effective stress – Pore pressure - Pressure diagrams

**Permeability:** Definition - Darcy's law - Factors affecting permeability – Laboratory determination - Stratified soils: average permeability.

**Shear Strength:** Definition - Mohr's strength and stress circles - origin of planes - Mohr's envelope - Mohr- Coulomb strength theory –Direct shear test – introduction to triaxial shear test- Measurement of pore pressure -Total and effective stress strength parameters - UCC test - Vane shear tests - Choice of test conditions for field problems.

**Module III** **(8 Hours)**

**Consolidation:** Definition –Spring analogy for primary consolidation - Terzaghi's theory of one dimensional consolidation – Concepts of coefficient of compressibility - Coefficient of volume change and compression index – Laboratory consolidation test - e-log p curves – pre-consolidation pressure - Time rate of consolidation - difference between consolidation and compaction.

**Compaction:** Definition and objectives of compaction – Standard and Modified Proctor tests- Concept of OMC and maximum dry density - Zero air voids line - Factors influencing compaction - Effect of compaction on soil properties - Field compaction methods – Proctor needle for field control.

**Module IV** **(6 Hours)**

**Earth pressure:** Earth pressure at rest - Active and passive earth pressure for cohesionless and cohesive soils - Rankine's and Coulomb's theories - Point of application of earth pressure for cases of with and without surcharge in cohesionless and cohesive soils - Culmann's and Rebhan's graphical construction for active earth pressure-

**Stability of slopes:** Slope failure, base failure and toe failure - Swedish circle method – $\Phi$ = 0analysis and c = 0 analysis - Friction circle method - Taylor's stability number –Stability charts.

**Practical**

Determination of water content of soil; Determination of specific gravity of soil; Determination of field density of soil by core cutter method; Determination of field density by sand replacement method; Grain size analysis by sieving (Dry sieve analysis); Grain size analysis by hydrometer method; Determination of liquid limit by Casagrande's method; Determination of liquid limit by cone penetrometer and plastic limit; Determination of shrinkage limit; Determination of permeability by constant head method; Determination of permeability by variable head method; Determination of compaction properties by standard proctor test; Determination of shear parameters by Direct shear test; Determination of unconfined compressive strength of soil; Determination of shear parameters by Tri-axial test; Determination of consolidation properties of soils.

**Lecture Schedule**

1. Formation of soils - Soil types in India,
2. Soil as a 3 phase system -void ratio - specific gravity - dry density - porosity -
3. Water content Saturated unit weight -submerged unit weight - degree of saturation
4. Soil Structure: single grained, honey combed, flocculated and dispersed structure and their effects on the basic soil properties.
5. Determination of water content by oven drying– Specific gravity using pycnometer and specific gravity bottle - Grain size analysis by sieve analysis
6. hydrometer analysis and pipette analysis -
7. Atterberg limits and indices –
8. Visual identification by simple field tests – Field density by core cutter, sand replacement and wax coating methods
9. Necessity of soil classification - Principles of classification - I.S. classification
10. Plasticity charts – Group index
11. Modes of occurrence of water in soil – adsorbed and capillary water types-Total stress - Effective stress – Pore pressure - Pressure diagrams
12. Permeability of soil - Darcy's law - Factors affecting permeability – Laboratory determination
13. Stratified soils : average permeability
14. Shear strength - definition - Mohr's strength and stress circles
15. origin of planes - Mohr's envelope - Mohr- Coulomb strength theory
16. Direct shear test – introduction to triaxial shear test-
17. Measurement of pore pressure. Total and effective stress strength parameters

18. UCC test - Vane shear tests
19. Choice of test conditions for field problems.
20. Consolidation - Definition –Spring analogy for primary consolidation - Terzaghi's theory of one dimensional consolidation
21. Concepts of coefficient of compressibility - Coefficient of volume change and compression index
22. Laboratory consolidation test. e-log p curves – pre-consolidation pressure
23. Time rate of consolidation - difference between consolidation and compaction
24. Compaction- definition and objectives of compaction – Standard and Modified Proctor tests
25. Concept of OMC and maximum dry density - Zero air voids line. Factors influencing compaction - Effect of compaction on soil properties
26. Field compaction methods - Proctor needle for field control.
27. Earth pressure -earth pressure at rest - Active and passive earth pressure for cohesionless and cohesive soils
28. Rankine's and Coulomb's theories -
29. Point of application of earth pressure for cases of with and without surcharge in cohesionless and cohesive soils
30. Culmann's and Rebhan's graphical construction for active earth pressure-
31. Stability of slopes -slope failure, base failure and toe failure - Swedish circle method – $\Phi$ = 0analysis and c = 0 analysis
32. Friction circle method - Taylor's stability number –Stability charts.

**Practical Schedule**

1. Determination of water content of soil
2. Determination of specific gravity of soil
3. Determination of field density of soil by core cutter method
4. Determination of field density by sand replacement method
5. Grain size analysis by sieving (Dry sieve analysis)
6. Grain size analysis by hydrometer method
7. Determination of liquid limit by Casagrande's method
8. Determination of liquid limit by cone penetrometer and plastic limit
9. Determination of shrinkage limit
10. Determination of permeability by constant head method
11. Determination of permeability by variable head method
12. Determination of compaction properties by standard proctor test
13. Determination of shear parameters by Direct shear test
14. Determination of unconfined compressive strength of soil
15. Determination of shear parameters by Tri-axial test
16. Determination of consolidation properties of soils.

**Text Books**

1. Punmia B. C., *Soil Mechanics & Foundations*, Laxmi Publications, 1988
2. Murthy V. N. S., *Soil Mechanics & Foundation Engineering*, DhanpatRai, 1996
3. Arora K. R., *Soil Mechanics & Foundation Engineering*, Standard Publications, 1987.

**Reference Books**

1. Terzaghi K. & Peck R.B., Soil Mechanics in Engineering Practice, John Wiley & Sons, US, 1967.
2. Venkatramiah C., Geotechnical Engineering, New Age International Publishers, 2006
3. GopalRanjan&Rao A. S. R., Basic & Applied Soil Mechanics, New Age International Publishers, 2000
4. Khan I.H., Text Book of Geotechnical Engineering, Prentice Hall of India
5. Cudoto, Geotechnical Engineering Principles and Practices, Pearson Education, 2007

## Lwre. 2206 Soil and Water Conservation Engineering 3(2+1)

**Objective**

The main objective is to study the causes of erosion, how to reduce erosion and other forms of soil degradation by using land in accordance with its capabilities. Proper application of different soil and water conservation measures to restore the productivity of the soil where it has been damaged. It is also helps to combine sound methods of soil management with other methods and inputs of modern agriculture to obtain satisfactory production on a sustained basis.

**Theory**

**Module I** **(8 Hours)**

Soil erosion - Introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion. Water erosion - Mechanics and forms - splash, sheet, rill, gully, ravine and stream bank erosion. Gullies - Classification, stages of development.

**Module II** **(8 Hours)**

Soil loss estimation – Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity - estimation by KE>25 and $EI_{30}$ methods. Soil erodibility - topography, crop management and conservation practice factors. Measurement of soil erosion - Runoff plots, soil samplers.

**Module III** **(10 Hours)**

Water erosion control measures - agronomical measures - contour farming, strip cropping, conservation tillage and mulching. Engineering measures– Bunds and terraces. Bunds - contour and graded bunds - design and surplussing arrangements. Terraces - level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stonewall and trenching. Gully and ravine reclamation - principles of gully control - vegetative measures, temporary structures and diversion drains. Grassed waterways and design. Use of Geotextiles in soil and water conservation

**Module IV** **(6 Hours)**

Wind erosion- Factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes. Land capability classification. Rate of sedimentation, silt monitoring and storage loss in tanks.

**Lecture Schedule**

1&2. Introduction, causes and types - geological and accelerated erosion and agents causing erosion

3&4 Water erosion - Mechanics and forms - splash, sheet, rill, gully, ravine and stream bank erosion.

5&6 Factors affecting and effects of erosion,

7&8.Gullies - Classification, stages of development.

9&10. Soil loss estimation – Universal soil loss equation (USLE) and modified USLE.

11 &12.Rainfall erosivity - estimation by KE>25 and $EI_{30}$ methods.

13&14Soil erodibility - topography, crop management and conservation practice factors. Measurement of soil erosion - Runoff plots, soil samplers.

15&16 Water erosion control measures - agronomical measures - contour farming, strip cropping, conservation tillage and mulching.

17-20 Engineering measures– Bunds and terraces. Bunds - contour and graded bunds - design and surplussing arrangements

21-23 Terraces - level and graded broad base terraces, bench terraces - planning, design and layout procedure

24 contour stonewall and trenching
25&26 Gully and ravine reclamation - principles of gully control - vegetative measures, temporary structures and diversion drains.
27&28 Grassed waterways and design.
29 Use of Geotextiles in soil and water conservation
30-32 Wind erosion- Factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes.
33 Land capability classification. Rate of sedimentation, silt monitoring and storage loss in tanks.

**Practical**

1. Study of different types and forms of water erosion.
2. Exercises on computation of rainfall erosivity index. Computation of soil erodibility index in soil loss estimation.
3. Determination of length of slope (LS) and cropping practice (CP) factors for soil loss estimation by USLE and MUSLE. Exercises on soil loss estimation/measuring techniques.
4. Study of rainfall simulator for erosion assessment.
5. Estimation of sediment rate using Coshocton wheel sampler and multi-slot devisor.
6. Determination of sediment concentration through oven dry method.
7. Design and layout of contour bunds.
8. Design and layout of graded bunds.
9. Design and layout of broad base terraces.
10. Design and layout of bench terraces.
11. Design of vegetative waterways.
12. Exercises on rate of sedimentation and storage loss in tanks.
13. Computation of soil loss by wind erosion. Design of shelterbelts and wind breaks for wind erosion control.
14. Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures.

**Suggested Readings**


1. Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service, New Delhi.
3. Mal, B.C. 2014. Introduction to Soil and Water Conservation Engineering. 2014. Kalyani Publishers.
4. Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
5. Murthy, V.V.N. 2002.Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
6. Norman Hudson. 1985. Soil Conservation. Cornell University Press, Ithaka, New York, USA. Frevert, R.K., G.O. Schwab, T.W. Edminster and K.K. Barnes. 2009. Soil and Water Conservation Engineering, 4th Edition, John Wiley and Sons, New York.
7. Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

## Lwre. 3107 Water Harvesting and Soil Conservation Structures 3(2+1)

**Objective**

- To familiriarise the water harvesting techniques based on source, storage and use and also introduce the soil and water conservation structures.
- To impart awareness on the design requirements, planning for design, design procedures such as hydrologic, hydraulic and structural design and stability analysis of different structures.

**Theory**

**Module I** **(4 Hours)**

Water harvesting -principles, importance and issues. Water harvesting techniques - classification based on source, storage and use. Runoff harvesting – short-term and long-term techniques.

**Module II** **(6 Hours)**

Structures Farm pond - components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction. Percolation pond - site selection, design and construction details. Design considerations of *nala* bunds.

**Module HI** **(10 Hours)**

Soil erosion control structures - introduction, classification and functional requirements. Permanent structures for soil conservation and gully control - check dams, drop, chute and drop inlet spillways - design requirements, planning for design, design procedures - hydrologic, hydraulic and structural design and stability analysis. Drop spillway - applicability, types - straight drop, box-type inlet spillways - description, functional use, advantages and disadvantages, straight apron and stilling basin outlet, structural components and functions.

**Module IV** **(6 Hours)**

Hydraulic jump and its application. Loads on head wall, variables affecting equivalent fluid pressure, triangular load diagram for various flow conditions, creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension.

**Module V** **(6 Hours)**

Chute spillway - description, components, energy dissipaters, design criteria of Saint Antony Falls (SAF) stilling basin and its limitations. Drop inlet spillway - description, functional use and design criteria. Design of Diversions.

**Practical**

Study of different types of farm ponds. Computation of storage capacity of embankment type of farm ponds. Design of dugout farm ponds. Design of percolation pond and *nala* bunds. Exercise on hydraulic jump. Exercise on energy dissipation in water flow. Hydrologic, hydraulic and structural design of drop spillway and stability analysis. Design of SAF stilling basins in chute spillway. Hydrologic, hydraulic and structural design of drop inlet spillway. Design of small earthen embankment structures. Practice on software for design of soil and water conservation structures. Field visit to watershed project areas treated with soil and water conservation measures / structures.

**Lecture schedule**

1. Water harvesting -principles, importance and issues.
2. Water harvesting techniques - classification based on source, storage and use.
3. Runoff harvesting – short-term techniques.

4. Runoff harvesting –long-term techniques
5. Structures: Farm pond –general description and its components, different types, site selection.
6. Farm pond- design criteria and storage capacity of embankment type farm ponds
7. Mechanical and emergency spillways-cost estimation and construction.
8. Percolation pond - site selection, design and construction details.
9. Percolation pond - Design problems
10. Design considerations of *nala* bunds.
11. Soil erosion control structures - introduction, classification and functional requirements.
12. Permanent structures for soil conservation and gully control –different types
13. Check dams, - design requirements, planning for design, design procedures
14. Check dams, - hydrologic, hydraulic and structural design and stability analysis.
15. Drop spillways- design requirements, planning for design, design procedures
16. Drop spillways- hydrologic, hydraulic and structural design and stability analysis.
17. Chute spillways- design requirements, planning for design, design procedures
18. Chute spillways- hydrologic, hydraulic and structural design and stability analysis.
19. Drop inlet spillways - design requirements, planning for design, design procedures
20. Drop inlet spillways - hydrologic, hydraulic and structural design and stability analysis.
21. Drop spillway - applicability, types - advantages and disadvantages,
22. Straight apron and stilling basin outlet, structural components and functions.
23. Hydraulic jump and its application, type of hydraulic jump,
24. Energy dissipation due to hydraulic jump, jump efficiency, relative loss of energy
25. Straight drop spillways, box-type inlet spillways - description, functional use,
26. Drop spillway structural design- Loads on head wall, Variables affecting equivalent fluid pressure
27. Triangular load diagram for various flow conditions, creep line theory
28. Uplift pressure estimation, safety against sliding,
29. Overturning, crushing and tension. Chute spillway - description, components,
30. Hydraulic design, Energy dissipaters. Design criteria of Saint Antony Falls (SAF) stilling basin and its limitations.
31. Drop inlet spillway - description, functional use and design criteria
32. Diversions structures – general description. Design of Diversions

**Practical**

1. Study of different types of farm ponds.
2. Computation of storage capacity of embankment type of farm ponds.
3. Design of dugout farm ponds.
4. Design of percolation pond and *nala* bunds.
5. Exercise on hydraulic jump.
6. Problems
7. Exercise on energy dissipation in water flow.
8. Hydrologic, hydraulic and structural design of drop spillway
9. Stability analysis of design of drop spillway.
10. Design of SAF stilling basins in chute spillway.
11. Stability analysis of design of chute spillway
12. Hydrologic, hydraulic and structural design of drop inlet spillway.
13. Design of small earthen embankment structures.
14. Practice on software for design of soil and water conservation structures I.
15. Practice on software for design of soil and water conservation structures II.
16. Field visit to watershed project areas treated with soil and water conservation measures / structures.

**Suggested Readings**


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


## Lwre. 3208 Watershed Planning and Management 2(1+1)

**Objectives**

- The student will get a comprehensive idea about watershed management.
- The student will be capable of planning and execution of watershed management projects.

**Theory**

**Module I** **(5 Hours)**

Watershed - introduction and characteristics. Watershed development - problems and prospects, investigation, topographical survey, soil characteristics, vegetative cover, land use practices and socio-economic factors. Watershed management - concept, objectives, factors affecting, watershed planning based on land capability classes, hydrologic data for watershed planning, watershed codification, delineation and prioritization of watersheds – sediment yield index. Water budgeting in a watershed.

**Module II** **(7 Hours)**

Management measures - rainwater conservation technologies - *in-situ* and *ex-situ* storage, water harvesting and recycling. Dry farming techniques - inter-terrace and inter-bund land management. Integrated watershed management - concept, components, arable lands - agriculture and horticulture, non-arable lands - forestry, fishery and animal husbandry. Effect of cropping systems, land management and cultural practices on watershed hydrology. Watershed programme - execution, follow-up practices, maintenance, monitoring and evaluation. Participatory watershed management - role of watershed associations, user groups and self-help groups. People's participation in watershed management.

**Module III** **(4 Hours)**

Estimate preparation for watershed projects- Detailed estimate-Analysis of rates-Abstract of estimate. Planning and formulation of project proposal for watershed management programme including cost-benefit analysis. Preparation of detailed project report (DPR) for watershed projects.

**Practical**

Exercises on delineation of watersheds using toposheets. Surveying and preparation of watershed map. Quantitative analysis of watershed characteristics and parameters. Watershed investigations for planning and development. Analysis of hydrologic data for planning watershed management.

Water budgeting of watersheds. Prioritization of watersheds based on sediment yield index. Study of functional requirement of watershed development structures. Study of watershed management technologies. Practice on softwares for analysis of hydrologic parameters of watershed. Study of role of various functionaries in watershed development programmes. Estimate preparation for watershed projects- Detailed estimate-Analysis of rates-Abstract of estimate. Study of preparation of detailed project report (DPR) for watershed projects. Techno-economic viability analysis of watershed projects. Visit to watershed development project areas.

**Lecture Schedule**

1. Watershed – introduction and characteristics.
2. Watershed development - problems and prospects, investigation, topographical survey, soil characteristics, vegetative cover, present land use practices and socio-economic factors.
3. Watershed management - concept, objectives, factors affecting.
4. Watershed planning based on land capability classes, hydrologic data for watershed planning,
5. Watershed delineation, coding of watershed, prioritization of watersheds – sediment yield index. Water budgeting in a watershed.
6. Management measures - rainwater conservation technologies - *in-situ* and *ex-situ* storage,
7. Water harvesting and recycling.
8. Dry farming techniques - inter-terrace and inter-bund land management.
9. Integrated watershed management - concept, components, arable lands - agriculture and horticulture, non-arable lands - forestry, fishery and animal husbandry.
10. Effect of cropping systems, land management and cultural practices on watershed hydrology.
11. Watershed programme - execution, follow-up practices, maintenance, monitoring and evaluation.
12. People's participation in watershed management.
13. Participatory watershed management - role of watershed associations, user groups and self-help groups.
14. Estimate preparation for watershed projects- Detailed estimate-Analysis of rates-Abstract of estimate.
15. Planning and formulation of project proposal for watershed management programme including cost-benefit analysis.
16. Preparation of detailed project report (DPR) for watershed projects

**Practical Schedule**

1. Exercises on delineation of watersheds using toposheets.
2. Surveying and preparation of watershed map.
3. Quantitative analysis of watershed characteristics and parameters.
4. Watershed investigations for planning and development.
5. Analysis of hydrologic data for planning watershed management.
6. Water budgeting of watersheds.
7. Prioritization of watersheds based on sediment yield index.
8. Study of functional requirement of watershed development structures.
9. Study of watershed management technologies.
10. Practice on softwares for analysis of hydrologic parameters of watershed.
11. Study of role of various functionaries in watershed development programmes.
12. Estimate preparation for watershed projects-
13. Detailed estimate-
14. Analysis of rates-
15. Abstract of estimate.
16. Study of preparation of detailed project report (DPR) for watershed projects.
17. Visit to watershed development project areas.

**Suggested Readings**


1. Ghanshyam Das. 2008. Hydrology and Soil Conservation Engineering: Including Watershed Management. 2nd Edition, Prentice-Hall of India Learning Pvt. Ltd., New Delhi.
2. Katyal, J.C., R.P. Singh, Shriniwas Sharma, S.K. Das, M.V. Padmanabhan and P.K. Mishra. 1995. Field Manual on Watershed Management. CRIDA, Hyderabad.
3. Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management.International Books and Periodicals Supply Service. New Delhi.
4. Sharda, V.N., A.K. Sikka and G.P. Juyal. 2006. Participatory Integrated Watershed Management: A Field Manual. Central Soil and Water Conservation Research and Training Institute, Dehradun.
5. Singh, G.D. and T.C. Poonia. 2003. Fundamentals of Watershed Management Technology. Yash Publishing House, Bikaner.
6. Singh, P.K. 2000. Watershed Management: Design and Practices. E-media Publications, Udaipur.
7. Singh, R.V. 2000. Watershed Planning and Management.Yash Publishing House, Bikaner.
8. Tideman,E.M. 1999. Watershed Management: Guidelines for Indian Conditions. Omega Scientific Publishers, New Delhi.


## Lwre. 3209 Remote Sensing and GIS Applications 2(1+1)

**Objective**

- To provide exposure to students in gaining knowledge on concepts and applications leading to modeling of earth resources management using Remote Sensing, GIS and GPS technologies.
- To acquire skills in storing, managing digital data for planning and development.

**Theory**

**Module I** **(6 Hours)**

Basic component of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources; electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface; major atmospheric windows; principal applications of different wavelength regions; typical spectral reflectance curve for vegetation, soil and water; spectral signatures; different types of sensors and platforms; contrast ratio and possible causes of low contrast.

**Module II** **(3 Hours)**

Aerial photography; types of aerial photographs, scale of aerial photographs, planning aerial photography- end lap and side lap; stereoscopic vision, requirements of stereoscopic photographs; air-photo interpretation- interpretation elements; Introduction to photogrammetry.

**Module III** **(4 Hours)**

satellite remote sensing, multispectral scanner- whiskbroom and push-broom scanner; different types of resolutions; analysis of digital data- image restoration; image enhancement; information extraction, image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices; Introduction to microwave remote sensing.

**Module IV** **(5 Hours)**

GIS and basic components, different sources of spatial data, basic spatial entities, major components of spatial data, Basic classes of map projections and their properties, Methods of data input into GIS, Data editing, spatial data models and structures, Attribute data management, integrating data (map overlay) in GIS. Introduction to GPS: History, Transit, Timation, NAVSTAR GPS, GLONASS, GALILEO, IRNSS; GPS design objectives and details of segments space, control and user. Application of remote sensing and GIS for the management of land and water resources.

**Practical**

Familiarization with remote sensing and GIS hardware; use of software for image interpretation; interpretation of aerial photographs and satellite imagery; basic GIS operations such as image display; study of various features of GIS software package; scanning, digitization of maps and data editing; data base query and map algebra. GIS supported case studies in water resources management.

**Lecture Schedule**

1. Basic component of remote sensing (RS), advantages and limitations of RS.
2. Possible use of RS techniques in assessment and monitoring of land and water resources
3. Electromagnetic spectrum and energy interactions in the atmosphere and with the Earth's surface
4. Major atmospheric windows; principal applications of different wavelength regions
5. Typical spectral reflectance curve for vegetation, soil and water; Spectral signatures.
6. Different types of sensors and platforms. Contrast ratio and possible causes of low contrast
7. Aerial photography; types of aerial photographs, scale of aerial photographs, planning aerial photography- end lap and side lap
8. Stereoscopic vision, requirements of stereoscopic photographs, Air-photo interpretation-interpretation elements
9. Photogrammetry- measurements on a single vertical aerial photograph.
10. Satellite remote sensing, multispectral scanner, whiskbroom and push-broom scanner.
11. Different types of resolutions; analysis of digital data- image restoration; image enhancement; information extraction.
12. Image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices;
13. Principles and physics of microwave remote sensing, Radar principle, radar image properties, polarimetry and SAR.
14. GIS and basic components, different sources of spatial data, basic spatial entities, major components of spatial data,
15. Basic classes of map projections and their properties, Methods of data input into GIS, Data editing, spatial data models and structures, Attribute data management, integrating data (map overlay) in GIS.
16. Introduction to GPS: History, Transit, Timation, NAVSTAR GPS, GLONASS, GALILEO, IRNSS; GPS design objectives and details of segments space, control and user, Application of remote sensing and GIS for the management of land and water resources.

**Practical Schedule**

1. Interpretation of aerial photograph
2. Photogrammetry
3. Introduction to image processing software
4. Image pre processing technique - contast enhancement
5. Image pre processing technique - spatial enhancement
6. Image classification - unsupervised

7. Image classification - supervised
8. Multiband operation
9. Introduction to GIS software
10. Coordinate systems
11. Georeferencing
12. Creation of point and line map
13. Creation of polygon map
14. spatial data management, attribute data handling
15. Digital elevation model (DEM)
16. Geostatistical analysis. RS and GIS application in Agricultural Engineering.

**Suggested Readings**


1. Lillesand, T., R.W. Kiefer and J. Chipman. 2015. Remote Sensing and Image Interpretation. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.
2. Jensen, J.R. 2013. Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education Limited, UK.
3. Chang, K.T. 2014. Introduction to Geographic Information System, Mc Graw Hill
4. George Joseph. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad.
5. Sabins, F.F. 2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA.
6. Shultz, G.A. and E.T. Engman. 2000. Remote Sensing in Hydrology and Water Management. Springer, New York

## Land and Water Resources and Conservation Engineering- Electives

### Ellw. 4201 Floods and Control Measures 3(2+1)

**Objectives**

- To familiarize the students with the relevance of different flood control measures.
- To impart the knowledge about planning of flood control projects and their economics.

**Theory**

**Module I** **(10 Hours)**

Floods - causes of occurrence, flood classification - probable maximum flood, standard project flood, design flood, flood estimation - methods of estimation; estimation of flood peak - rational method, empirical methods, unit hydrograph method. Statistics in hydrology, flood frequency methods - log normal, Gumbel's extreme value, log-Pearson type-III distribution; depth-area-duration analysis. Flood forecasting. Flood routing - channel routing, Muskingum method, reservoir routing, modified Pul's method. Flood control - history of flood control, structural and non-structural measures of flood control, storage and detention reservoirs, levees, channel improvement.

**Module II** **(10 Hours)**

Gully erosion and its control structures - design and implementation. Ravine control measures. River training works, planning of flood control projects and their economics. Earthen embankments - functions, classification - hydraulic fill and rolled fill dams - homogeneous, zoned and diaphragm type, foundation requirements, grouting, seepage through dams.

**Module III** **(7 Hours)**

Flow net and its properties, seepage pressure, seepage line in composite earth embankments, drainage filters, piping and its causes. Design and construction of earthen dam, stability of earthen embankments against failure by tension, overturning, sliding etc., stability of slopes - analysis of failure by different methods.

**Module IV** **(5 Hours)**

Subsurface dams - site selection and constructional features. Check dam - Small earthen embankments - types and design criteria. Subsurface dams - site selection and constructional features.

**Practical**

Determination of flood stage-discharge relationship in a watershed. Determination of flood peak-area relationships. Determination of frequency distribution functions for extreme flood values using Gumbel's method. Determination of confidence limits of the flood peak estimates for Gumbel's extreme value distribution. Determination of frequency distribution functions for extreme flood values using log-Pearson Type-III distribution. Determination of probable maximum flood, standard project flood and spillway design flood. Design of levees for flood control. Design of jetties. Study of vegetative and structural measures for gully stabilization. Design of gully/ravine control structures and cost estimation. Designing, planning and cost- benefit analysis of a flood control project. Study of different types, materials and design considerations of earthen dams. Determination of the position of phreatic line in earth dams for various conditions, stability analysis of earthen dams against head water pressure, foundation shear, sudden draw down condition etc. Stability of slopes of earth dams by friction circle and other methods. Construction of flow net for isotropic and anisotropic media. Computation of seepage by different methods.

Determination of settlement of earth dam. Input-output-storage relationships by reservoir routing. Visit to sites of earthen dam and water harvesting structures.

**Lecture schedule**

1. Floods - causes of occurrence, flood classification
2. Probable maximum flood, standard project flood
3. Probable maximum flood, standard project flood
4. Design flood, flood estimation - methods of estimation; estimation of flood peak - rational method, empirical methods, unit hydrograph method
5. Design flood, flood estimation - methods of estimation; estimation of flood peak - rational method, empirical methods, unit hydrograph method
6. Statistics in hydrology, flood frequency methods - log normal, Gumbel's extreme value, log-Pearson type-III distribution
7. Statistics in hydrology, flood frequency methods - log normal, Gumbel's extreme value, log-Pearson type-III distribution
8. Depth-area-duration analysis
9. Depth-area-duration analysis
10. Flood forecasting. Flood routing - channel routing, Muskingum method, reservoir routing, modified Pul's method
11. Flood forecasting. Flood routing - channel routing, Muskingum method, reservoir routing, modified Pul's method
12. Flood control - history of flood control, structural and non-structural measures of flood control, storage and detention reservoirs, levees, channel improvement
13. Flood control - history of flood control, structural and non-structural measures of flood control, storage and detention reservoirs, levees, channel improvement
14. Gully erosion and its control structures - design and implementation
15. Gully erosion and its control structures - design and implementation
16. Ravine control measures
17. Ravine control measures
18. River training works, planning of flood control projects and their economics
19. River training works, planning of flood control projects and their economics
20. Earthen embankments – functions, advantages and disadvantages
21. Classification - hydraulic fill and rolled fill dams - homogeneous, zoned and diaphragm type
22. Classification - hydraulic fill and rolled fill dams - homogeneous, zoned and diaphragm type
23. Foundation requirements, grouting, seepage through dams
24. Foundation requirements, grouting, seepage through dams
25. Flow net and its properties, seepage pressure, seepage line in composite earth embankments, drainage filters, piping and its causes
26. Flow net and its properties, seepage pressure, seepage line in composite earth embankments, drainage filters, piping and its causes
27. Design and construction of earthen dam, stability of earthen embankments against failure by tension, overturning, sliding etc
28. Design and construction of earthen dam, stability of earthen embankments against failure by tension, overturning, sliding etc
29. Stability of slopes - analysis of failure by different methods
30. Subsurface dams - site selection and constructional features
31. Check dam - Small earthen embankments - types and design criteria
32. Subsurface dams - site selection and constructional features.

**Practical Schedule**

1. Determination of flood stage-discharge relationship in a watershed
2. Determination of flood peak-area relationships
3. Determination of frequency distribution functions for extreme flood values using Gumbel's method
4. Determination of confidence limits of the flood peak estimates for Gumbel's extreme value distribution
5. Determination of frequency distribution functions for extreme flood values using log-Pearson Type-III distribution
6. Determination of probable maximum flood, standard project flood and spillway design flood
7. Design of levees for flood control
8. Design of jetties
9. Study of vegetative and structural measures for gully stabilization
10. Design of gully/ravine control structures and cost estimation
11. Designing, planning and cost- benefit analysis of a flood control project
12. Study of different types, materials and design considerations of earthen dams.
13. Determination of the position of phreatic line in earth dams for various conditions
14. Stability analysis of earthen dams against head water pressure, foundation shear, sudden draw down condition etc.
15. Stability of slopes of earth dams by friction circle and other methods.
16. Construction of flow net for isotropic and anisotropic media.
17. Visit to sites of earthen dam and water harvesting structures.

**Suggested Readings**


1. Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
2. Murthy, V.V.N. 2002.Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
3. Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.
4. Mutreja, K.N. 1990. Applied Hydrology. Tata McGraw-Hill Publishing Co., New York, Delhi.
5. Subramanya, K. 2008. Engineering Hydrology.3rd Edition, Tata McGraw-Hill Publishing Co., New Delhi.
6. Bureau of Reclamation. 1987. Design of Small Dams. US Department of Interior, Washington DC, USA.
7. Arora, K.R. 2014.Soil Mechanics and Foundation Engineering (Geotechnical Engineering).Standard Publishers Distributors, Delhi.
8. Garg, S.K. 2014.Soil Mechanics and Foundation Engineering. Khanna Publishers Pvt. Ltd., New Delhi.
9. Stephens Tim. 2010. Manual on Small Earth Dams - A Guide to Siting, Design and Construction. Food and Agriculture Organization of the United Nations, Rome.

## Ellw. 4202 Wasteland Development 3(2+1)

**Objectives**

- To familiarize the students with the relevance of wasteland development and its socio economic perspectives.
- To impart the knowledge about the planning and design of engineering measures for reclamation of wasteland.

**Theory**

**Module I** **(10 Hours)**

Land degradation – concept, classification - arid, semiarid, humid and sub-humid regions, denuded range land and marginal lands. Wastelands - factors causing, classification and mapping of wastelands, planning of wastelands development - constraints, agro-climatic conditions, development options, contingency plans. Conservation structures - gully stabilization, ravine rehabilitation, sand dune stabilization, water harvesting and recycling methods.

**Module II** **(10 Hours)**

Afforestation - agro-horti-forestry-silvipasture methods, forage and fuel crops - socioeconomic constraints. Shifting cultivation, optimal land use options. Wasteland development – hills, semi-arid, coastal areas, water scarce areas, reclamation of waterlogged and salt-affected lands.

**Module III** **(7 Hours)**

Mine spoils- impact, land degradation and reclamation and rehabilitation, slope stabilization and mine environment management. Micro-irrigation in wastelands development. Sustainable wasteland development - drought situations, socio-economic perspectives.

**Module IV** **(5 Hours)**

Government policies. Participatory approach. Preparation of proposal for wasteland development and benefit-cost analysis.

**Practical**

Mapping and classification of wastelands. Identification of factors causing wastelands. Estimation of vegetation density and classification. Planning and design of engineering measures for reclamation of wastelands. Design and estimation of different soil and water conservation structures under arid, semiarid and humid conditions. Planning and design of micro-irrigation in wasteland development. Cost estimation of the above measures / structures. Visit to wasteland development project sites.

**Lecture schedule**

1. Land degradation – concept
2. Classification - arid, semiarid, humid and sub-humid regions, denuded range land and marginal lands
3. Classification - arid, semiarid, humid and sub-humid regions, denuded range land and marginal lands
4. Wastelands - factors causing, classification and mapping of wastelands
5. Wastelands - factors causing, classification and mapping of wastelands
6. Planning of wastelands development - constraints, agro-climatic conditions, development options, contingency plans.
7. Planning of wastelands development - constraints, agro-climatic conditions, development options, contingency plans.
8. Conservation structures - gully stabilization

9. Conservation structures - gully stabilization
10. Conservation structures - ravine rehabilitation
11. Conservation structures - ravine rehabilitation
12. Conservation structures - sand dune stabilization
13. Conservation structures - water harvesting and recycling methods
14. Conservation structures - water harvesting and recycling methods
15. Afforestation - agro-horti-forestry-silvipasture methods, forage and fuel crops - socioeconomic constraints
16. Afforestation - agro-horti-forestry-silvipasture methods, forage and fuel crops - socioeconomic constraints
17. Shifting cultivation, optimal land use options
18. Wasteland development - hills
19. Wasteland development - semi-arid regions
20. Wasteland development - coastal areas
21. Wasteland development - water scarce areas
22. Wasteland development - reclamation of waterlogged and salt-affected lands
23. Wasteland development - reclamation of waterlogged and salt-affected lands
24. Mine spoils- impact, land degradation and reclamation and rehabilitation, slope stabilization and mine environment management
25. Mine spoils- impact, land degradation and reclamation and rehabilitation, slope stabilization and mine environment management
26. Micro-irrigation in wastelands development
27. Micro-irrigation in wastelands development
28. Sustainable wasteland development - drought situations, socio-economic perspectives
29. Sustainable wasteland development - drought situations, socio-economic perspectives
30. Government policies, Participatory approach
31. Preparation of proposal for wasteland development
32. benefit-cost analysis

**Practical schedule**

1. Mapping and classification of wastelands
2. Mapping and classification of wastelands
3. Identification of factors causing wastelands
4. Identification of factors causing wastelands
5. Estimation of vegetation density and classification
6. Estimation of vegetation density and classification
7. Planning and design of engineering measures for reclamation of wastelands
8. Planning and design of engineering measures for reclamation of wastelands
9. Design and estimation of different soil and water conservation structures under arid conditions
10. Design and estimation of different soil and water conservation structures under semiarid conditions
11. Design and estimation of different soil and water conservation structures under humid conditions
12. Planning and design of micro-irrigation in wasteland development
13. Planning and design of micro-irrigation in wasteland development
14. Cost estimation of the above measures / structures
15. Cost estimation of the above measures / structures
16. Visit to wasteland development project sites

**Suggested Readings**

1. Abrol, I.P., and V.V. Dhruvanarayana. 1998. Technologies for Wasteland Development. ICAR, New Delhi.
2. Ambast, S.K., S.K. Gupta and Gurcharan Singh (Eds.) 2007.Agricultural Land Drainage - Reclamation of Waterlogged Saline Lands. Central Soil Salinity Research Institute, Karnal, Haryana.
3. Hridai Ram Yadav. 2013. Management of Wastelands. Concept Publishing Company. New Delhi.
4. Karthikeyan, C., K. Thangaraja, C. Cinthia Fernandez and K. Chandrakandon.2009.Dryland Agriculture and Wasteland Management. Atlantic Publishers and Distributors Pvt. Ltd., New Delhi.
5. Rattan Lal and B.A. Stewart (Ed.). 2015. Soil Management of Smallholder Agriculture. Volume 21 of Advances in Soil Science. CRC Press, Taylor and Francis Group, Florida, USA.
6. Robert Malliva and Thomas Missimer. 2012. Arid Lands Water Evaluation and Management. Springer Heidelberg, New York.
7. Swaminathan, M.S. 2010. Science and Integrated Rural Development. Concept Publishing Company (P) Ltd., Delhi.
8. The Energy and Resources Institute. 2003. Looking Back to Think Ahead-Green India 2047. Growth with Resource Enhancement of Environment and Nature. New Delhi.
9. Virmani, S.M. (Ed.). 2010. Degraded and Wastelands of India: Status and Spatial Distribution. ICAR, New Delhi.

## Ellw. 4203 Information Technology for Land and Water Management 3(2+1)

**Objective**

- To gain knowledge on the application of IT for the sustainable and productive use of land and water especially from the point of view of agriculture.

**Theory**

**Module I** **(8 Hours)**

Concept of Information Technology (IT) and its application potential.Role of IT in natural resources management. Existing system of information generation and organizations involved in the field of land and water management. Application and production of multimedia.Internet application tools and web technology.

**Module II** **(8 Hours)**

Networking system of information.Problems and prospects of new information and communication technology.Development of database concept for effective natural resources management.

**Module III** **(8 Hours)**

Application of remote sensing, geographic information system (GIS) and GPS. Rational data base management system. Object oriented approaches. Information system, decision support systems and expert systems.

**Module IV** **(8 Hours)**

Agricultural information management systems - use of mathematical models and programmes. Application of decision support systems, multi sensor data loggers and overview of software packages in natural resource management. Video-conferencing of scientific information.

**Practical**

Multimedia production. Internet applications: E-mail, voice mail, web tools and technologies. Handling and maintenance of new information technologies and exploiting their potentials. Exercises on database management using database and spreadsheet programmes. Usage of remote sensing, GIS and GPS survey in information generation and processing. Exercises on running computer software packages dealing with water balance, crop production, land development, land and water allocation, watershed analysis etc. Exercises on simple decision support and expert systems for management of natural resources. Multimedia production using different softwares. Exercises on development of information system on selected theme(s).Video-conferencing of scientific information.

**Lecture Schedule**

1-2. Concept of Information Technology (IT) and its application potential
3. Role of IT in natural resources management.
4-5. Existing system of information generation and organizations involved in the field of land and water management.
6-7 Application and production of multimedia.
8-9. Internet application tools and web technology.
10-11. Networking system of information.
12-13 Problems and prospects of new information and communication technology.
14-15 Development of database concept for effective natural resources management.
16-18. Introduction to remote sensing
19 Application of remote sensing in land and water management.
20-21 Introduction to GIS
22-23 Introduction to GPS technology
25-26 Principles of rational data base management system.
27 Object oriented approaches in DBMS. Information system
28 Decision support systems and expert systems.
29-30 Agricultural information management systems
31. Use of mathematical models and programmes for LWR management.
32 Application of decision support systems, multi sensor data loggers and overview of software packages in natural resource management. Video-conferencing of scientific information.

**Practical**

1. Multimedia production.
2. Internet applications: E-mail, voice mail, web tools and technologies.
3. Handling and maintenance of new information technologies and exploiting their potentials.
4. Exercises on database management using database and spreadsheet programmes.
5. Use of Remote Sensing in information generation and processing
6. Use of GIS in information generation and processing
7. Use of GPS survey in information generation and processing.
8. Exercises on water balance with software package
9. Exercise on crop production with software package
10. Exercise on crop production with software package
11. Exercise on land development, land and water allocation with software package,
12. Exercise on watershed analysis with software package.
13. Exercises on simple decision support and expert systems for management of natural resources.
14. Multimedia production using different softwares.
15. Exercises on development of information system on selected theme(s).
16. Video-conferencing of scientific information.

**Suggested Readings**

1. Climate-Smart Agriculture – Source Book. 2013. Food and Agriculture Organization, Rome.
2. Daniel P. Loucks and Eelco van Beek. 2005. Water Resources Systems Planning and Management - An Introduction to Methods, Models and Applications. UNESCO, Paris.
3. Dipak De and Basavaprabhu Jirli (Eds.). 2010. Communication Support for Sustainable Development. Ganga Kaveri Publishing House, Varanasi – 221001.
4. FAO. 1998. Land and Water Resources Information Systems. FAO Land and Water Bulletin 7, Rome.
5. FulingBian and YichunXie (Eds.). 2015. Geo-Informatics in Resource Management and Sustainable Ecosystem. Springer, New York.
6. ICFAI Business School (IBS). 2012. Information Technology and Systems. IBS Centre for Management Research, Hyderabad.
7. Robert Malliva and Thomas Missimer. 2012. Arid Lands Water Evaluation and Management. Environmental Science.Springer, New York.
8. Sarvanan. R. 2011. Information and Communication Technology for Agriculture and Rural Development.New India Publishing Agency, New Delhi.
9. Soam, S.K., P.D. Sreekanth and N.H. Rao (Eds.).2013. Geospatial Technologies for Natural Resources Management.New India Publishing Agency, Delhi.

## Ellw. 4204 Precision Farming Techniques for Protected Cultivation 3(2+1)

**Objective**

1. To familiarize the students with the relevance and scope of precision farming and protected cultivation.
2. To impart knowledge about the various modern precision farming techniques and their application in protected cultivation.

**Theory**

**Module I** **(10 Hours)**

Protected cultivation: Introduction, History, origin, development, National and International Scenario, components of green house, perspective, Types of green houses, polyhouses /shed nets, Cladding materials, Plant environment interactions – principles of limiting factors, solar radiation and transpiration, greenhouse effect, light, temperature, relative humidity, carbon dioxide enrichment, Design and construction of green houses – site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system, selection of equipment, Greenhouse cooling system – necessity, methods – ventilation with roof and side ventilators, evaporative cooling, different shading material fogging, combined fogging and fan-pad cooling system, design of cooling system, maintenance of cooling and ventilation systems, pad care etc.

**Module II** **(10 Hours)**

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

**Module III** **(7 Hours)**

Fertilization – nutrient deficiency symptoms and functions of essential nutrient elements, principles of selection of proper application of fertilizers, fertilizer scheduling, rate of application

of fertilizers, methods, automated fertilizer application. Greenhouse climate measurement, control and management.

**Module IV** **(5 Hours)**

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

**Practical**

Estimation of material requirement for construction of greenhouse ; Determination of fertilization schedule and rate of application for various crops; Estimation of material requirement for preparation of root media; Root media preparation, bed preparation and disinfections; Study of different planting techniques ; Design and installation of irrigation system; Design and installation of fogging system ; Greenhouse heating; Study of different greenhouse environment control instruments; Study of operation maintenance and fault detection in irrigation system; Study of operation maintenance and fault detection in fogging system; Economic analysis of greenhouses and net houses; Visit to greenhouses.

**Lecture schedule**

1. Protected cultivation: Introduction, History, origin and development
2. National and International Scenario, components of green house, perspective
3. Types of green houses
4. Polyhouses /shed nets
5. Cladding materials
6. Plant environment interactions – principles of limiting factors, solar radiation and transpiration.
7. Greenhouse effect, light, temperature, relative humidity and carbon dioxide enrichment
8. Design and construction of green houses – site selection
9. Greenhouse orientation, design and construction
10. Design for ventilation requirement using exhaust fan system, selection of equipment
11. Greenhouse cooling system – necessity, methods – ventilation with roof and side ventilators.
12. Evaporative cooling, different shading material fogging, combined fogging and fan-pad cooling system.
13. Design of cooling system, maintenance of cooling and ventilation systems, pad care etc.
14. Greenhouse heating – necessity, components, methods.
15. Design of greenhouse heating system.
16. Root media – types – soil and soil less media, composition, estimation and preparation
17. Disinfection and bed preparation
18. Planting techniques in green house cultivation
19. Irrigation in greenhouse and net house
20. Water quality, types of irrigation system, components, design, installation and material requirement.
21. Fogging system for greenhouses and net houses – introduction, benefits
22. Design, installation and material requirement of fogging system
23. Maintenance of irrigation system
24. Maintenance of fogging system
25. Principles of selection of proper application of fertilizers, fertilizer scheduling
26. Rate of application of fertilizers, methods, automated fertilizer application
27. Greenhouse climate measurement and control
28. Insect and disease management in greenhouse and net houses,
29. Selection of crops for greenhouse cultivation
30. Major crops in greenhouse – irrigation requirement, fertilizer management and cultivation

31. Harvesting of greenhouse crops and post harvest techniques
32. Economic analysis

**Practical schedule**

1. Estimation of material requirement for construction of greenhouse
2. Determination of fertilization schedule and rate of application for various crops
3. Estimation of material requirement for preparation of root media
4. Root media preparation, bed preparation and disinfections
5. Root media preparation, bed preparation and disinfections
6. Study of different planting techniques
7. Design and installation of irrigation system
8. Design and installation of irrigation system
9. Design and installation of fogging system
10. Design and installation of fogging system
11. Greenhouse heating
12. Study of different greenhouse environment control instruments
13. Study of operation maintenance and fault detection in irrigation system
14. Study of operation maintenance and fault detection in fogging system
15. Economic analysis of greenhouses and net houses
16. Visit to greenhouses

**Suggested Readings**


1. Ernst van Heurn and Kees Van der Post. 2004. Protected Cultivation. Digigrafi, Wageningan, The Netherlands.
2. Peter, K.V. and Sing D.K. 2013. Protected Cultivation of Horticulture Crops, New India Publishing Company.
3. Reddy P.P. 2016. Sustainable Crop Protection under Protected Cultivation. Springer Singapore.
4. Singh Brahma and Balraj Singh. 2014. Advances in protected cultivation, New India Publishing Company.
5. Sharma P. 2007.Precision Farming. Daya Publishing House New Delhi


## Ellw. 4205 Water Quality and Management Measures 3(2+1)

**Objective**

1. To familiarize the water quality in relation to domestic, industrial and agricultural activities.
2. To impart awareness of impurities which contaminated the surface and ground water and also give the awareness on its control and management measures.

**Theory**

**Module I** **(6 Hours)**

Natural factors affecting quality of surface water and groundwater, water quality objectives in relation to domestic, industrial and agricultural activities, drinking water quality standards, irrigation water quality classification as per USSL and All Indian Coordinated Research Project (AICRP) criteria.

**Module II** **(14 Hours)**

Impurities in water. Point and non-point water pollution sources, water contamination due to inorganic and organic compounds, water contamination related to agricultural chemicals, food industry, hydrocarbon and synthetic organic compounds.

**Module III** **(12 Hours)**

Arsenic and fluoride contamination in groundwater and remedial measures, water decontamination technologies, cultural and management practices for using poor quality water for irrigation. Modelling studies in water pollution.

**Practical**

Water quality analysis and classification according to USSL and AICRP criteria; soil chemical analysis and estimation of lime and gypsum requirements; Determination of dissolved impurities and suspended impurities. Bacteriological test of water, study of salinity development under shallow and deep water table conditions; study of contamination movement and transport in soil profile; study of different water decontamination techniques; study of different cultural and management practices for using poor quality water for irrigation; field visit to industrial effluent disposal sites.

**Lecture schedule**

1-2. Natural factors affecting quality of surface water and groundwater
3-4. Water quality objectives in relation to domestic, industrial and agricultural activities
5-6. Drinking water quality standards, irrigation water quality classification as per USSL and All Indian Coordinated Research Project (AICRP) criteria.
7-9. Physical, Chemical and Biological impurities in water and its analysis
10-11. Point and non-point water pollution sources, water contamination due to inorganic compounds
12-13. Point and non-point water pollution sources, water contamination due to organic compounds
14-16. Water contamination related to agricultural chemicals & food industry and its control measures
17-18. Water contamination related to hydrocarbon and synthetic organic compounds and its control measures.
19-20. Problems.
21-22. Arsenic contamination in groundwater and remedial measures
22-24. Fluoride contamination in groundwater and remedial measures
25-28. Water decontamination technologies.
29-30. Cultural and management practices for using poor quality water for irrigation.
31-32. Modelling studies in water pollution.

**Practical**

1. Water quality analysis and classification according to USSL criteria
2. Water quality analysis and classification according to AICRP criteria
3. Determination of dissolved impurities
4. Determination of dissolved impurities
5. Determination of suspended impurities
6. Determination of suspended impurities
7. Bacteriological test of water
8. Bacteriological test of water
9. Soil chemical analysis and estimation of lime and gypsum requirements;
10. Study of salinity development under shallow water table conditions
11. Study of salinity development under deep water table conditions

12. Study of contamination movement and transport in soil profile
13. Study of different water decontamination techniques
14. Study of different water decontamination techniques
15. Study of different cultural and management practices for using poor quality water for irrigation;
16. Field visit to industrial effluent disposal sites.

**Suggested Readings**


1. FAO. 1996. Control of water pollution from agriculture - FAO irrigation and drainage paper 55.
2. Gray, N.F. Water Technology. Raj Kamal Electric Press, Kundli, Haryana.
3. Hussain, S.K. 1986. Text Book of Water Supply and Sanitary Engineering. Oxford & IBH Publishing Co. New Delhi.
4. Manahan, S.E. 2009. Fundamentals of Environmental Chemistry. CRC Press, New York.
5. McGauhey, P.H. 1968. Engineering Management of water quality. McGraw Hill Book Company, New York.
6. Minhas, P.S. and Tyagi, N.K. 1998.Guidelines for irrigation with saline and alkali waters. Bull. No, 1/98, CSSRI, Karnal, p. :36.
7. Punmia, B.C. and Lal, P.B.B. 1981. Irrigation and water power engineering. Standard Publishers Distributors, Delhi.


## Ellw. 4206 Plastic Applications in Agriculture 3(2+1)

**Objective**

- To study the different plastic products used in agricultural sector
- To study the innovations in plasticulture for improving the production.

**Theory**

**Module I** **(7 Hours)**

Introduction of plasticulture - types and quality of plastics used in soil and water conservation, production agriculture and post harvest management. Quality control measures. Present status and future prospective of plasticulture in India.

**Module II** **(8 Hours)**

Water management - use of plastics in in-situ moisture conservation and rain water harvesting. Plastic film lining in canal, pond and reservoir. Plastic pipes for irrigation water management, bore-well casing and subsurface drainage. Use of polymers in control of percolation losses in fields. Soil conditioning - soil solarisation, effects of different colour plastic mulching in surface covered cultivation.

**Module III** **(7 Hours)**

Nursery management - Use of plastics in nursery raising, nursery bags, trays etc. Controlled environmental cultivation - plastics as cladding material, green / poly / shade net houses, wind breaks, poly tunnels and crop covers. Plastic nets for crop protection - anti insect nets, bird protection nets.

**Module IV** **(10 Hours)**

Plastic fencing. Plastics in drying, preservation, handling and storage of agricultural produce, innovative plastic packaging solutions for processed food products. Plastics for aquacultural

engineering and animal husbandry - animal shelters, vermi-beds and inland fisheries. Silage film technique for fodder preservation. Agencies involved in the promotion of plasticulture in agriculture at national and state level.

**Lecture Schedule**

1 Introduction of plasticulture
2 - 4 Types and quality of plastics used in soil and water conservation, production agriculture and post harvest management.
5 - 6 Quality control measures
7 Present status and future prospective of plasticulture in India.
8 -10 Water management - use of plastics in in-situ moisture conservation and rain water harvesting. Plastic film lining in canal, pond and reservoir.
11-13 Plastic pipes for irrigation water management, bore-well casing and subsurface drainage. Use of polymers in control of percolation losses in fields.
14 - 15 Soil conditioning - soil solarisation, effects of different colour plastic mulching in surface covered cultivation
16 Nursery management - Use of plastics in nursery raising, nursery bags, trays etc.
17-18 Controlled environmental cultivation - plastics as cladding material, green / poly / shade net houses, wind breaks, poly tunnels and crop covers
19 Plastic nets for crop protection - anti insect nets, bird protection nets..
20-22 Plastic fencing, Plastics in drying, preservation, handling and storage of agricultural produce, innovative plastic packaging solutions for processed food products.
23-25Plastics for aqua cultural engineering and animal husbandry - animal shelters, vermi-beds and inland fisheries
26 Silage film technique for fodder preservation.
27 Agencies involved in the promotion of plasticulture in agriculture at national and state level.

**Practical**

1. Design, estimation and laying of plastic films in lining of canal, reservoir and water harvesting ponds.
2. Study of components of subsurface drainage system.
3. Study of different colour plastic mulch laying.
4. Design, estimation and installation of green, poly and shade net houses, low tunnels etc.
5. Study on use of plastics in nursery, plant protection, inland fisheries, animal shelters, preparation of vermi-bed and silage film for fodder preservation.
6. Visits to nearby manufacturing units/dealers of PVC pipes, drip and sprinkler irrigation systems, greenhouse/ polyhouse/shadehouse/nethouse etc.
7. Visits to farmers' fields with these installations.

**Suggested Readings**

Brahma Singh, Balraj Singh, NavedSabir and MurtazaHasan. 2014.Advances in Protected Cultivation. New India Publishing Agency, New Delhi.
Brown, R.P. 2004. Polymers in Agriculture and Horticulture. RAPRA Review Reports : Vol. 15, No. 2. RAPRA Technology Limited, U.K.
Central Pollution Control Board. 2012. Material on Plastic Waste Management. PariveshBhawan, East Arjun Nagar, Delhi-110032.
Charles A. Harper. 2006. Handbook of Plastics Technologies. The Complete Guide to Properties and Performance.McGraw-Hill, New Delhi.
Dubois. 1978. Plastics in Agriculture. Applied Science Publishers Limited, Essex, England.
ManasChanda, Salil K. Roy. 2008. Plastics Fundamentals, Properties, and Testing.CRC Press.

Ojha,T.P. and Michael, A.M., 2012, Principles of Agricultural Engineering - I. Jain Brothers, Karol Bagh, New Delhi.
Pandey, P.H. 2014.Principles and Practices of Agricultural Structures and Environmental Control.Kalyani Publishers, Ludhiana, India.
Shankar, A.N. 2014.Integrated Horticulture Development in Eastern Himalayas, Plasticulture in Agri-Horticulture Systems, 241-247.
Srivastava, R.K., R.C. Maheswari, T.P. Ojha, and A. Alam. 1988. Plastics in Agriculture. Jain Brothers, Karol Bagh, New Delhi.

## Ellw. 4207 Quantity Surveying and Valuation 3(2+1)

**Objectives**

After studying the subject, the student should be able

1. To set out any agricultural engineering work and to prepare estimates.
2. To have a thorough idea regarding the quality and quantity of materials, quantity and classes of skilled and unskilled labours and tools and plants required for the project.
3. To calculate the exact quantities of items of work done for affecting payment
4. To mould themselves as entry level graduate engineers competent to manage any agricultural engineering project confidently either alone or jointly.

**Theory**

**Module I** **(12 Hours)**

Estimation – basic terms - types of estimates - revised estimate – supplementary estimate - maintenance estimate - approximate estimate - plinth area method – cubic rate method - unit rate method - bay method - approximate quantity from bill method - comparison method - cost from materials and labour etc. - preparation of detailed estimate for buildings - centre line method and 'long wall - short wall' method .

**Module II** **(10 Hours)**

Methods of measurements of different items of work - preparation detailed estimate for sanitary and water supply works - roads - irrigation works - steel structures – doors and windows - R C C Structures - Preparation of bar bending schedule.

**Module III** **(5 Hours)**

Detailed specifications for common building materials and items of work as per I.S specifications - preparation of conveyance statement - calculation of quantities of materials for items of work - analysis of rate for items of works required for agricultural engineering works - preparation of abstract of estimate of agricultural engineering works. Measurement books.

**Module IV** **(5 Hours)**

Valuation - explanation of items - types of values - sinking fund - years purchase - depreciation - straight line method - constant percentage method - S.F method - obsolescence - valuation of real property - rental method - profit based method - depreciation method - valuation of land - belting method - development method - hypothecated building scheme method - rent calculation - lease and lease hold property.

**Practical**

Study of different types of estimates. Preparation of detailed estimate. Preparation of detailed estimate for buildings. Preparation of detailed estimate for irrigation works. Preparation of detailed estimate for greenhouses. Preparation of detailed estimate for water supply works. Preparation of detailed estimate for Roads. Preparation of detailed estimate for drainage works. Preparation of

detailed estimate for check dams. Preparation of detailed estimate for water harvesting structures. Preparation of detailed estimate for dairy barn.Preparation of detailed estimate for storage structures. Methods of measurements of different items of work. Analysis of rate for items of works required for agricultural engineering works. Preparation of abstract of estimate.Measurement and writing measurement book. Visit to a work site.

**Lecture Schedule**

**Theory**

1-2 Introduction to estimation and coasting – basic terms
3 - 4 Methods of estimation
5 Types of estimates
6 Revised estimate
7 Supplementary estimate
8 Maintenance estimate
9 Approximate estimate
10 Plinth area method – cubic rate method - unit rate method - bay method
11 Approximate quantity from bill method - comparison method - cost from materials and labour etc.
12 - 14 Preparation of detailed estimate for buildings - centre line method and 'long wall - short wall' method.
15 - 16 Methods of measurements of different items of work
17 - 18 Preparation detailed estimate for sanitary and water supply works
19 Preparation detailed estimate for roads
20 Preparation detailed estimate for irrigation works
21 Preparation detailed estimate for steel structures
22 Preparation detailed estimate for doors and windows
23 Preparation detailed estimate for R C C Structures
24 Preparation of bar bending schedule.
25 Detailed specifications for common building materials and items of work as per I.S specifications
26 Preparation of conveyance statement
27 Calculation of quantities of materials for items of work
28 Analysis of rate for items of works required for agricultural engineering works
29 Preparation of abstract of estimate of agricultural engineering works.Measurement books.
30 Valuation - explanation of items - types of values - sinking fund - years purchase
31 - 32 Depreciation - straight line method - constant percentage method - S.F method - obsolescence
33 - 34valuation of real property - rental method - profit based method - depreciation method - valuation of land - belting method - development method - hypothecated building scheme method - rent calculation - lease and lease hold property.

**Practical**

1. Study of different types of estimates.
2. Preparation of detailed estimate.
3. Preparation of detailed estimate for buildings.
4. Preparation of detailed estimate for irrigation works.
5. Preparation of detailed estimate for greenhouses.
6. Preparation of detailed estimate for water supply works.
7. Preparation of detailed estimate for Roads.
8. Preparation of detailed estimate for drainage works.
9. Preparation of detailed estimate for check dams.

10. Preparation of detailed estimate for water harvesting structures.
11. Preparation of detailed estimate for dairy barn.
12. Preparation of detailed estimate for storage structures.
13. Methods of measurements of different items of work.
14. Analysis of rate for items of works required for agricultural engineering works.
15. Preparation of abstract of estimate.
16. Measurement and writing measurement book.
17. Visit to a work site.

**Suggested Readings**

1. Dutta, B.N. (2007) Estimating and costing in civil engineering. USB publishers distributors, New Delhi.
2. Chakraborthi, M. Estimating costing & Specification in Civil Engineering
3. Rangawala, S.C. Valuation of real properties

## Department of Food & Agricultural Process Engineering- Core courses

### Fape. 1101 Engineering Properties of Agricultural Produce 2(1+1)

**Objective**

To acquaint and equip the students with different engineering properties and its application in design of food processing equipments.

**Theory**

**Module I** **(8 Hours)**

Classification and importance of engineering properties of Agricultural Produce, shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area of grains, fruits and vegetables, Thermal properties, Heat capacity, Specific heat, Thermal conductivity, Thermal diffusivity, Heat of respiration; Co-efficient of thermal expansion, Friction in agricultural materials; Static friction, Kinetic friction, rolling resistance, angle of internal friction, angle of repose, Flow of bulk granular materials, Aero dynamics of agricultural products, drag coefficients, terminal velocity.

**Module II** **(6 Hours)**

Rheological properties; force, deformation, stress, strain, elastic, plastic and viscous behaviour, ideal classical models, rheological models, Newtonian and Non-Newtonian liquid, Visco-elasticity, Newtonian and Non-Newtonian fluid, Pseudo-plastic, Dilatant, Thixotropic, Rheopectic and Bingham Plastic Foods, Flow curves.

**Module III** **(2 Hours)**

Electrical properties; dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant, method of determination. Application of engineering properties in handling processing machines and storage structures.

**Practical**

Determination of the shape and size of grains, fruits and vegetables, Determination of bulk density and angle of repose of grains, Determination of the particle density/true density and porosity of solid grains, Finding the co-efficient of external and internal friction of different crops, Finding out the terminal velocity of grain sample and study the separating behaviour in a vertical wind tunnel, Finding the thermal conductivity of different grains, Determination of specific heat of some food grains, Determination of hardness of food material and determination of viscosity of liquid foods.

**Lecture schedule**

1. Introduction - engineering properties of biological material- classification and importance.
2. Physical properties- shape- size – roundness –Sphericity- application.
3. Physical properties-volume – density- porosity- specific gravity- surface area of grains-fruits and vegetables- application.
4. Thermal properties- heat capacity- specific heat- thermal conductivity-thermal diffusivity-application.
5. Heat of respiration-co-efficient of thermal expansion.
6. Friction in agricultural materials-static friction- kinetic friction- rolling resistance- angle of internal friction- angle of repose- application.
7. Flow of bulk granular materials.

8. Aero dynamics of agricultural products- drag coefficients- terminal velocity.
9. Rheological properties- force- deformation- stress- strain- elastic- plastic and viscous behaviour.
10. Ideal rheological models- Hookean body- St.Venant body- Newtonian fluid.
11. Rheological models- Kelvin model- generalized Kelvin model
12. Rheological models- Maxwell model- generalized Maxwell model- 4 element burger model
13. Rheological models- Maxwell model- generalized Maxwell model- 4 element burger model- application.
14. Newtonian and Non-Newtonian liquid-visco-elasticity- Newtonian and Non-Newtonian fluid-pseudo-plastic-dilatant- thixotropic- rheopectic-binghamplastic foods- flow curves- application- examples.
15. Electrical properties- dielectric loss factor- loss tangent- A.C. conductivity and dielectric constant- method of determination.
16. Application of engineering properties in handling processing machines and storage structures

**Practical schedule**

1. Determination of surface area of the agricultural materials
2. Determination of the shape and size of grains.
3. Determination of the shape and size of fruits and vegetables
4. Determination of bulk density
5. Determination of specific gravity
6. Determination of angle of repose of grains
7. Determination of the particle density/true density and porosity of solid grains
8. Finding the co-efficient of external and internal friction of different crops
9. Determination of filling angle of repose
10. Determination of emptying angle of repose
11. Finding out the terminal velocity of grain sample
12. Study the separating behavior in a vertical wind tunnel
13. Finding the thermal conductivity of different grains
14. Determination of specific heat of some food grains
15. Determination of hardness of food material
16. Determination of viscosity of liquid foods.

**Suggested Readings**


1. Mohesin, N.N. 1980. Physical Properties of Plants & Animals. Gordon & Breach Science Publishers , New York.
2. Mohesin, N.N. 1980. Thermal Properties of Foods and Agricultural Materials. Gordon & Breach Science Publishers , New York.
3. Prentice, J.H. 1984. Measurement in Rheological Properties of Food Stuffs. Elsevier Applied science Pub. Co. Inc. New York.
4. Rao, M.A. and Rizvi, S.H., .1995. Engineering Properties of Foods. Marcel Dekker Inc. New York.
5. Singhal OP and Samuel DVK. 2003. Engineering Properties of Biological Materials. Saroj Prakashan.

## Fape. 2102 Post Harvest Engineering of Cereals, Pulses and Oil Seeds 3(2+1)

**Objective**

To acquaint and equip the students with the post-harvest technology of major cereals, pulses and oilseeds with special emphasis on their equipments and also to create awareness on various unit operations related to these crops.

**Theory**

**Module I** **(11 Hours)**

Cleaning and grading, aspiration, scalping; size separators, screens, sieve analysis, capacity and effectiveness of screens. Various types of separators: specific gravity, magnetic, disc, spiral, pneumatic, inclined draper, velvet roll, colour sorters, cyclone, shape graders. Size reduction: principle, Bond's law, Kick's law, Rittinger's law, procedure (crushing, impact, cutting and shearing), Size reduction machinery: Jaw crusher, Hammer mill, Plate mill, Ball mill. Material handling equipment. Types of conveyors: Belt, roller, chain and screw. Elevators: bucket, Cranes & hoists. Trucks (refrigerated/ unrefrigerated), Pneumatic conveying.

**Module II** **(10 Hours)**

Drying: moisture content and water activity; Free, bound and equilibrium moisture content, isotherm, hysteresis effect, EMC determination, Psychrometric chart and its use in drying, Drying principles and theory, Thin layer and deep bed drying analysis, Falling rate and constant rate drying periods, maximum and decreasing drying rate period, drying equations, Mass and energy balance, Shedd's equation, Dryer performance, Different methods of drying, batch-continuous; mixing-non-mixing, Sun-mechanical, conduction, convection, radiation, superheated steam, tempering during drying, Different types of grain dryers: bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray. Mixing: Theory of mixing of solids and pastes, Mixing index, types of mixers for solids, liquid foods and pastes.

**Module III** **(4 Hours)**

Milling of rice: Conditioning and parboiling, advantages and disadvantages, traditional methods, CFTRI and Jadavpur methods, Pressure parboiling method, Types of rice mills, Modern rice milling, different unit operations and equipment. Milling of wheat, unit operations and equipment. By-products utilization

**Module IV** **(7 Hours)**

Milling of pulses: traditional milling methods, commercial methods, pre-conditioning, dry milling and wet milling methods: CFTRI and Pantnagar methods. Pulse milling machines, Milling of corn and its products. Dry and wet milling. Milling of oilseeds: mechanical expression, screw press, hydraulic press, solvent extraction methods, preconditioning of oilseeds, refining of oil, stabilization of rice bran., Extrusion cooking: principle, factors affecting, single and twin screw extruders..

**Practical**

Performance evaluation of different types of cleaners and separators, Determination of separation efficiency, Study of different size reduction machines and performance evaluation, Determination of fineness modulus and uniformity index, Study of different types of conveying and elevating equipments, Study of different types of mixers. Measurement of moisture content:

dry basis and wet basis, Study on drying characteristics of grains and determination of drying constant, Determination of EMC (Static and dynamic method), Study of various types of dryers, Study of different equipments in rice mills and their performance evaluation, Study of different equipments in pulse mills and their performance evaluation, Study of different equipments in oil mills and their performance evaluation, Type of process flow charts with examples relating to processing of cereals pulses and oil seeds, Visit to grain processing industries.

**Lecture schedule**

1. Cleaning and grading - types of screen-screen opening- ideal and actual screen – Effectiveness of screen.
2. Equipments for cleaning and grading – Air-screen cleaners – Rotary screen cleaner.
3. Various types of separators - disk separator – Indented cylinder separator – Spiral separator - specific gravity separator.
4. Separators –Destoner – Inclined draper – Velvet roll separator - magnetic, pneumatic separator.
5. Separators - colour sorters- cyclone separators – graders – rotating reel graders.
6. Size reduction – sieve analysis –fineness modulus - average size of particle.
7. Size reduction - principles of communition - Bond's law- Kick's law - Rittinger's law- Size reduction procedures-crushing, impact, cutting and shearing
8. Size reduction machinery – introduction- types -jaw crusher – gyratory crusher – crushing rolls - grinders – attrition mill- hammer mill-ball mill – cutting machines.
9. Material handling equipment- types of conveyors-belt conveyor- bucket elevator- screw conveyor.
10. Design considerations of material handling devices-capacity- power requirement.
11. Elevators: Cranes & hoists. Trucks (refrigerated/ unrefrigerated), Pneumatic conveying.
12. Drying- theory of grain drying - moisture content and water activity - Free, bound and equilibrium moisture content- moisture content determination methods – Direct and indirect methods.
13. Hysteresis effect- EMC determination - psychrometry- Psychrometric chart – psychrometric processes- solving problems.
14. Drying principles - thin layer and deep bed drying analysis, falling rate and constant rate drying period- critical moisture content- maximum and decreasing drying rate period, drying equations-solving problems
15. Drying models-Mass and energy balance, Shedd's equation, Dryer performance,
16. Different methods of drying – sun drying – mechanical drying –contact drying, convective drying , freeze drying, radiation drying, osmotic drying, vacuum drying, fluidized bed drying, desiccated air drying and super heater steam drying.
17. Grain dryers- introduction- batch- continuous -mixing-non-mixing
18. Different types of grain dryers- Deep bed dryer- flat bed dryer-continuous flow dryer-recirculating dryer-LSU dryer-fluidised bed dryer- rotary dryer- RPEC- tray dryer.
19. Mixing-introduction-theory of mixing-equipments- mixers for solid, liquid, paste and high viscous masses-mixing index-rate of mixing -effectiveness.
20. Paddy-production, structure and composition of paddy- Parboiling of paddy- merits and demerits—traditional methods- modern methods-CFTRI and Jadavpur methods - Pressure parboiling method.
21. Dehusking of paddy- traditional methods- pounding of paddy – Modern methods- Engleburg huller, Under runner disk huller – centrifugal dehusker
22. Milling of paddy- rubber roll sheller – paddy separator – Husk separator –Whitening – vertical whitening cone – horizontal abrasive whitener

23. Rice polishers – vertical polishing cone – horizontal polisher- rice graders-milling efficiency
24. Products and by products from paddy- utilization of rice bran and rice husk- layout of a modern rice mill - Rice products-beaten rice- puffed rice.
25. Wheat-production, structure and composition of wheat- conditioning of wheat-milling of wheat- unit operations and equipment-components of a wheat mill.
26. Pulses-production, structure and composition- types-unit operations in pulse milling-conventional methods of milling of pulses- commercial methods,
27. Commercial methods of milling of pulses- dry milling and wet milling methods: CFTRI and Pant nagar methods- pulse milling machines.
28. Corn- production, structure and its composition-corn dry milling- process in dry milling-Wet milling-process- corn wet milling products.
29. Oil seeds- production status- status of oil milling in India- oil extraction methods- expression and extraction- expression devices- hydraulic press-screw press-filtration equipment-plate and frame filter press.
30. Solvent extraction- principles-method-types of extractors.
31. Rice bran oil-stabilization of rice bran- composition of fatty acids in rice bran oil-extraction of rice bran oil-refining of rice bran oil-uses of rice bran oil.
32. Extrusion cooking-introduction- principle-types-Single and twin screw extruders.

**Practical schedule**

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

**Suggested Readings**


1. Chakraverty, A. 1995. Post Harvest Technology of cereals, pulses and oilseeds. Oxford & IBH publishing Co. Ltd., New Delhi.
2. Dash, S.K., Bebartta, J.P. and Kar, A. 2012. Rice Processing and Allied Operations. Kalyani Publishers, New Delhi.
3. Earle, R.L. 2003. Unit Operations in Food Processing. Pergamon Press. Oxford. U.K.
4. Geankoplis C. J. 1997. Transport processes and unit operations, Prentice Hall of India Pvt Ltd, New Delhi
5. McCabe, W.L., Smith J.C. and Harriott, P. 2005. Unit operations of Chemical Engineering. McGraw Hill.

6. Sahay, K.M. and Singh, K.K. 1994. Unit operations of Agricultural Processing. Vikas Publishing house Pvt. Ltd. New Delhi.
7. Singh, R. Paul. and Heldman, R.Dennis. 2004. Introduction to Food Engineering. 3rd Edition. Academic Press, London.

## Fape. 2203 Heat and Mass Transfer 2(2+0)

**Objective**

To impart the concept of various modes of heat and mass transfer and to develop an idea about the method of determination of heat transfer rates in conduction, convection and radiation and also to impart the concept of various heat exchangers.

**Theory**

**Module I** **(8 Hours)**

Concept, modes of heat transfer, thermal conductivity of materials, measurement. General differential equation of conduction. One dimensional steady state conduction through plane and composite walls, tubes and spheres with and without heat generation. Electrical analogy. Insulation materials, fins.

**Module II** **(6 Hours)**

Free and forced convection. Newton's law of cooling, heat transfer coefficient in convection. Dimensional analysis of free and forced convection. Useful non dimensional numbers. Equation of laminar boundary layer on flat plate and in a tube. Laminar forced convection on a flat plate and in a tube. Combined free and forced convection.

**Module III** **(8 Hours)**

Introduction. Absorptivity, reflectivity and transmissivity of radiation. Black body and monochromatic radiation, Planck's law, Stefan-Boltzman law, Kirchoff's law, grey bodies and emissive power, solid angle, intensity of radiation. Radiation exchange between black surfaces, geometric configuration factor.

**Module IV** **(10 Hours)**

Heat transfer analysis involving conduction, convection and radiation by networks. Types of heat exchangers, fouling factor, log mean temperature difference, heat exchanger performance, transfer units. Heat exchanger analysis restricted to parallel and counter flow heat exchangers. Steady state molecular diffusion in fluids at rest and in laminar flow, Fick's law, mass transfer coefficients. Reynold's analogy.

**Lecture Schedule**

1. Introduction to modes of heat transfer- conduction, convection and radiation
2. Mechanism of thermal conduction in solids, liquids and gases.
3. Fourier's law, heat transfer at the interference of two solids.
4. Electrical analogy in heat transfer
5. Thermal conductivity of materials.
6. Three dimensional Fourier conduction equations- derivations.
7. Steady state unidirectional heat flow through slabs, cylinders and spheres.
8. One dimensional steady state conduction through plane and composite walls with and without heat generation.

9. One dimensional steady state conduction through tubes with and without heat generation.
10. One dimensional steady state conduction through and spheres with and without heat generation.
11. Insulators-introduction –purpose-critical thickness of insulation.
12. Heat transfer of extended surface-fins
13. Introduction to free and forced convection-Newton's law of cooling
14. Heat transfer coefficient in convection-Dimensional analysis of free and forced convection
15. Useful non dimensional numbers
16. Equation of laminar boundary layer on flat plate and in a tube
17. Laminar forced convection on a flat plate and in a tube
18. Combined free and forced convection
19. Fundamentals of radiation – radiation spectrum – thermal radiation
20. Concept of black body and grey body
21. Absorptivity, reflectivity and transmissivity of radiation
22. Monochromatic radiation and total emissive power
23. Planck's law, Stefan-Boltzman law, Kirchoff's law
24. Intensity of radiation. Radiation exchange between black surfaces
25. Radiation between two surfaces - geometric configuration factor.
26. Introduction to Heat exchangers-Types of heat exchangers, fouling factor, scaling, log mean temperature difference (LMTD)
27. Heat exchanger performance, transfer units
28. Heat exchanger analysis restricted to parallel and counter flow heat exchangers
29. NTU method of performance evaluation of heat exchangers.
30. Steady state molecular diffusion in fluids at rest and in laminar flow
31. Introduction to mass transfer – Fick's law of diffusion
32. Mass transfer coefficients. Reynold's analogy.

**Suggested Readings**


1. Arora, S.C and Domkunderwar, S(1984). A course in Heat & Mass transfer, Dhanpat Rai & Sons, Delhi.
2. Geankoplis, C.J (1997), Transport Process and Unit Operations, Prentice Hall of India, New Delhi.
3. Holman, J.P. (1993), Heat Transfer S.I. Metric Edition, McGraw Hill Ltd., New Delhi.
4. Necati Ozisik (1985). Heat Transfer- A basic approach, International student edition, Mc Graw Hill Book Co. ltd., New Delhi.
5. Treybal, R.E., (1997), Mass Transfer Operation, McGraw Hill Ltd., New Delhi

## Fape. 3104 Agricultural Structures and Environmental Control 3(2+1)

**Objective**

This course is designed to impart a thorough understanding of the design and construction of various farm structures which an agricultural engineer ought to design. The course also highlights various standards and the environmental parameters involved in the design of such structures.

**Theory**

**Module I** **(6 Hours)**

Planning and layout of farm stead. Scope, importance and need for environmental control, physiological reaction of livestock, environmental factors, environmental control systems and their design, control of temperature, humidity and other air constituents by ventilation and other methods, Livestock production facilities, BIS Standards for dairy, piggery, poultry and other farm structures.

**Module II** **(9 Hours)**

Design, construction and cost estimation of farm structures; animal shelters, compost pit, fodder silo, fencing and implement sheds, barn for cows, buffalo, poultry, etc.

**Module III** **(10 Hours)**

Storage of grains, Causes of spoilage, Water activity for low and high moisture food and its limits for storage, Moisture and temperature changes in grain bins; Traditional storage structures and their improvements, Improved storage structures (CAP, hermetic storage, Pusa bin, RCC ring bins), Design consideration for grain storage godowns, Bag storage structures, Shallow and Deep bin, Calculation of pressure in bins, Storage of seeds.

**Module IV** **(7 Hours)**

Rural living and development, rural roads, their construction cost and repair and maintenance. Sources of water supply, norms of water supply for human being and animals, drinking water standards and water treatment suitable to rural community. Site and orientation of building in regard to sanitation, community sanitation system; sewage system and its design, cost and maintenance, design of septic tank for small family. Estimation of domestic power requirement, source of power supply and electrification of rural housing.

**Practical**

Measurements for environmental parameters and cooling load of a farm building, Design and layout of a dairy farm, Design and layout of a poultry house, Design and layout of a goat house/sheep house, Design of a farm fencing system, Design of a feed/fodder storage structures, Design of grain storage structures, Design and layout of commercial bag and bulk storage facilities, Study and performance evaluation of different domestic storage structure, Estimation of a Farm building.

**Lecture schedule**

1. Farmstead – location of farm stead – size and arrangement- planning
2. Physiological reaction of livestock to solar radiation and environmental factors
3. Environment control systems and their design
4. Control of temperature, Humidity and other factors by ventilation and others methods

5. BIS- introduction- objectives- importance- standards for dairy
6. BIS for poultry- piggery and other important structures
7. Design, construction and cost estimation of farm fencing systems- fencing posts
8. Compost pit – mechanism of composting-types of composting
9. Design, construction and cost estimation of compost pit
10. Fodder silo – types - Design construction and cost estimation of fodder silo.
11. Design, construction and cost estimation of implement shed
12. Dairy barns – types- design parameters
13. Design, construction and cost estimation of stanchion barn.
14. Poultry house – types- general design factors
15. Design and construction of deep litter and wire floored poultry houses
16. Cage housing system- poultry equipments
17. Storage of grains, Causes of spoilage, Water activity for low and high moisture food and its limits for storage
18. Moisture and temperature changes in stored grains – moisture movement
19. Traditional storage structures-Bhukari, Morai and Kothar
20. Improved storage structures- CAP, hermetic storage, Pusa bin, RCC ring bins
21. Grain storage silo – deep bin – shallow bin – plain of rupture
22. Lateral pressure inside bin – Janssens equation, Rankin's equation
23. Design of grain storage bin-Control of environment inside silo – aeration inside bin
24. Design and layout of bag storage structures- grain godowns
25. Constructional details of grain godowns- storage of seeds
26. Rural roads – types - construction
27. Maintenance and repair of rural roads
28. Sources of water supply, norms of water supply for human being and animals, drinking water standards and water treatment suitable to rural community
29. Sewage system and its design, cost and maintenance
30. Design of septic tank for small family – Soak pit.
31. Source of power supply and electrification of rural housing power requirement.
32. Estimation of domestic power requirement.

**Practical Schedule**

1. Estimation of cooling load of a farm building
2. Design and layout of a farm stead
3. Design and layout of a dairy barn
4. Design and layout of a poultry house
5. Design and layout of a goat house/sheep house
6. Design of a farm fencing system
7. Design of a feed/fodder storage structures
8. Design of grain storage structures – Grain bin
9. Design and layout of commercial bag – Grain godown
10. Study and performance evaluation of different domestic storage structure
11. Cost Estimation of a Farm building.
12. Design and layout of a farm fencing
13. Cost estimation of farm fencing and implement shed
14. Design and layout of a septic tank
15. Design and layout of a rural road
16. Design and layout of compost pit

**Suggested Readings**


1. Banerjee, G.C. 1998. A Text Book of Animal Husbandry, Oxford IBH Publishing Co, New Delhi.
2. Dutta, B.N. 1969. Estimating and Costing in Civil Engineering, Duttta & CO, Lucknow.
3. Garg, S.K. 2001. Water Supply Engineering, Khanna Publishers, New Delhi-6.
4. Nathonson, J.A. 2003. Basic Environmental Technology, Prentice Hall of India, New Delhi.
5. Ojha, T.P and Michael, A.M. 2002. Principles of Agricultural Engineering, Vol. I, Jain Brothers, Karol Bag, New Delhi.
6. Pandey, P.H. 2004. Principles and practices of Agricultural Structures and Environmental Control, Kalyani Publishers, Ludhiana.
7. Sahay, K.M. and Singh, K.K. 1994. Unit Operations of Agricultural Processing, Vikas publishing pvt. Ltd, Noida.
8. Venugopal Rao, P. 2002. Text Book of Environmental Engineering, Prentice Hall of India, New Delhi.


## Fape. 3105 Refrigeration and Air Conditioning 3(2+1)

**Objective**

To impart the concept of the basic principles, working, scientific analysis and system components of different types of refrigeration and air conditioning systems and also to impart the knowledge of various types of refrigerants, their properties, selection criteria and environmental aspects.

**Theory**

**Module I** **(9 Hours)**

Thermodynamics properties, closed and open system, flow and non-flow processes, gas laws, laws of thermodynamics, internal energy. Application of first law in heating and expansion of gases in non-flow processes. First law applied to steady flow processes. Carnot cycle, Carnot theorem. Entropy, physical concept of entropy, change of entropy of gases in thermodynamics process.

**Module II** **(9 Hours)**

Principles of refrigeration, - units, terminology, production of low temperatures, air refrigerators working on reverse Carnot cycle and Bell Coleman cycle. Vapour refrigeration-mechanism, P-V, P-S, P-H diagrams, vapour compression cycles, dry and wet compression, super cooling and sub cooling. Vapour absorption refrigeration system. Common refrigerants and their properties.

**Module III** **(7 Hours)**

Design calculations for refrigeration system. Cold storage plants. Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychometric chart and its use, elementary psychometric process.

**Module IV** **(7 Hours)**

Air conditioning – principles –Type and functions of air conditioning, physiological principles in air conditioning, air distribution and duct design methods, fundamentals of design of complete

air conditioning systems – humidifiers and dehumidifiers – cooling load calculations, types of air conditioners – applications.

**Practical**

Tutorials on thermodynamic air cycles, Study and application of P V and T S chart in refrigeration, P H chart (or) Mollier diagram in refrigeration, Numerical on air refrigeration cycle systems, Numerical on vapour compression cycle refrigeration system, Study of domestic water cooler, Study of domestic household refrigerator, Study of absorption type solar refrigeration system, Study cold storage for fruit and vegetables, Freezing load and time calculations for food materials, Determination of refrigeration parameters using refrigeration tutor – II, Numerical on design of air conditioning systems, Study of window air conditioner, Study on repair and maintenance of refrigeration and air-conditioning systems. Visit to chilling or ice making and cold storage plants.

**Lecture Schedule**

1. Thermodynamics properties
2. Thermodynamic Systems, closed and open system
3. Flow and non-flow processes
4. Gas laws -Laws of thermodynamics
5. Internal energy- Application of first law in heating and expansion of gases in non-flow processes
6. First law applied to steady flow processes.
7. Carnot cycle, Carnot theorem
8. Entropy, physical concept of entropy
9. Change of entropy of gases in thermodynamics process
10. Principles of refrigeration
11. Refrigeration- units and terminology
12. Production of low temperatures, air refrigerators working on reverse Carnot cycle and Bell Coleman cycle
13. Vapour refrigeration-mechanism
14. P-V, P-S, P-H diagrams
15. Vapour compression cycles
16. Dry and wet compression
17. Super cooling and sub cooling
18. Vapour absorption refrigeration system
19. Common refrigerants and their properties.
20. Design calculations for refrigeration system
21. Cold storage plants.
22. Thermodynamic properties of moist air
23. Perfect gas relationship for approximate calculation
24. Adiabatic saturation process
25. Wet bulb temperature and its measurement- Psychrometric chart and its use
26. Elementary psychrometric process.
27. Air conditioning – principles, type and functions of air conditioning
28. Physiological principles in air conditioning
29. Air distribution and duct design methods
30. Fundamentals of design of complete air conditioning systems
31. Humidifiers and dehumidifiers,cooling load calculations,
32. Types of air conditioners – applications.

**Practical Schedule**

1. Tutorials on thermodynamic air cycles
2. Study and application of P V chart in refrigeration
3. Study and application of T S chart in refrigeration
4. Study and application of P H chart (or) Mollier diagram in refrigeration
5. Numerical on air refrigeration cycle systems
6. Numerical on vapour compression cycle refrigeration system
7. Study of domestic water cooler
8. Study of domestic household refrigerator
9. Study of absorption type solar refrigeration system
10. Study cold storage for fruit and vegetables
11. Freezing load and time calculations for food materials
12. Determination of refrigeration parameters using refrigeration tutor – II
13. Numerical on design of air conditioning systems
14. Study of window air conditioner
15. Study on repair and maintenance of refrigeration and air-conditioning systems.
16. Visit to chilling or ice making and cold storage plants.

**Suggested Readings**


1. Ballney P. L. 1994. Thermal Engineering. Khanna Publishers, New Delhi.
2. Khurmi R S. 1992. Engineering Thermodynamics. S Chand and Co. Ltd., Ram Nagar, New Delhi.
3. Kothandaraman C P Khajuria P R and Arora S C. 1992. A Course in Thermodynamics and Heat Engines. Dhanpet Rai and Sons, NaiSarak, New Delhi.
4. Mathur M L and Mehta F S. 1992. Thermodynamics and Heat Power Engineering. DhanpatRai and Sons, NaiSarak, New Delhi.
5. Nag P K.1995. Engineering Thermodynamics. Tata McGraw Hill Publishing Co.Ltd., 12/4 Asaf Ali Raod, New Delhi.


## Fape. 3206 Post Harvest Engineering of Horticultural Crops 2(1+1)

**Objective**

To acquaint and equip the students with processing and handling of fruits and vegetables to minimize the post harvest losses and also to facilitate the design features of the equipments used for the processing

**Theory**

**Module I** **(9 Hours)**

Importance of processing of fruits and vegetables, spices, condiments and flowers. Characteristics and properties of horticultural crops important for processing, Peeling: Different peeling methods and devices (manual peeling, mechanical peeling, chemical peeling, and thermal peeling), Slicing of horticultural crops: equipment for slicing, shredding, crushing, chopping, juice extraction, etc., Blanching: Importance and objectives; blanching methods, effects on food (nutrition, colour, pigment, texture), Thermal processing of food- microbial kinetics-D value, Z value and F value-Canning of fruits and vegetables- Chilling and freezing: Application of refrigeration in different perishable food products, Thermophilic, mesophilic & Psychrophilic micro-organisms, Chilling requirements of different fruits and vegetables, Freezing of food, freezing time calculations, slow and fast freezing, Equipment for chilling and

freezing (mechanical & cryogenic), Effect on food during chilling and freezing, Cold storage heat load calculations and cold storage design, refrigerated vehicle and cold chain system, Dryers for fruits and vegetables, Osmo-dehydration.

**Module II** **(3 Hours)**

Packaging of horticultural commodities, Packaging requirements (in terms of light transmittance, heat, moisture and gas proof, micro organisms, mechanical strength), Different types of packaging materials commonly used for raw and processed fruits and vegetables products, bulk and retail packages and packaging machines, handling and transportation of fruits and vegetables, Pack house technology, Minimal processing, Common methods of storage, Low temperature storage, evaporative cooled storage, Controlled atmospheric storage, Modified atmospheric packaging.

**Module III** **(4 Hours)**

Preservation Technology, General methods of preservation of fruits and vegetables, Brief description and advantages and disadvantages of different physical/ chemical and other methods of preservation, Flowcharts for preparation of different finished products, Important parameters and equipment used for different unit operations, Post harvest management and equipment for spices and flowers, Quality control in Fruit and vegetable processing industry. Food supply chain.

**Practical**

Performance evaluation of peeler and slicer, Performance evaluation of juicer and pulper, Performance evaluation of blanching equipment, Testing adequacy of blanching, Study of cold storage and its design, Study of CAP and MAP storage, Minimal processing of vegetables, Preparation of value added products, Visit to fruit and vegetable processing industry, Visit to spice processing plant

**Lecture schedule**

1. Horticultural crops-introduction-classification-importance-status of production and export value.
2. Characteristics and properties of horticultural crops important for processing.
3. Peeling and Slicing of horticultural crops- Different methods and equipments used.
4. Principles of processing and preservation: blanching- types-canning-bottling-surface coatings-chemical dips.
5. Thermal processing of food
6. Principles of processing and preservation-freezing-Refrigeration- Cold storage – cooling load calculation.
7. Thermo plasticity – chemical changes during drying.-osmotic dehydration-osmo vac dehydration and osmo air drying of fruits.
8. Drying and dehydration– importance – water activity-pretreatments before drying – drying curve – shrinkage, case hardening.
9. Types of dryer – tray, drum, pneumatic, spray, fluidized bed dryer ,freeze dryer and foam mat during.
10. Packaging of horticultural commodities- materials-basic requirements of packaging materials-transportation.
11. Minimal processing-fruits and vegetables-methods and principles.
12. Handling and storage-refrigerated storage-evaporative cooled storage- Modified and Controlled atmosphere storage

13. Preservation Technology- general methods of preservation of fruits and vegetables-its advantages and disadvantages.
14. Flowcharts for preparation of different finished products.
15. Post harvest management and equipment for spices and flowers.
16. Quality control in Fruit and vegetable processing industry-Food supply chain.

**Practical Schedule**

1. Performance evaluation of peeler and slicer.
2. Performance evaluation of juicer and pulper.
3. Performance evaluation of blanching equipment.
4. Determination of firmness of fruit by penetrometer.
5. Testing adequacy of blanching.
6. Determination of fruit acids by titration and calculation of the sugar/acid ratio.
7. Determination of ascorbic acid.
8. Study of cold storage and its design.
9. Study of CAP and MAP storage.
10. Minimal processing of vegetables
11. Preparation of tomato products (puree, ketchup).
12. Preparation of fruit juice, Jam, jelly and RTS.
13. Moisture content determination of fruits and Vegetables.
14. Drying characteristics of fruits and vegetables using Convective dryer.
15. Determination of vase life extension of cut flowers.
16. Visit to fruit and vegetable processing industry.

**Suggested Readings**


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


## Fape. 3207 Dairy and Food Engineering 3(2+1)

**Objective**

To disseminate the knowledge of properties of products, unit operations and packaging involved in dairy and food engineering.

**Theory**

**Module I** **(6 Hours)**

Deterioration in food products and their controls, Physical, chemical and biological methods of food preservation. Dairy development in India, Engineering, thermal and chemical properties of milk and milk products, Process flow charts for product manufacture, Unit operation of various dairy and food processing systems. Principles and equipment related to receiving of milk

**Module II** **(11 Hours)**

Pasteurization, sterilization, homogenization, centrifugation and cream separation. Preparation methods and equipment for manufacture of cheese, paneer, butter and ice cream, Filling and packaging of milk and milk products; Aseptic processing.

**Module III** **(6 Hours)**

Dairy plant design and layout, Plant utilities; Principles of operation and equipment for thermal processing, Evaporation of food products: principle, types of evaporators, steam economy, multiple effect evaporation, vapour recompression.

**Module IV** **(9 Hours)**

Drying of liquid and perishable foods: principles of drying, spray drying, drum drying, freeze drying, Filtration: principle, types of filters; Membrane separation, RO, Nano-filtration, Ultra filtration and Macro-filtration, equipment and applications, Nanotechnology: fundamental concepts.

**Practical**

Study of pasteurizers, Study of sterilizers, Study of homogenizers, Study of separators, Study of butter churns, Study of evaporators, Study of milk dryers, Study of freezers, Study of filtration, Design of food processing plants & preparation of layout, Visit to multi-product dairy plant, Estimation of steam requirements, Estimation of refrigeration requirements in dairy & food plant, Visit to Food industry.

**Lecture schedule**

1. Deterioration in food products and their controls, Physical, chemical and biological methods of food preservation.
2. Dairy development in India, Nutritive value of milk- Engineering, thermal and chemical properties of milk and milk products
3. Classification of milk- market milk and special milks – standardization of milk
4. Unit operation of various dairy and food processing systems
5. Milk reception – milk cans – can washing- cleaning requirements and agents
6. CIP cleaning – components of CIP circuits
7. Pasteurization of milk – HTST and UHT pasteurization
8. Pasteurization process and equipments
9. Sterilization – batch and continuous sterilization
10. In-bottle sterilization- hydrostatic continuous sterilization hydrolock sterilizer- hot air sterilization
11. Homogenization- Process and equipment
12. centrifugation and cream separation – process and equipment- creaming efficiency- flow rate and power requirement
13. Preparation methods and equipment for manufacture of cheese and paneer,
14. Preparation methods and equipment for manufacture of butter
15. Preparation methods and equipment for manufacture of ice cream – overrun in ice cream
16. Filling and packaging of milk and milk products –filling by metering
17. Aseptic processing and packaging – combiblock, Zupack and Tetrabrick systems.
18. Location of dairy plant- layout – types of dairy plant layout
19. Plant utilities – steam, refrigeration, water, electricity requirements
20. Evaporation of food products – single effect and multiple effect evaporation
21. Changes in food products during evaporation- Heat and mass balance in evaporators

22. Types of evaporators- steam economy
23. Vapour recompression
24. Drying of liquid and perishable foods: principles of drying
25. Drum drying – equipment
26. Spray drying – classification – equipment – Properties of dried milk
27. Freeze drying – theory- freeze dryer
28. Filtration: principle, - filtration media- filter resistance
29. Constant rate and constant pressure filtration- filtration equipment
30. Membrane separation – membrane configuration- types of membranes
31. RO, Nano-filtration, Ultra filtration and Macro-filtration, equipment and applications
32. Nanotechnology: fundamental concepts

**Practical schedule**

1. Study of pasteurizers
2. Study of sterilizers
3. Study of homogenizers
4. Study of separators- cream separation
5. Study of butter churns
6. Study of evaporators
7. Study of milk dryers – drum dryer
8. Study of milk dryers – Spray dryer
9. Study of freezers -Ice cream freezer
10. Study of filtration – constant rate
11. Constant pressure filtration
12. Design of food processing plants & preparation of layout
13. Study of milk packaging and fillers
14. Estimation of refrigeration requirements in dairy & food plant
15. Estimation of steam requirements
16. Visit to Dairy industry

**Suggested Readings**


1. Ahmed, T. 1997. Dairy Plant Engineering and Management. 4th Ed. Kitab Mahal.
2. McCabe, W.L. and Smith, J. C. 1999. Unit Operations of Chemical Engineering. McGraw Hill.
3. Rao, D.G. 2010. Fundamentals of Food Engineering. PHI learning Pvt. Ltd. New Delhi.
4. Singh, R.P. & Heldman, D.R. 1993. Introduction to Food Engineering. Academic Press.
5. Toledo, R. T. 1997. Fundamentals of Food Process Engineering. CBS Publisher.
6. Tufail Ahmed, "Dairy Plant Engineering and Management", CBS Publishers and Distributors, New Delhi, 2001.

## Department of Food and Agricultural Process Engineering-Electives

### Elfa. 4201 Food Quality and Safety 3(2+1)

**Objective**

To acquaint and equip the students with the latest standards to maintain food quality as well as to study food laws and regulations,, FSSAI and HACCP protocol.

**Theory**

**Module I** **(7 Hours)**

Basics of Food Science and Food Analysis, Concept, objectives and need of food quality. Measurement of colour, flavour, consistency, viscosity, texture and their relationship with food quality and composition.

**Module II** **(10 Hours)**

Sampling; purpose, sampling techniques, sampling procedures for liquid, powdered and granular materials, Quality control, Quality control to ols, Statistical quality control, Sensory evaluation methods, panel selection methods, Interpretation of sensory results. Instrumental method for testing quality.

**Module III** **(6 Hours)**

Food adulteration and food safety. TQM and TQC, consumer preferences and acceptance, Food Safety Management Systems GAP, GHP, GMP, Hazards and HACCP (Hazard analysis and critical control point).

**Module IV** **(9 Hours)**

Sanitation in food industry (SSOP), Food Laws and Regulations in India, FSSAI, Food grades and standards BIS, AGMARK, PFA, FPO, ISO 9000, 22000 Series. CAC (Codex Alimantarious Commission), Traceability and Quality Assurance system in a process plant, Bio safety and Bioterrorism.

**Practical**

Examination of cereals & pulses from one of go-downs and market shops in relation to FPO and BIS specifications, Detection of adulteration and examination of ghee for various standards of AGMARK & BIS standards, Detection of adulteration and examination of spices for AGMARK and BIS standards, Detection of adulteration and examination of milk and milk products for BIS standards, Detection of adulteration and examination of fruit products such as jams, jellys, marmalades for FPO specification, Visit to quality control laboratory, Case study of statistical process control in food processing industry, Study of registration process and licensing procedure under FSSAI, Study of sampling techniques from food processing establishments, Visit to food processing laboratory and study of records and reports maintained by food processing laboratory.

**Lecture Schedule**

1. Food safety- need for quality control and safety.
2. Basics of Food Science and Food Analysis, Concept, objectives and need of food quality.
3. Strategy and criteria for food safety - microbiological criteria for safety and quality.

4. Sources of microorganisms for food spoilage
5. Food spoilage food borne diseases and their control.
6. Measurement of colour, flavour, consistency, and their relationship with food safety and quality aspects
7. Measurement of texture, viscosity and their relationship with food quality food safety and quality aspects
8. Food safety- sampling plans and criteria for microbial assessments in foods.
9. Sampling- purpose, sampling techniques, sampling procedures for liquid.
10. Sampling procedures for powdered and granular materials.
11. Food contaminants – physical, biological and chemical contaminants
12. Factors affecting toxicity of compounds- quality control and food safety.
13. Quality control, Quality control tools
14. Statistical tool for quality control, methods of quality control
15. Sensory evaluation methods, panel selection methods
16. Interpretation of sensory results.
17. Instrumental method for testing quality.
18. Personnel hygienic standards.
19. Food adulteration and food safety. TQM and TQC, consumer preferences and acceptance,
20. Food Safety Management Systems GAP, GHP, influence on food processing industry
21. Food Safety Management Systems GMP-influence on food processing industry
22. Hazards and HACCP (Hazard analysis and critical control point)- principles.
23. Preparation of HACCP plan, Development of HACCP plan for food industries
24. Sanitation in food industry (SSOP) - principles
25. SSOP- applications in food industry
26. Food Laws and Regulations in India- FSSAI,
27. National standards – FPO and PFA standards for food products
28. National standards – AGMARK and BIS standards for food products
29. International standards - ISO 9001 and ISO 22,000 standards
30. International standards -FPEDA, CFR, Codex Alimentarius Commission Standards
31. Traceability and Quality Assurance system in a process plant,
32. Bio safety and Bioterrorism.

**Practical Schedule**

1. Examination of cereals & pulses from one of go-downs in relation to FPO and BIS specifications
2. Examination of cereals & pulses from one of market shops in relation to FPO and BIS specifications
3. Detection of adulteration and examination of ghee for various standards of AGMARK & BIS standards
4. Detection of adulteration and examination of common food product
5. Detection of adulteration and examination of spices for AGMARK standards
6. Detection of adulteration and examination of spices for BIS standards
7. Detection of adulteration and examination of milk and milk products for BIS standards,
8. Detection of adulteration and examination of fruit products such as jams, jellys, for FPO specification
9. Detection of adulteration and examination of fruit products such as squash, marmalades for FPO specification,
10. Visit to quality control laboratory,

11. Case study of statistical process control in food processing industry,
12. Study of registration process and licensing procedure under FSSAI
13. Study of FSSAI functions
14. Study of sampling techniques from food processing establishments,
15. Visit to food processing laboratory
16. Study of records and reports maintained by food processing laboratory.

**Suggested Readings**


1. Dean, J.W. and J.R.Evans, (1994). Total Quality. West Publishing company, New York.
2. Frazier, W.C and D.C. Westhoff. (1978). Food microbiology. Tata Mc Graw Hill Publishing Co. Ltd. New Delhi. 540pp.
3. Hobbs. B.C and R.J. Gilbert. (1982). Food Poisoning and food hygiene., The English Language Book Society and Edward Arnold Publishers Ltd., London.
4. Luning, P.A, W.J.Marcelis and W.M.F. Jongen, (2002). Food quality management: A technomanagerial approach, Wageningen press, ISBN 9074134815, Wageningen, The Netherlands, 323 pp.
5. Luning. P.A., F. Devlieghere and R. Verhe, (2007). Safety in the agri- food chain, Wageningen academic publishers


## Elfa. 4202 Food Plant Design and Management 3(2+1)

**Objective**

To acquaint and equip the students with the design features of different food processing equipments used in the food industries and also to give an idea about the plant layout.

**Theory**

**Module I** **(6 Hours)**

Food plant location, selection criteria, Selection of processes, plant capacity, Requirements of plant building and its components, Project design, flow diagrams, selection of equipment, process and controls, Objectives and principles of food plant layout.

**Module II** **(9 Hours)**

Salient features of processing plants for cereals, pulses, oilseeds, horticultural and vegetable crops, poultry, fish and meat products, milk and milk products. Introduction to Finance, Food Product Marketing, Food Business Analysis and Strategic Planning.

**Module III** **(12 Hours)**

Introduction to Marketing, Food Marketing Management, Supply chain management for retail food products, Entrepreneurship development in food industry, SWOT analysis, generation, incubation and commercialization of ideas and innovations, New product development process.

**Module IV** **(5 Hours)**

Government schemes and incentive for promotion of entrepreneurship, Govt. policy on small and medium scale food processing enterprise, export and import policies relevant to food processing sector, procedure of obtaining license and registration under FSSAI, Cost analysis and preparation of feasibility report.

**Practical**

Preparation of project report, Preparation of feasibility report, Salient features and layout of pre processing house, Salient features and layout of Milk and Milk product plants, Evaluation of given layout, Salient features, design and layout of modern rice mill, Salient features, design and layout of Bakery and related product plant, Study of different types of records relating to production of a food plant, Study of different types of records relating to finance of a food plant, Study of different types of records relating to marketing of a food business, Brain storming and SWOT analysis to start a food processing business.

**Lecture Schedule**

1. Food plant location, selection criteria- plant location, location theory and models
2. Selection of processes, plant capacity, different criteria for plant site selection
3. Plant layout objectives-classical and practical layout
4. Types of plant layout –process, product and layout
5. Fixed position and combination layout
6. Development and presentation of the layout - objectives and principles of food plant layout
7. Requirements of plant building and its components for food processing units
8. Project design, flow diagrams, selection of equipment, process and controls
9. Preparation of layout for fruit processing industry
10. Preparation of layout for vegetable processing industry
11. Salient features of processing plants for cereals, pulses
12. Salient features of processing plants for oilseeds
13. Salient features of processing plants for poultry, fish and meat products
14. Salient features of processing plants for milk and milk products.
15. Introduction to Finance, -Financial management for food processing units
16. Introduction to Marketing, -consumer behavior and market sementation
17. Product mix-product brand-product life cycle
18. Channels of distribution-sales promotion of food products
19. Advertising-advertising media for small food processing industries
20. Personal selling-marketing research
21. Food Marketing Management- Management information systems in agro-food processing units
22. Food Business Analysis and Strategic Planning
23. Supply chain management for retail food products
24. Entrepreneurship development in food industry – implementation of business plans
25. SWOT analysis, generation, incubation of agro-food processing units
26. Commercialization of ideas and innovations – development of small scale food processing unit
27. New product development process, implementation – steps involved in product development
28. Government schemes and incentive for promotion of entrepreneurship, Govt. policy on small and medium scale food processing enterprise
29. Export and import policies relevant to food processing sector
30. Procedure of obtaining license and registration under FSSAI, functions and use of FSSAI
31. Cost analysis and preparation of feasibility report for food processing industries
32. Prospects of agro food processing industries in the emerging economic scenario

**Practical Schedule**

1. Preparation of project report.
2. Preparation of feasibility report.
3. Salient features and layout of pre-processing house.
4. Salient features and layout of Milk and Milk product plants
5. Evaluation of given layout.
6. Salient features, design and layout of modern rice mill.
7. Salient features, design and layout of fruit processing unit.
8. Salient features, design and layout of canning unit.
9. Salient features, design and layout of Bakery and related product plant
10. Study of different types of records relating to production of a food plant
11. Study of different types of records relating to finance of a food plant
12. Study of different types of records relating to marketing of a food business
13. Brain storming on Agri business opportunity
14. SWOT analysis to start a food processing business.
15. Preparation of business proposal for small scale industry
16. Visit to small scale industry

**Suggested Readings**


1. Lopez Antonio. Gomez. 2005. Food Plant Design.
2. James,M.More.1976. Plant Layout and Design. MacMillian Publishing Co., New York.
3. Geankoplis,C.J.1997. Transport processes and Unit operations, Prentice Hall of IndiaPublication, New Delhi
4. Jowitt, R.(Ed.), 1980. Hygienic Design and Operation of Food Plant. Ellis Horwood, Chichester.
5. Slade,F.H.1967. Food processing plant. Leonardhill Books, London.


## Elfa. 4203 Food Packaging Technology 3(2+1)

**Objective**

To acquaint and equip the students with different packaging materials, methods of packaging, packaging technology and packaging machineries used in food industry.

**Theory**

**Module I** **(7 Hours)**

Factors affecting shelf life of food material during storage, Interactions of spoilage agents with environmental factors as water, oxygen, light, pH, etc. and general principles of control of the spoilage agents; Difference between food infection, food intoxication and allergy. Packaging of foods, requirement, importance and scope, frame work of packaging strategy, environmental considerations, Packaging systems, types: flexible and rigid; retail and bulk; levels of packaging; special solutions and packaging machines, technical packaging systems and data management packaging systems.

**Module II** **(11 Hours)**

Different types of packaging materials, their key properties and applications, Metal cans, manufacture of two piece and three piece cans, Plastic packaging, different types of polymers used in food packaging and their barrier properties. manufacture of plastic packaging materials, profile extrusion, blown film/ sheet extrusion, blow molding, extrusion blow molding, injection

blow molding, stretch blow molding, injection molding. Glass containers, types of glass used in food packaging, manufacture of glass and glass containers, closures for glass containers. Paper and paper board packaging, paper and paper board manufacture process, modification of barrier properties and characteristics of paper/ boards. Relative advantages and disadvantages of different packaging materials; effect of these materials on packed commodities Nutritional labelling on packages.

**Module III** **(10 Hours)**

CAS and MAP, shrink and cling packaging, vacuum and gas packaging; Active packaging, Smart packaging, Packaging requirement for raw and processed foods, and their selection of packaging materials, Factors affecting the choice of packaging materials, Disposal and recycle of packaging waste, Printing and labelling, Lamination.

**Module IV** **(4 Hours)**

Package testing: Testing methods for flexible materials, rigid materials and semi rigid materials; Tests for paper (thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply bond test, surface oil absorption test, etc.), plastic film and laminates (thickness, tensile strength, gloss, haze, burning test to identify polymer, etc.), aluminium foil (thickness, pin holes, etc.), glass containers (visual defects, colour, dimensions, impact strength, etc.), metal containers (pressure test, product compatibility, etc.).

**Practical**

Identification of different types of packaging materials, Determination of tensile/ compressive strength of given material/package, To perform different destructive and non-destructive tests for glass containers, Vacuum packaging of agricultural produces, Determination of tearing strength of paper board, Measurement of thickness of packaging materials, To perform grease-resistance test in plastic pouches, Determination of bursting strength of packaging material, Determination of water-vapour transmission rate, Shrink wrapping of various horticultural produce, Testing of chemical resistance of packaging materials, Determination of drop test of food package and visit to relevant industries.

**Lecture schedule**

1. Introduction to packaging- application in food industry
2. Factors affecting shelf life of food material during storage-Interactions of spoilage agents with environmental factors as water- oxygen, light, pH.
3. General principles of control of the spoilage agents;
4. Difference between food infection, food intoxication and allergy.
5. Packaging of foods-requirement-importance and scope- frame work of packaging strategy-environmental considerations-
6. Packaging systems- types- flexible and rigid- retail and bulk- levels of packaging- special solutions and packaging machines.
7. Packaging systems-technical packaging systems and data management packaging systems,
8. Different types of packaging materials- key properties- applications
9. Metal cans- types.
10. Metal cans- manufacture of two piece and three piece cans
11. Plastic packaging- different types of polymers used in food packaging - barrier properties.

12. Manufacture of plastic packaging materials- profile extrusion- blown film/ sheet extrusion- blow molding,
13. Manufacture of plastic packaging materials-extrusion blow molding- injection blow molding- stretch blow molding- injection molding.
14. Glass containers- types of glass used in food packaging
15. Manufacture of glass and glass containers- closures for glass containers.
16. Paper and paper board packaging- paper and paper board manufacture process
17. Modification of barrier properties - characteristics of paper/ boards.
18. Relative advantages and disadvantages of different packaging materials, Nutritional labelling on packages
19. CAS and MAP
20. Shrink and cling packaging
21. Vacuum and gas packaging
22. Active packaging- Smart packaging
23. Packaging requirement for raw and processed foods- selection of packaging materials
24. Factors affecting the choice of packaging materials
25. Disposal and recycle of packaging waste
26. Printing of packaging material-types
27. Labellingof packaging material-types
28. Laminationof packaging material-types
29. Package testing- methods for flexible materials- rigid materials and semi rigid materials
30. Package testing -Tests for paper (thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply bond test, surface oil absorption test, etc.)
31. Package testing-plastic film and laminates (thickness, tensile strength, gloss, haze, burning test to identify polymer, etc.), aluminium foil (thickness, pin holes, etc.)
32. Package testing-glass containers (visual defects, colour, dimensions, impact strength, etc.), metal containers (pressure test, product compatibility, etc.).

**Practical schedule**

1. Identification of different types of packaging materials
2. Determination of tensile/ compressive strength of given material/package
3. To perform different destructive tests for glass containers
4. To perform different non-destructive
5. Vacuum packaging of agricultural produces
6. Modified atmospheric packaging of agricultural produces
7. Study on retort packaging
8. Determination of tearing strength of paper board
9. Measurement of thickness of packaging materials
10. Measurement of grammage of packaging materials
11. To perform grease-resistance test in plastic pouches
12. Determination of bursting strength of packaging material
13. Determination of water-vapour transmission rate
14. Shrink wrapping of various horticultural produce
15. Testing of chemical resistance of packaging materials
16. Determination of drop test of food package and visit to relevant industries.

**Suggested Readings**


1. Coles, R., McDowell, D., Kirwan, M .J. (2003). Food Packaging Technology. Blackwell Publishing Co.
2. Gosby, N.T. (2001). Food Packaging Materials. Applied Science Publication
3. John, P.J. (2008). A Handbook on Food Packaging Narendra Publishing House,
4. Mahadevia, M., Gowramma, R.V. (2007). Food Packaging Materials. Tata McGraw Hill
5. Robertson, G. L. (2001). Food Packaging and Shelf life: A Practical Guide. Narendra Publishing House.
6. Robertson, G. L. (2005). Food Packaging: Principles and Practice. Second Edition. Taylor and Francis Pub.


## Elfa. 4204 Development of Processed Products 3(2+1)

**Objective**

To acquire basic knowledge about food processing and also to study the processing methods of various food materials like fruits & vegetables, dairy products, cereals, meat, poultry, fish and bakery products .

**Theory**

**Module I** **(9 Hours)**

Process design, Process flow chart with mass and energy balance, Unit operations and equipments for processing, New product development, Technology for value added products from cereal, pulses and oil seeds

**Module II** **(9 Hours)**

Milling, puffing, flaking, Roasting, Bakery products, snack food. Extruded products, oil extraction and refining, Technology for value added products from fruits, vegetables and spices

**Module III** **(8 Hours)**

Canned foods, Frozen foods, dried and fried foods, Fruit juices, Sauce, Sugar based confection, Candy, Fermented food product, spice extracts

**Module IV** **(6 Hours)**

Technology for animal produce processing , meat, poultry, fish, egg products, Health food, Nutra-ceuticals and functional food, Organic food.

**Practical**

Process design and process flow chart preparation, preparation of different value added products, Visit to roller wheat flour milling, rice milling, spice grinding mill, milk plant, dal and oil mill, fruit/vegetable processing plants & study of operations and machinery, Process flow diagram and study of various models of the machines used in a sugar mill.

**Lecture schedule**

1. Introduction about product development - process design, unit operations
2. Introduction ,equations –Energy balance- importance
3. Numerical approach on energy mass balance
4. Unit operations–various process involved ,definitions-flow charts

5. Different equipments for processing of products.
6. New product development – factors considered.
7. Various value added products from cereals- flow charts
8. Introduction, classification - value added products of pulses- flow chart
9. Introduction, classification - value added products of oil seeds- flow chart
10. Milling – equipments- types -classification of different agriculture products.
11. Puffing – flaking – pounding – major ingredients –equipments – flow chart
12. Roasting of different products – equipments - changes in composition.
13. Bakery products – ingredients, its role-baking technology.
14. Snack food- ingredients, its role-processing methods – flow chart
15. Extruded products- ingredients –processing technology.
16. Oil extraction and refining – methods.
17. Introduction, classification - value added products from fruits and vegetables
18. Introduction, classification - value added products from spices- flow chart
19. Canned foods - processing, frozen foods-advantages and disadvantages.
20. Dried and fried foods – preparation methods- flow chart-
21. Fruit juices – types : squash, RTS, cordial ,nectar
22. Sauce –ketchup-puree- preparation methods.
23. Sugar based confectioneries – role of ingredients, processing method.
24. Candy, toffee, marzipans – ingredients - preparation –definition - types.
25. Fermented food product – benefits, processing methods.
26. Spice extracts –difference between oleoresins and essential oils- processing methods.
27. Technology for animal produce processing - meat, composition-processing and preservation methods
28. Poultry –composition -processing methods – preservation methods
29. Fish – classification - composition – fish cookery-spoilage-preservation and storage
30. Egg- nutritive value – products and by products.
31. Health food – examples, Nutraceuticals and functional food
32. Overview on organic food – advantages.

**Practical Schedule**

1. Study based on process design.
2. Process flow chart preparation.
3. Preparation of different value added products -- cereals.
4. Preparation of different value added products – confectionery products.
5. Preparation of different value added products-pulses.
6. Preparation of different value added products – extrusion method.
7. Preparation of different value added products – fruits.
8. Preparation of different value added products – vegetables.
9. Study on rice milling machineries.
10. Study on spice grinding –hammer mill & cryogenic mill.
11. Preparation of milk based products.
12. Study on dhal and oil mill.
13. Visit to fruit processing plants & study of operations and machinery.
14. Visit to Spice industry & study of operations and machinery.
15. Process flow diagram and study of various models of the machines used in a sugar mill.
16. Visit to roller wheat flour milling.

**Suggested Readings**


1. Achaya, K T (2011)Everyday Indian Processed foods. National Book Trust.
2. Geankoplis C. J.(1997) Transport processes and unit operations, Prentice-Hall.
3. Norman N. (1995) Potter and Joseph H. Hotchikss. Food Science. Chapman and Hall Pub.
4. Rao, D. G.(2010) Fundamentals of Food Engineering PHI Learning Pvt. Ltd, New Delhi.


## Elfa. 4205 Process Equipment Design 3(2+1)

**Objective**

To equip the students to study the design aspects of the food processing equipments and also to understand the relationship between process design and safety.

**Theory**

**Module I** **(6 Hours)**

Introduction on process equipment design, Application of design engineering for processing equipments, Design parameters and general design procedure. Design of shafts, pulleys, bearings, belts, springs, drives, speed reduction systems. Corrosion and protective coatings.

**Module II** **(5 Hours)**

Material specification, Types of material for process equipments, Design codes, Pressure vessel design, Design of cleaners. Design of pulper, homogingers, crushers and storage vessels: Operating conditions, design conditions and stress, temperature effects, radiation effects, effects of fabrication method

**Module III** **(8 Hours)**

Design of shell and its component, stresses from local load and thermal gradient, mountings and accessories, Design of heat exchangers: Design of tubular heat exchanger, shell and tube heat exchanger and plate heat exchanger, Design of belt conveyer, screw conveyer and bucket elevator. Design of freezers.

**Module IV** **(13 Hours)**

Design of dryers: Design of tray dryer, tunnel dryer, fluidized dryer, spray dryer, vacuum dryer, freeze dryer and microwave dryer, , Design of milling equipments. Optimization of design with respect to process efficiency, energy and cost, Computer Aided Design.

**Practical**

Design of pressure vessel, cleaners, milling equipments, tubular heat exchanger, shell and tube type heat exchanger, plate heat exchanger, dryer, belt conveyor, bucket elevator, screw conveyor.

**Lecture Schedule**

1. Introduction and scope of process equipments design, classification of materials properties and mechanical properties
2. Corrosion, corrosion prevention methods for equipment, protective coatings materials, ductility, hardness
3. Application of Engineering Principles to design and selection of food processing equipments
4. Design of equipment components such as shafts, pulleys, bearings, belts, springs, drives, speed reduction systems
5. Construction and design of pressure vessels: storage tank

6. Introduction ,definition and types of design parameters
7. Material codes : definition ,classification, different types and theories failure
8. Definition, classification and types of Material specification and design codes
9. Construction and design of pulping and crushing equipments
10. Construction and design of different types of cleaners and homogenisers
11. Safety factor, temperature effects, radiation effects, effects of fabrication method, economic considerations.
12. Design of shell and its component, stresses from local load and thermal gradient, mountings and accessories
13. Construction and design of tubular heat exchanger and plate heat exchanger
14. Construction and design of shell and tube heat exchanger
15. Introduction , definition , types of conveyors and elevators
16. Construction and design of belt conveyer
17. Construction and design of screw conveyer
18. Construction and design of bucket elevator
19. Freezing, definition, methods and design of freezers
20. Definition , types of dryers and drying methods
21. Construction and design of LSU dryer
22. Design of tray dryer, tunnel dryer and fluidized bed dryer
23. Design of spray dryer, vacuum dryer and microwave dryer
24. Definition ,types and methods of milling equipments, Construction and design of rubber roll Sheller
25. Construction and design of attrition mill and ball mill
26. Construction and design of hammer mill and pin mill
27. Optimization of design with respect to process efficiency
28. Energy and cost economics of different design equipments
29. Introduction ,definition and classification of computer aided design
30. Brief description about computer aided design
31. Numerical discussion about drying methods and milling and conveying methods
32. Numerical discussion about heat exchange methods

**Practical Schedule**

1. Design and drawing of pressure vessel
2. Design and drawing of different types of cleaners
3. Design and drawing of continuous dryers
4. Design and drawing of Batch dryers
5. Numerical approach on Design of dryers
6. Design and drawing of rubber roll Sheller
7. Design and drawing of hammer and ball mill
8. Design aspects of tubular heat exchanger
9. Design aspects of shell and tube heat exchanger
10. Design aspects of plate heat exchanger
11. Numerical approach on design of heat exchangers
12. Design aspects of belt conveyor
13. Design aspects of bucket elevator
14. Design aspects of screw conveyor.
15. Numerical approach on design of conveyors
16. Computer assisted design of dryer

**Suggested Readings**


1. Brounsel and Young(1993), Process Equipment Design.
2. Geankoplis,C.J.(1997). Transport processes and Unit operations, Prentice Hall of IndiaPublication, New Delhi
3. James,M.More (1976). Plant Layout and Design. MacMillian Publishing Co., New York.
4. Perry, R.H and C.H.Chilton.(1973). Chemical Engineering Hand Book. McGraw Hill, Tokyo.
5. Rao, D. G. (2010) Fundamentals of Food Engineering PHI Learning Pvt. Ltd, New Delhi.


## Elfa. 4206 Agricultural By-Product Utilization 3(2+1)

**Objective**

To acquaint and equip the students with the proper utilization of agricultural waste and by-products and also about development of value added products from wastes.

**Theory**

**Module I** **(7 Hours)**

Types, formation and sources of agricultural waste and byproducts; magnitude of waste generation in different food processing industries, waste utilization in various industries, whey utilization from dairy industry, furnace and boilers run on agricultural wastes and byproducts, briquetting of biomass as fuel, production of charcoal briquette

**Module II** **(9 Hours)**

Generation of electricity using surplus biomass, producer gas generation and utilization, waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants, concept of vermin-composting.

**Module III** **(11 Hours)**

Thermo and thermochemical conversion of biomass combustion, pyrolysis of biomass, gasification. Production of silica, silicon, ceramic materials, furfural from wastes. Utilization of rice bran.

**Module IV** **(5 Hours)**

Production of pulp and paper from biomass. Alcholic fermentation of biomass, Production of ethanol from molasses.

**Practical**

Waste characterization:(a)temperature (b)pH (c) solids content (d)turbidity (e)BOD (f)COD, Determination of ash content of agril. Wastes, Determination of unburnt carbon in ash of paddy straw, To study about briquetting of agricultural residues', Estimation of excess air for better combustion of briquettes, To study about extraction of oil from rice bran, To study about waste treatment plant in food industry, To study about utilization of whey, To study about recovery of peel oil, To study about recovery of germ and germ oil from by-product of cereals, Practical on bioconversion of agro-wastes-part 1, Practical on bioconversion of agro-wastes-part 2, Practical on recycling of agro-wastes and by products, Visits to various industries using waste and food by products

**Lecture Schedule**

1. Agricultural wastes- introduction-types-formation-sources
2. Waste generation in food processing industries-economic product obtained and utilization
3. Whey utilization from dairy industry
4. Combustion of biomass-principles of combustion-parameter affecting combustion-combustion process
5. Furnaces for biomass combustion-horizontal gate inclined slip grate-cyclone furnace
6. Design of furnaces and boilers-efficiency calculation
7. Briquetting- Production of charcoal briquette
8. Biomass- Generation of electricity from biomass-utilization
9. Biomass-generation of Producer gas-utilization
10. Waste treatment and disposal of agricultural waste-introduction-waste treatment methods
11. Design of biogas plants-institutional-community-family size
12. Construction of biogas plants
13. Operation and management of biogas plants
14. Vermicomposting-introduction-advantages-concept-preparation
15. Thermo and thermo-chemical conversion of biomass combustion
16. Incineration of solid wastes-design
17. Pyrolysis of biomass-principle-products
18. Gasification of biomass-principle and types
19. Bio chemical and biological reaction of biomass
20. Production of amorphous silica from rice husk-structure and properties
21. Production of silicon from rice husk-structure and properties
22. Ceramic materials from rice husk-introduction-production
23. Furfural from agricultural wastes
24. Structure of furfural and furon derivatives and properties
25. Extraction of oil from rice bran-Soxhelet apparatus
26. Solvent extraction process-refining of rice bran oil
27. Stabilization of rice bran-different types of stabilizers
28. Production of pulp and paper from biomass-introduction-type, Production of sulphate pulp by kraft process-chemicals used during pulping
29. Manufacture of paper-paper board from agricultural wastes-principals and methods-unit operation in paper production
30. Principles of bio gasification-alcoholic fermentation-principles, fermentation system - batch and continuous fermentation-design of fermentors
31. Design of batch and continuous fermentors
32. Production of ethanol from hemi cellulose materials, molasses

**Practical Schedule**

1. Waste characterization: (a) temperature(b)pH(c) solids content(d)turbidity(e)BOD(f)COD
2. Waste characterization: (a) temperature(b)pH(c) solids content(d)turbidity(e)BOD(f)COD
3. Determination of ash content of agril. wastes
4. Determination of ash content of agril. wastes
5. Determination of unburnt carbon in ash of paddy straw
6. To study about briquetting of agricultural residues'
7. Estimation of excess air for better combustion of briquettes

8. To study about extraction of oil from rice bran
9. To study about waste treatment plant in food industry
10. To study about utilization of whey
11. To study about recovery of peel oil
12. To study about recovery of germ and germ oil from by-product of cereals
13. Practical on bioconversion of agro-wastes-part 1
14. Practical on bioconversion of agro-wastes-part 2
15. Practical on recycling of agro-wastes and by products
16. Visits to various industries using waste and food by products

**Suggested Readings**


1. Alba S., A.E. Humphery and N.E. Milles. (1973). *Bio Chemical Engineering* (2 ed.).
2. Baily, J.E and D.F. Ollies. (1986). *Bio Chemical Engineering Fundamentals* (2 ed.). Prescott and Dunn Industrial Micro Biology.
3. Chahal, D.S. (1985). *Food, Feed and Fuel from Biomass*. IBH Publishing. Pvt. Ltd. New Delhi.
4. Chakravarty, A. (1989). *Bio Technology and other Alternative Technologies for Utilization of Bio-mass/ Agrl. Wastes*. Oxford & IBH Pub.Co.Pvt Ltd.


## Elfa. 4207 Emerging Methods of Food Preservation 3(2+1)

**Objective**

To acquaint the students with the novel and emerging technologies in food preservation so as to keep pace with the recent technological developments which are less, energy and cost intensive, while maintaining quality and safety.

**Theory**

**Module I** **(11 Hours)**

Introduction, type and sources of radiation, dosimetry, mode of action of ionizing radiation – direct and indirect effect, radiation effect on food constituents, dose requirement for different products and regulations. Hurdle technology – Ozone – its role in food industry – generation – application.

**Module II** **(12 Hours)**

Pulsed electrified sterilization - application. Pulsed light processing - High pressure technology – application, Oscillating magnetic field sterilization, Ultra sound – application in food industry.

**Module III** **(5 Hours)**

Nano Technology: History, tools and techniques nanomaterials, applications in food packaging and products, implications, environmental impact of nanomaterials and their potential effects on global economics, Enzyme Technology: importance and significance, Effect of Enzyme Technology and its application in food industries.

**Module IV** **(4Hours)**

Ohmic heating-fundamentals-UV-sterilization - microwave heating – Microwave assisted process in food processing- Radio Frequency heating- cold plasma technique.

**Practical**

Study of radiation processes – Application of hurdle concept – study of synthetic production of ozone- study of intermediate moisture foods-pulsed electric field sterilization – study of ultrasound processing- study of application of nano materials in food processing- study of Ohmic heating of food- UV sterilization of food- study of microwave assisted extraction of spice oils – study of enzyme application in food processing. Study of magnetic field processing-Study of pulsed light processing -Study of radio frequency heating of food-Study of cold plasma technique in food processing

**Lecture Schedule**

1. Introduction, scope of emerging food preservation methods
2. Radiation- sources and types of radiation in food industries
3. Dosimetry - mode of action of ionizing radiation, Radiation effect on food constituents - direct and indirect effect
4. Radiation dose requirement for different products-Regulations involved in the application of radiation-Equipments
5. Hurdle technology – introduction and importance
6. Different types of hurdles occur in food spoilage-Hurdle effect – examples
7. Homeostasis – multi target preservation- metabolic exhaustion
8. Different types of hazards, physical, chemical and biological hazards.
9. Ozone – introduction and its role in food industry-advantages
10. generation of Ozone and its application
11. Different levels of ozone in preservation
12. Pulsed electric field sterilization – definition and significance-theory
13. Generation of pulsed electric fields- treatment chamber design-
14. Electric field strength- treatment time temperature – pulse geometry-
15. Application of Pulsed electrified sterilization in food industries
16. Pulsed light processing- theory – generation
17. Applications of Pulsed light processing
18. High pressure technology - importance and significance-Theory
19. HPP-equipment Effect of High pressure technology – Applications in food processing
20. Oscillating magnetic field sterilization- importance and significance- theory
21. Equipments for generation of magnetic field pulses - Effect of Oscillating magnetic field sterilization
22. Ultra sound - importance and significance- theory
23. Ultrasonic processing equipment- Application of ultrasound in food industries.
24. Nano Technology - importance and significance
25. Nano materials - Effect of Nano Technology and its impact in global scenario-
26. Application of nano technology in food processing
27. Enzyme Technology- mode of action - importance and significance
28. Major enzymes and potential food applications
29. Ohmic , UV, microwave and radio frequency heating of food – theory and applications
30. Ohmic , UV, microwave and radio frequency heating of food – theory and applications
31. Ohmic , UV, microwave and radio frequency heating of food – theory and applications
32. Cold plasma technique - fundamentals – applications in food processing.

**Practical Schedule:**

1. Study of radiation processes
2. Application of hurdle concept
3. study of ozone application in food processing
4. Study of intermediate moisture foods
5. Pulsed electric field sterilization
6. Study of ultrasound processing
7. Study of application of nano materials in food processing
8. Study of Ohmic heating of food
9. UV sterilization of food
10. Study of microwave assisted extraction of spice oils
11. Study of enzyme application in food processing.
12. Study of magnetic field processing
13. Study of pulsed light processing
14. Study of radio frequency heating of food
15. Study of cold plasma technique in food processing
16. Visit to food industry

**Suggested Readings**


1. Da-Wen Sun. (2005). Emerging Technologies for Food Processing, Food Science and Technology International, UK
2. Fellows, P.J (2001). Food Processing Technology.
3. Marcus Karel and Daryl B.Lund. (1975)Physical Principles of Food Preservation. Marcel Dekkaer Inc. New York.
4. Peter Zeuthen and Leif Bogh- Sorensen.(2003) Food Preservation Techniques, Wood head Publishing Ltd. Cambridge.


## Elfa. 4208 Processing of Fish and Marine Products 3(2+1)

**Objective**

To impart basic knowledge in Fish Processing by understanding the basics of Fisheries Science. Also, to acquaint and equip the students with various Fish Processing operations and applications in Sea Food Processing Industries.

**Theory**

**Module I** **(12 Hours)**

Fisheries resources, global and Indian scenario; Types of fish and other marine products; Classification of fish (fresh water and marine), composition of fish, characteristics of fresh fish, spoilage of fish- microbiological, physiological, biochemical; Relationship between chilling and storage life, MAP, general aspects of fish freezing, changes in quality during chilled and frozen storage;

**Module II** **(7 Hours)**

Principles of canning, effect of heat processing on fish, storage of canned fish, pre-process operations, post-process operations, cannery operations for specific canned products; Fish products: Introduction, fish muscle proteins, surimi process, traditional and modern surimi production lines, quality of surimi products, comparison of surimi and fish mince products;

**Module III** **(7 Hours)**

Fish protein concentrates (FPC), fish protein extracts (FPE), fish protein hydrolysates (FPH); Preparation protocols of indigenous products: Fish sauce and paste. Novel methods; Low dose irradiation; High pressure treatment, MAP, vacuum packaging, gas packaging.

**Module IV** **(6 Hours)**

Oxygen absorbents and $CO_2$ generators, ethanol vapour generation, hurdle barrier concept, value added fish products, packaging; Sea food quality assurance, HACCP, EU hygienic regulations and ISO 9000 standards; New kinds of quality and safety problems emerging in sea food processing and preservation.

**Practical**

Study of anatomy and dressing of fish; Study of anatomy and dressing of prawn and other marine products; Identification of different types of fish - Selection and grading; Identification of different types of prawn and other marine products - Selection and grading; Quality evaluation of fish; Preparation of sun dried and salt cured fish, fish sauce; Chilling and freezing of fish; Preparations of fish protein concentrate; Preparation of fish meal; Preparation of marine fish oils and various fish products; Utilization of fish by-products; Preparation of marine algal products; Preservation of fish: Drying, pickling; Preservation of marine products using fermentation process; Preparation of value added sea products: Cutlets, bullets, wafers; Processing of fish oils; Canning methods for marine fishery products; Estimation of TVB and TMA; Determination of iodine value; Protein estimation by Folin-Lowrey's method; Visit to fish and prawn processing industry.

**Lecture Schedule**

1. Introduction ,Fisheries resources, global and Indian scenario;
2. Types of fish and other marine products;
3. Classification of fish (fresh water ,brackishand marine),
4. Composition of fish, characteristics of fresh fish,
5. Preservation methods of Fish .
6. Curing of Fish –Smoking,Briningetc
7. Drying
8. Freezers
9. Cold storage
10. Spoilage of fish- microbiological, Physiological spoilage of Fish.Biiochemical spoilage of Fish.
11. Chilling of fish Relationship between chilling and storage life, general aspects of fish freezing,
12. changes in quality during chilled and frozen storage
13. Thermal Processing -effect of heat processing on fish,
14. Principles of canning, storage of canned fish,
15. Canning of Tuna,Mackeral and Sardine.
16. Pre-process operations, post-process operations, cannery operations for specific canned products; Fish products
17. Fish products: Introduction, fish muscle proteins,
18. Surimi process, traditional and modern surimi production lines, quality of surimi products, comparison of surimi
19. Minced Fish products;

20. Fish protein concentrates (FPC),
21. Fish protein extracts (FPE), fish protein hydrolysates (FPH);
22. Preparation protocols of indigenous products:
23. Fish sauce and paste.
24. Novel methods; Low dose irradiation;
25. High pressure treatment,
26. MAP, Vacuum packaging,
27. Gas packaging; Oxygen absorbents and $CO_2$ generators, ethanol vapour generation, hurdle barrier concept,
28. Value added Fish products
29. Preparation of value added sea products: Cutlets, bullets, wafers;
30. Processing of fish oils;
31. HACCP, EU hygienic regulations and ISO 9000 standards;
32. New kinds of quality and safety problems emerging in sea food processing and preservation.

**Practical Schedule**

1. Identification of different types of prawn and other marine products –
2. Identification of different types of fish - Selection and grading;
3. Study of anatomy and dressing of prawn and other marine products;
4. Processing of fish oils
5. Study of anatomy and dressing of fish;
6. Preparation of marine algal products
7. Preservation of fish: Drying, pickling
8. Preservation of marine products using fermentation process
9. Preparation of value added sea products: Cutlets, bullets, wafers;
10. Identification of different types of fish
11. Selection and grading and Identification of different types of prawn and other marine products
12. Canning methods for marine fishery products
13. Estimation of TVB & Estimation of TMA
14. Determination of iodine value;
15. Protein estimation by Folin-Lowrey's method;
16. Visit to fish and prawn processing industry.

**Suggested Reading**


1. Brend W. Rautenstrauss and Thomas Liehr. (2002). Fish Technology. Springer-Verlag, US.
2. Brigitte Maas-van Berkel, Brigiet van den Boogaard and Corlien Heijnen. (2004). Preservation of Fish and Meat. Agromisa Foundation, Wageningen.
3. C.O. Chichester and H.D. Graham. (1973). Microbial safety of Fishery products. Academic Press, New York.
4. D.P. Sen. (2005).Advances in Fish Processing Technology. Allied Publishers Pvt. Ltd., Delhi.
5. FAO. (2003). Code of Practices of Canned Fishery products. FAO, UN, Rome.
6. G.M. Hall. (1997). Fish Processing Technology, 2nd Ed. Chapman & Hall, London, UK.
7. K. Gopakumar. (2002)Textbook of Fish Processing Technology. ICAR, New Delhi.

## Elfa. 4209 Processing of Spices and Plantation Crops 3(2+1)

**Objective**

To understand the processing steps involved for different plantation products, spices and aromatic and medicinal plants.

**Theory**

**Module I** **(7 Hours)**

Status of production, Processing and Utilization, Domestic and international demand of plantation crops, Processing of Tea, coffee and cocoa and its by-product utilisation, including the processes and equipments.

**Module II** **(12 Hours)**

Status of production, Processing, Domestic and international demand, by-product utilisation and processing equipments of coconut, arecanut, rubber, cashew nut and oil palm.

**Module III** **(9 Hours)**

Processing of spices and condiments: Pepper, cardamom, clove, ginger, vanilla, turmeric and chillies. Processing of aromatic and medicinal plants like lemon grass, citronella grass, palmarosa, lemon mint, celery, vetivel, cinchona, kacholam, asgand and dill.

**Module IV** **(4 Hours)**

Extraction of oleoresins and essential oils from aromatic plants and spices.Packaging and Storage of processed plantation products.Technologies for product diversification and by product utilization.

**Practical**

Performance evaluation of coconut dehusker, Production and evaluation of activated carbon from coconut shell, Production and evaluation of particle board from coirpith, Study of a colloid mill, Performance evaluation of a cashew nut sheller, Determination of moisture content of spices- Dean stark apparatus , Extraction of essential oil and oleoresin from spices and aromatic plants – clevenger apparatus and soxhelet apparatus, Performance evaluation of a pepper thresher, Performance evaluation of a pepper grader, Performance evaluation of a white pepper decorticator, Visit to a solvent extraction industry and determination of solvent recovery, Visit to various processing industries –tea, coffee and cashew, Visit to a rubber processing unit, Visit to an oil palm processing unit, Practical Examination.

**Lecture schedule**

1. Status of production, Processing and Utilization of plantation crops
2. Plantation crops-classification-production & processing-Status and Exports-Domestic and international demand of plantation crops
3. Processing of Tea-unit operation-flow chart, process and equipment
4. Processing of coffee-Dry and wet processing-Green, cherry Coffee and Instant coffee powder
5. Coffee -Unit operation-flow charts-equipments and operation of coffee and its by-products
6. Processing of Cocoa-Important unit operation
7. Flow charts in cocoa processing-Equipments-Chocolate processing-flow charts

8. Coconut -introduction ,production-processing-postharvest methods
9. Coconut -Different products-unit operation-flow chart ,equipment and operation
10. Arecanut- -introduction ,production ,postharvest methods, Processing
11. Arecanut-Different products-unit operation-flow chart ,equipment and operation
12. Cashew nut- introduction ,production ,postharvest methods-Processing
13. Cashew nut -unit operations-flow chart, equipment and processing methods of cashew nut
14. Processing of cashew apple- by-product utilisation of cashew industry
15. Processing of rubber - introduction ,production ,postharvest methods
16. Rubber -unit operations-flow chart, equipment and processing methods of rubber
17. Processing of oil palm - introduction ,production ,postharvest methods
18. Oil palm -unit operations-flow chart, equipment and processing methods of oil palm
19. Refining of oil from crude oil palm and packaging
20. Status of production, Processing and Utilization of spices
21. Flavor extraction methods from spices-minor spices and major spices
22. Processing of pepper- value added products-flow chart-packaging methods.
23. Processing of cardamom&Clove- stages of harvest-cleaning, drying, grading equipments.
24. Processing and utilization of Minor spices-herbs, leaves and spartan seasonings
25. Processing of Ginger -flow chart-various products, Processing of chilli- drying-dryers, value added products.
26. Processing of turmeric- boiling and polishing-drying methods-equipments and operation
27. Processing of vanilla and annatto-flowchart, utilization
28. Processing of medicinal plants –flow chart,utilization,methods and unit operations
29. Grinding of spices- problems- cryogenic grinding, Extraction of oleoresins and essential oils from aromatic plants and spices
30. Hydro-distillation- steam distillation – micro assisted distillation of major spices
31. Packaging of processed products -materials- methods-packaging equipments-types – construction and operation and Storage of processed plantation products
32. Packaging of processed products -materials- methods-packaging equipments-types – construction and operation and Storage of processed plantation products

**Practical schedule:**

1. Experiment on Performance evaluation of coconut dehusker
2. Experiment on Production and evaluation of activated carbon from coconut shell
3. Experiment on Production and evaluation of particle board from coirpith
4. Experiment on Performance evaluation of a cashew nut Sheller
5. Experiment on Study of a colloid mill
6. Determination of moisture content of spices- Dean stark apparatus
7. Extraction of essential oil and oleoresin from spices - Clevenger apparatus
8. Extraction of essential oil and oleoresin from aromatic plants - soxhelet apparatus
9. Performance evaluation of a pepper thresher,
10. Experiment on Performance evaluation of a pepper grader,
11. Experiment on Performance evaluation of a white pepper decorticator
12. Packaging study of spices ,aromatic plants and medicinal plants
13. Visit to a solvent extraction industry and determination of solvent recovery
14. Visit to various processing industries –tea, coffee and cashew
15. Visit to a rubber processing unit,
16. Visit to an oil palm processing unit,

**Suggested Reading**


1. Kumar N. , Abdul Khadeer , Rangaswami P. Irulappan I.(1995), Introduction to Spices , Plantation crops, Medicinal and aromatic Plants; IBH Publishing Co. Pvt. Ltd. New Delhi.
2. Mulky, M.J., Sharma V.S. (1995). Tea, Culture, Processing and Marketing., IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Pruthi J.S.(1993). Major Spices in India – Crop Management andPost Harvest Technology, Publication and Information division –I.C.A.R. New Delhi.
4. Purseglove J.W. , Brown E.G. , Green C.L. , Robbins S.R.J.(1981). Spices Vol. I & II; Long man Scientific and Technical,. New York

## Department of Supportive and Allied Courses of Studies

### Sacs. 1101Engineering Mathematics-I 3(2+1)

**Objectives**

- Differential equations are very useful when several of the factors of a problem are known and several unknowns.
- Calculus is used to determine the rates of change or rates by which factors, such as acceleration or weight, change.
- To impart analytical ability in solving mathematical problems as applied to the respective branches of Engineering

**Theory**

**Module I** **(12 Hours)**

Differential calculus: Taylor's and Maclaurin's expansions, indeterminate form; asymptotes, function of two or more independent variables, partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivatives, derivative of an implicit function, change of variables, Jacobians, maxima and minima. Integral calculus: volumes and surfaces of revolution of curves; double and triple integrals, change of order of integration.

**Module II** **(3 Hours)**

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

**Module III** **(10 Hours)**

Differential equations of higher orders, methods of finding complementary functions and particular integrals, method of variation of parameters, Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients, series solution techniques, Bessel's and Legendre's differential equations.

**Module IV** **(7 Hours)**

Vector calculus: Differentiation of vectors, scalar and vector point functions, vector differential operator Del, Gradient of a scalar point function, Divergence and Curl of a vector point function and their physical interpretations, identities involving Del, second order differential operator; Line, surface and volume integrals, Stoke's, divergence and Green's theorems(without proof.)

**Practical**

Indeterminate forms, Asymptotes, Function of two or more variables, Partial differentiation, homogeneous functions and Euler's theorem, composite functions. Total derivatives, Change of variables, Jacobians. Integral calculus: volumes and surfaces of revolution of curves; double and triple integrals, change of order of integration. Equations reducible to exact form by integrating factors. Methods of finding complementary function and particular integrals. Method of variation of parameters. Cauchy's and Legendre's linear equations. Bessel's equation. Legendre's differential equations. Differentiation of vectors, Scalar and vector point functions, Gradient of a scalar point function. Divergence and curl of a vector point function and their physical interpretations. Identities involving Del, line integrals, Surface integrals. Green's theorem. Stoke's theorem for surface integrals. Volume integrals, Gauss divergence theorem, Green's theorems (without proof)

**Lecture schedule**

1. Taylor's and Maclaurin's expansions
2. Indeterminate forms
3. Asymptotes
4. Tracing of curves, Cartesian curves.
5. polar curves.
6. Function of two or more variables, Partial differentiation
7. Homogeneous functions and Euler's theorem.
8. Composite functions.
9. Total derivatives.
10. Change of variables.
11. Jacobians.
12. Maxima and minima of functions of more than one variable
13. Linear and Bernoulli's differential equations
14. Equations reducible to exact form by integrating factors
15. Equations reducible to exact form by integrating factors, Clairaut's equation
16. Methods of finding complementary function and particular integrals
17. Methods of finding complementary function and particular integrals
18. Method of variation of parameters
19. Method of variation of parameters
20. Cauchy's and Legendre's linear equations
21. Simultaneous linear differential equations with constant coefficients
22. Bessel's equation.
23. Recurrence formula, value of $J_{\frac{1}{2}}$
24. Legendre's differential equations
25. Rodrigue's formula. recurrence formula.
26. Differentiation of vectors, Scalar and vector point functions.
27. Gradient of a scalar point function
28. Divergence and curl of a vector point function and their physical interpretations
29. Identities involving Del
30. Line integrals, Surface integrals
31. Green's theorem .Stocke's theorem for surface integrals.
32. Volume integrals, Gauss divergence theorem, Green's theorems (without proof).

**Practical schedule**

1. Indeterminate forms, Asymptotes.
2. Function of two or more variables, Partial differentiation, homogeneous functions and Euler's theorem, composite functions.
3. Total derivatives, Change of variables, Jacobians.
4. Integral calculus: volumes and surfaces of revolution of curves; double and triple integrals, change of order of integration.
5. Equations reducible to exact form by integrating factors
6. Methods of finding complementary function and particular integrals
7. Method of variation of parameters..
8. Cauchy's and Legendre's linear equations.
9. Bessel's equation.
10. Legendre's differential equations.
11. Differentiation of vectors, Scalar and vector point functions, Gradient of a scalar point function.

12. Divergence and curl of a vector point function and their physical interpretations
13. Identities involving Del, line integrals, Surface integrals
14. Green's theorem
15. Stoke's theorem for surface integrals.
16. Volume integrals, Gauss divergence theorem, Green's theorems (without proof)

**Suggested Reading**


1. B.S. Grewal. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi.
2. Shanti Narayan. 2004. Differential Calculus. S. Chand and Co. Ltd., New Delhi.
3. Shanti Narayan. 2004. Integral Calculus. S. Chand and Co. Ltd. New Delhi.
4. Shanti Narayan. 2004. A Textbook of Vector Calculus. S. Chand and Co. Ltd. New Delhi.


## Sacs. 1102 Engineering Physics 3(2+1)

**Objectives**

- To apply the concepts of physics in solving engineering problems and to understand the general scientific concepts required for technology.
- To understand the concept of magnetism and application of different types of magnets in various disciplines.
- To know the property of semiconductor materials by projecting the view of energy bands and analyzing the characteristics of semiconductor components like various diodes.
- To understand the principle of working of laser and its industrial and scientific applications.
- To understand the structure of optical fibre, propagation mechanisms, its loss through the fibre and its industrial applications.
- To understand the Application of concepts of nano-science in technology and study the drastic change in the properties of nano sized materials.

**Theory**

**Module I** **(5 Hours)**

Interference in Thin Films, Interference in thin film by reflected light and transmitted light, interference filters, Newton's rings, Newton's Rings in transmitted and reflected light Dia, Para and ferromagnetism-classification. Langevin theory of dia and para magnetism- a brief note, Qualitative explanation of Zeeman effect, Stark effect and Paschan Back effect, Raman spectroscopy.

**Module II** **(13 Hours)**

Energy Bands iii solids, Distinction between metals, insulators and semiconductors. Intrinsic and extrinsic semiconductors, law of mass action. Determination of energy gap in semiconductors. Donors and acceptor levels. Superconductivity, critical magnetic field. Meissner effect.Isotope effect.Type-I and II superconductors, Josephson's effect DC and AC, Squids. Introduction to high $T_c$ superconductors.

**Module III** **(5 Hours)**

LASERS, Spontaneous and stimulated emission, Einstein A and B coefficients.Population inversion, He-Ne and Ruby lasers.Ammonia and Ruby masers, Holography-Note. Recording and Reconstruction of a Hologram, Applications

**Module IV** **(9 Hours)**

Optical fiber.Physical structure.basic theory. Mode type, input output characteristics of optical fiber and applications.Nanotechnology, Nanoscale materials, nano sensors, nano devices, nano drug delivery systems, Applications in agriculture.

**Practical**

To study the wavelength of light using Newton's Rings,. Newton's Rings Refractive Index,Fresnel's Biprism for determining wavelength of light,.To determine the energy band gap in a semiconductor using a p-n Junction diode.. To determine the slit width from Fraunhofer diffraction pattern using laser beam, To set up the fiber optic analog and digital link, To find the wave length of light by prism, To study the refractive index of the material of the prism using spectrometer, Spectrometer-i-d curve, Spectrometer-i-for d, To study the dispersive power using spectrometer, Diffraction grating normal incidence method, Diffraction grating Minimum deviation, Diffraction grating-oblique incidence, To find the frequency of A C supply using an electrical vibrator,To determine the To find the numerical aperture of optical fiber: To set up the fiber optic analog and digital link, To study the variations of thermo emf of a copper-constantan thermo-couple with temperature.

**Lecture Schedule**

1. Interference in thin films-reflected light-transmitted light-condition for brightness & darkness.
2. Interference filters-applications of thin film interference.
3. Newtons rings- Experimental arrangement-condition for bright and dark fringe-Dark central spot-circular fringes.
4. Radii of circular fringes-fringes of equal thickness.-determination of wavelength of light-determination of refractive index of liquid.
5. Diffraction, Fresnel & Fraunhofer diffraction, Diffraction Grating.
6. Determination of wavelength of light by diffraction grating.
7. Dia-magnetism- classical and quantum theory- para magnetism-Langevin theory of Dia and Para magnetism.
8. Ferromagnetism- statement of curie-Weiss law-curie point-ferromagnetic domains-ferrites.
9. Anti-ferro magnetism-domain wall-hard and soft magnetic materials.
10. Zeeman effect-definition-normal and anomalous Zeeman effect.
11. Stark effect-explanation.
12. Nuclear magnetic resonance-NMR spectrometer.
13. Paschen back effect-explanation of energy levels.
14. Raman effect-classical and quantum theory- applications.
15. Distinction between metals semiconductors and insulators-intrinsic and extrinsic semiconductors-donor and acceptor levels.
16. Superconductivity-effect of applied magnetic field-persistent current.
17. Meissner effect-London equation-London penetration depth.
18. Thermodynamics of superconducting phase transition-entropy-specific heat capacity.
19. Energy gap-isotope effect-BCS theory-cooper pair-.type I and type ii superconductor.
20. Josephson effect-AC and DC Josephson effect-Josephson tunneling.
21. High temp superconductors-SQUIDS-Josephson junction switch-applications.
22. Lasers-spontaneous and stimulated emissions-population inversion-coherence –spatial and temporal coherence.
23. Bandwidth-laser broadening-natural-collisional – doppler broadening.

24. Ruby laser-He-Ne laser-NdYag laser-$Co_2$ laser-PN junction diode laser.
25. Holography –hologram-recording-reconstruction of hologram-applications.
26. Optical fibers-numerical aperture-acceptance angle-modes-single and multimode.
27. Step index and graded index fibers-intermodal dispersion-fiber optic communication-applications.
28. History, definition, terminology in nano-science and importance of moors law.
29. Nanomaterials-biosensors-principle-components-types-applications.
30. Synthesis of nonmaterial-top down and bottom up approach.
31. Nano tech equipment's, Applications of nano technology-nano fertilizer-nano-herbicides-nano pesticides-nano packaging-nano-encapsulation-
32. Nano technology in food systems-nano foods- socio-economic and ethical issues in nano tech and nano toxicology.

**Practical schedule**

1. To study the wavelength of light using Newton's Rings
2. Newton's Rings Refractive Index
3. Fresnels Biprism for determining wavelength of light
4. To determine the energy band gap in a semiconductor using a p-n Junction diode
5. To determine the slit width from Fraunhofer diffraction pattern using laser beam
6. To find the numerical aperture of optical fiber
7. To set up the fiber optic analog and digital link.
8. To find the wave length of light by prism
9. To study the refractive index of the material of the prism using spectrometer
10. Spectrometer-i-d curve
11. Spectrometer-i-for d.
12. To study the dispersive power using spectrometer
13. Diffraction grating normal incidence method
14. Diffraction grating Minimum deviation.
15. Diffraction grating-oblique incidence
16. To find the frequency of A C supply using an electrical vibrator

**Suggested Reading**


1. Brijlal and Subrahmanyam.Text Book of optics. S. Chand and Co., New Delhi.
2. SarkarSubir Kumar. Optical State Physics and Fiber Optics. S. Chand and Co., New Delhi.
3. Gupta S L, Kumar V Sharma R C. Elements of Spectroscopy. PragatiPrakasam, Meeruth.
4. Saxena B S and Gupta R C. Solid State Physics.PragatiPrakasam, Meeruth.
5. Srivastava B N. Essentials of Quantum Mechanics.Pragati Prakasam, Meeruth.
6. Vasudeva D N. Fundamentals of Magnetism and Electricity. S. Chand and Co., New Delhi.
7. Nano the essentials understanding nanoscience and nanoT RADDEB 2009 McGraw hill
8. Nano materials B Viswanathan 2009 Narosa.
9. Nano tech applications in agriculture CR Chinnamuthu , B chadrsseharan and C Ramasamy 2008.

## Sacs. 1103 Engineering Chemistry 3(2+1)

**Objectives:**

- To develop economic ways of using materials and energy, Designing and performing experiments to create new and better ways of production, controlling pollution and conserving resources.
- To turn raw materials into usable products, such as medicine, petrochemicals and plastics on a large-scale, industrial setting.

**Theory**

**Module I** **(6 Hours)**

Water- temporary and permanent hardness, disadvantages of hard water, scale and sludge formation in boilers, boiler corrosion, demineralization, desalination, disinfection of water. Analytical methods -thermogravimetric analysis and polarographic analysis, U.V. Spectra – verification of Beer Lambert's Law. Chromatography.

**Module II** **(6 Hours)**

Fuels - classification, calorific value, Coal- classification, analysis of coal-proximate and ultimate methods. Petroleum, synthesis of petrol, coal gas and biogas. Analysis of flue gas by Orsat apparatus. Colloids- classification, properties.

**Module III** **(8 Hours)**

Corrosion- causes, types and method of prevention. Polymers- types of polymerization, properties and uses of different types of high polymers.

**Module IV** **(12 Hours)**

Lubricants- classification, properties. Principles of food chemistry-introduction to lipids, proteins, carbohydrates, vitamins, food preservatives, colouring and flavouring reagents of food. Enzymes and their use in the manufacturing of ethanol and acetic acid by fermentation methods.

**Practical**

Determination of temporary and permanent hardness of water by EDTA method: Estimation of chloride in water: Estimation of dissolved oxygen in water: Determination of BOD in water sample: Determination of COD in water sample: Estimation of available chlorine in bleaching powder: Determination of viscosity of oil: Estimation of activity of water sample: Estimation of alkalinity of water sample: Determination of carbonate and non- carbonate hardness by soda reagent: Determination of coagulation of water and chloride ion content: Determination of specific rotation of an optically active compound: Determination of Xnax and verification of Beer Lambert Law: Determination of calorific value of fuel: Identification of functional groups (alcohol, aldelyde, ketones, carboxylic acid and amide) by IR: Chromatographic analysis: Determination of molar refraction of organic compounds.

**Lecture schedule**

**I. Water**

1. Sources of water, impurities in water, nature of impurities and their removal.
2. Hardness of water - effect of hardness, determination of hardness.
3. Softening of water - (l)Lime -soda process (2) zeolite method
4. Demineralization, ion exchange method, (l)Process that separate water from salt water - Evaporation/distillation, solvent extraction & reverse osmosis (2) Process that separate salt from saline water - electro dialysis

5. Water treatment - Removal of bacteria and microorganism by sterilization - bleaching power, chlorine, chloramines, ozone and u.v light.
6. Potability of water,Various methods of treatment of industrial waste and radio active waste.

**II. Fuels**

7. Classification of fuels, calorific values, gross and net calorific values - coal - origin and its classification
8. Proximate and ultimate analysis of coal.
9. Petroleum- origin, classification, fractionation of petroleum, refining of petrol, knocking property, octane number, knocking and anti knocking agents.
10. Cracking of petrol, synthesis of petrol- Fischer Tropsch processes& Bergius processes.
11. Gaseous fuels -manufacture, composition and calorific values of coal gas and biogas.
12. Flue gas analysis by Orsat apparatus.

**III. Corrosion**

13. Definition, cause of corrosion, types of corrosion, theories of corrosion
14. Galvanic cell corrosion, concentration cell corrosion, pitting corrosion, stress corrosion, dezincification,microbial corrosion, atmospheric corrosion.
15. Control of corrosion - by purification, alloying, cathodic protection, using inhibitors &passivators
16. Protective coating - paint, lacquer, enamel and varnish

**IV. Polymers**

17. Types of polymerization, properties and uses of different types of high polymers
18. Plastics- types of plastics, Compounding of plastics
19. Rubber - Natural rubber, synthesis of rubber
20. Fibers - Natural & synthetic fibers and use of Nylon, Terylene and Rayon

**V. Lubricants**

21. Classification, types of lubrication, properties and tests (Viscosity and viscosity index, flash and fire point, cloud and pour point, emulsification)
22. Classification, types of lubrication, properties and tests (Viscosity and viscosity index, flash and fire point, cloud and pour point, emulsification)
23. Classification, types of lubrication, properties and tests (Viscosity and viscosity index, flash and fire point, cloud and pour point, emulsification)

**VI. Colloids**

24. Colloids -classification of colloids, Colloids-Preparation of colloidal solution - Dispersion and Condensation methods-purification.
25. Colloids - Properties of colloidal solution - electrical double layer, Zeta potential – Cataphoresis, Origin of charge on colloidal solutions and application of colloids

**VII.Food chemistry**

26. Chemistry of carbohydrates, classification- mono saccharides, properties of monosaccharides, disaccharides, properties of disaccharides
27. Polysaccharides -properties, cellulose, starch, dextrin, glycogen, gums, pectic substances, hemicellulose.
28. Chemistry of lipids - classification-fat constants and characteristics of fats.
29. Classification of fatty acids, alcohols in fats - properties of fats and fatty acids, simple lipids, phospholipids
30. Chemistry of fat soluble vitamins and water soluble vitamins.Amino acids and proteins.-classification and properties
31. Chemistry of enzymes ,use of enzyme in the manufacture of ethanol and acetic acid by fermentation methods. Flavours-important flavour compounds, Colours –natural

and artificial colours.Food preservatives -class I and class 11 preservatives

**VIII. Analytical methods**

32. Thermo gravimetric analysis, Polarographic analysis. U.V. Spectra - verification of Beer Lambert's Law.Chromatography- principle, types of chromatography.

**Practical**

1. Determination of temporary hardness of water by EDTA method
2. Determination of permanent hardness of water by EDTA method
3. Estimation of chloride in water
4. Estimation of dissolved oxygen in water
5. Determination of BOD in water sample
6. Determination of COD in water sample
7. Estimation of available chlorine in bleaching powder
8. Estimation of alkalinity of water sample
9. Estimation of acidity of water sample
10. Estimation of iron in water by colourimetry
11. Determination of carbonate and noncarbonated hardness by soda reagent
12. Qualitative test for carbohydrates and proteins
13. Qualitative test for lipids
14. Qualitative test for fats
15. Determination of fat constant – sapponification values, iodine value – acid number
16. Estimation of Vitamin C

**Suggested Readings**


1 Albert L.Lebninger. *Biochemistry.* Kalyani Publishers, New Delhi.
2 B. R. Puri & R.L.Sharma & Pathania. (2004). *Principles of Physical chemistry.* Vishal Publishing Co.Jalandhar.
3 Bahl B. S & G.DTuli. *Essentails of Physical chemistry.* S. Chand and Co. Ltd.
4 Bhatnagar M.S. (1999). *Textbook of Pure and Applied Physical Chemistry.* A.H.Wheeler & Co., New Delhi.
5 Grudeep Dr. & Harish. *Advanced Physical Chemistry.* Goel Publishing House, Meerut.
6 Hobart H.Willard, Lynna L.Merritt, Jr and John A.Dean. *Instrumental Methods of Analysis.* D.Van Nostrand Company, Inc.
7 I.L, F. *Organic Chemistry* (6 ed.). ELBS & Longmen.
8 Jain J.L., Sanjay Jain, Nitin Jain. (2007). *Fundamentals of Biochemistry-* . S.Chand and Company Ltd.
9 Khopkar, S.M. *Basic concepts of Analytical Chemistry.* Wiley Eatern Ltd.,New Delhi.
10 Philip R.Ashurst. *Food flavorings* (3 ed.). An Aspen Publications.
11 Raymond Chang. *Basic Principles of Spectroscopy.* Mc Graw-Hill Kogakusha Ltd.
12 Shakuntala Many N., M.Shadaksharaswamy. (2000). *Foods - Facts and Principles.* New Age International (P) Ltd.
13 Sharma B.K. *Colloidal Chemistry* . Goel Publishing House.
14 Sharma, B.K. *Instrumental Methods of Chemical Analysis.* Goel Publishing House, Meerut.
15 Uppal M.M. (2001). *A text book of Engineering Chemistry.* Khanna Publishers.
16 Vogel, A.I. *A Text Book of Quantitative Inorganic analysis.* ELBS & Longman.
17 Vogel, A.I. . *Organic Analisis.* ELBS & Longman.

## Sacs. 1104 Principles of Soil Science 2(2+0)

**Objectives**

- To build fundamental knowledge and skills of the students within the different areas of soil science to enhance their professional skills
- To familiarize the students with the origin of soil, different soil forming processes and different soil taxonomy orders
- To identify and describe soil physical, chemical, and biological properties and processes that affect agricultural and non-agricultural land use and management

**Theory**

**Module I** **(10 Hours)**

Nature and origin of soil; soil forming rocks and minerals, their classification and composition, soil forming processes, classification of soils – soil taxonomy orders.

**Module II** **(6 Hours)**

Important soil physical properties; and their importance; soil particle distribution; soil inorganic colloids – their composition, properties and origin of charge; ion exchange in soil and nutrient availability.

**Module III** **(11 Hours)**

Soil organic matter – its composition and decomposition, effect on soil fertility; soil reaction – acidic, saline and sodic soils.

**Module IV** **(5 Hours)**

Quality of irrigation water; Use of saline and sodic water for crop production, Gypsum requirement for reclamation of sodic soils and neutralising RSC; Liquid fertilisers and their solubility and compatibility.

**Lecture schedule**

1. Soil-definition-nature and origin of soil
2. Weathering process-definition-types
3. Physical weathering-factors affecting physical weathering
4. Chemical weathering-factors affecting chemical weathering
5. Biological weathering-factors
6. Soil forming rocks and minerals, their classification and composition
7. Soil forming factors
8. Soil forming processes
9. Classification of soils – soil taxonomy orders
10. Characteristic features of different orders
11. Important soil physical properties of soil -texture, bulk density
12. Particle density, soil porosity and soil plasticity - their importance
13. Soil particle distribution; soil inorganic colloids
14. Composition and properties of soil inorganic colloids
15. Origin of charge; ion exchange in soil
16. Nutrient availability in soil
17. Soil organic matter – its composition and decomposition
18. Effect of soil organic matter on soil fertility
19. Soil reaction –Acid soils-nature of soil acidity
20. Sources and effect of acidity on plant growth- lime requirement of acid soils

21. Management of acid soils
22. Saline soils- genesis, morphology
23. Sodic soils- genesis, morphology
24. Characterization of salt affected soils - soluble salts, ESP, pH
25. Physical, chemical and microbiological properties of salt affected soils
26. Management of salt-affected soils; salt tolerance of crops
27. Biological sickness of soils and its management
28. Quality of irrigation water-criteria.
29. Irrigation water-quality-parameters
30. Classification-management. Use of saline and sodic water for crop production
31. Gypsum requirement for reclamation of sodic soils and neutralizing RSC
32. Liquid fertilizers and their solubility and compatibility

**Suggested Reading**


1. Brady Nyle C and Ray R Well. 2002. Nature and properties of soils. Pearson Education Inc., New Delhi.
2. Indian Society of Soil Science. 1998. Fundamentals of Soil Science. IARI, New Delhi.
3. SehgalJ.. A. Textbook of Pedology Concepts and Applications. Kalyani Publishers, New Delhi.
4. Hillel D. 1982.Introduction to Soil Physics. Academic Press, London.


## Sacs. 1105 Principles of Agronomy 2(2+0)

**Objective**

To equip the students with necessary theoretical and practical knowhow on basic principles of cropping and acquaint them with the cultivation practice of paddy being the most important crop of Kerala.

**Theory**

**Module I** **(6 Hours)**

Introduction to agriculture and relevance of the course with respect to agricultural engineers. Introduction and scope of agronomy. Classification of crops, Effect of different weather parameters on crop growth and development.

**Module II** **(19 Hours)**

Principles of tillage, tilth and its characteristics. Crop seasons.Methods, time and depth of sowing of major field crops.Soil fertility; essential plants nutrients – their functions and deficiency symptoms in plants; important inorganic fertilizers and their reactions in soils. Methods and time of application of manures, fertilizers and biofertlizers-Integrated Nutrient Management.Soil water plant relationship, crop coefficients, water requirement of crops and critical stages for irrigation, weeds and their control.

**Module III** **(4 Hours)**

Cropping systems- mono cropping, multiple cropping, relay cropping, inter cropping, mixed cropping, crop rotation; organic farming, sustainable agriculture-integrated farming systems, precision farming.

**Module IV** **(3 Hours)**

Scientific cultivation and management of paddy crop-origin, varieties, soil, climate; land preparation and puddling; manuring, fertilizer application, weeding and water management; harvesting and post harvest operations.

**Lecture schedule**

1. Introduction to agriculture and relevance of the course with respect to agricultural engineers.
2. Agronomy- definition – scope.
3. National and international agricultural research-major institutes.
4. Classification of crops.
5. Weather parameters-temperature, humidity, rainfall, wind, solar radiation.
6. Effect of different weather parameters on crop production.
7. Tillage-definition-principles.
8. Tillage-objective, disadvantages-tilth and its characteristics.
9. Types-benefits-methods of tillage.
10. Crop seasons- sowing-methods.
11. Time and depth of sowing of major field crops.
12. Soil fertility- essential plants nutrients.
13. Plant nutrients-essentiality-functions- deficiency symptoms.
14. Organic manures-types-nutrient content.
15. Inorganic fertilizers- classification- nutrient content -their reactions in soils.
16. Biofertilizers-definition-classification.
17. Methods and time of application of manures, fertilizers and biofertlizers.
18. Integrated nutrient management.
19. Soil water plant relationship, crop coefficients.
20. Water requirement of crops.
21. Critical stages for irrigation and scheduling of irrigation.
22. Weeds-definition-classification-harmful and beneficial effects.
23. Weed control methods-cultural, mechanical.
24. Chemical method of weed control.
25. Biological weed control-integrated weed management.
26. Cropping systems- mono cropping, multiple cropping, relay cropping
27. Inter cropping, mixed cropping, crop rotation
28. Organic farming-Sustainable agriculture-integrated farming systems
29. Precision farming
30. Scientific management of paddy crop-origin, varieties, soil, climate. Land preparation and puddling
31. Manuring, fertilizer application, weeding and water management
32. Harvesting and post harvest operations.

**Suggested Reading**


1. William L Donn. 1965. Meteorology. McGraw-Hill Book Co. New York.
2. Arnon L. 1972. Crop Production in Dry Regions.Leonard Hill Publishing Co. London.
3. Yawalkar K S and Agarwal J P. 1977. Manures and Fertilizers. Agricultural Horticultural Publishing House, Nagpur.
4. Gupta O P. 1984. Scientific Weed Management in the Tropics and Sub- Tropics. Today and Tomorrow's Printers and Publishers. New Delhi.

5. Rao V S. 1992. Principles of Weed Science.Oxford and IBH Publishing Co. Ltd. New Delhi.
6. Reddy Yellamanda T and Shankar Reddy G H. 1995.Principles of Agronomy.Kalyani Publishers Ludhiana.

## Sacs. 1206 Engineering mathematics-II 3(2+1)

### Objectives

- To understand the concept of complex geometry which is very useful in constructing machines. Complex analyses have a great role in many circuits.
- To understand about Fourier series which represents periodic functions. It is used in the resolution of partial differential equations, which appears in many engineering problems such as heat diffusion, wave propagation and fluid mechanics problem.

**Theory**

**Module I** **(4 Hours)**

Infinite series: Infinite series and its convergence, comparison tests, ratio test, cauchy's root test, integral test, raabes's test, gauss test, absolutely and conditionally convergent series.

**Module II** **(7 Hours)**

Fourier Analysis: Periodic functions, Fourier series, Euler's formulae, Dirichlet's conditions, functions having arbitrary period, functions having point of discontinuity, even and odd functions, Half range series, complex Fourier series, Fourier integrals, Fourier sine and cosine transforms, Fourier transform, properties.

**Module III** **(8 Hours)**

Partial differential equations: Formation of partial differential equations, Lagrange's linear equations, homogeneous linear equation with constant coefficients, solution of nonlinear partial differential equations, Charpit's method, method of separation of variables, application of partial differential equations (one dimensional wave and heat flow equations, two dimensional steady state heat flow equation).

**Module IV** **(13 Hours)**

Complex analysis: Complex functions, derivative, analytic function, Cauchy-Riemann equations, Laplace's equation, complex integration, line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula, power series, functions given by power series, Taylor series and Maclaurin's series. Laurent's series, singularities and zeros, Residue, integration method, Evaluation of real integrals.

**Practical**

Tutorials on solution of ordinary differential equations of first and higher orders.Series solutions of differential equations.Bessel's and Legendre's differential equations, Convergence of infinite series. Fourier series, harmonic analysis, analytical functions, Cauchey-Riemann equations, harmonic functions, Solution of partial differential equations, Application of partial differential equations.

**Lecture schedule**

1. Infinite series and its convergence, Comparison tests
2. Ratio test, Cauchy's root test.
3. Integral test, Raabes's test, gauss test

4. Absolutely and conditionally convergent series
5. Periodic functions, Fourier series, Euler's formulae
6. Dirichlet's conditions, functions having points of discontinuity.
7. Change of interval.
8. Even and odd functions
9. Half range series, Complex Fourier series.
10. Fourier integrals, Fourier sine and cosine transforms
11. Fourier transform , properties.
12. Formation of partial differential equations
13. Lagrange's linear equations
14. Solution of nonlinear partial differential equations
15. Charpit's method
16. Homogeneous linear equation with constant coefficients.
17. Method of separation of variables, application of partial differential equations (one dimensional wave equation)
18. Application of partial differential equations(heat flow equations)
19. Two dimensional steady state heat flow equation
20. Complex functions, limit, derivative, Cauchy-Riemann equations.
21. Analytic function, harmonic function, Laplace's equation
22. Complex integration, Cauchy's theorem.
23. Cauchy's integral formula(problems)
24. Power series, Functions given by power series
25. Taylor series and Maclaurin's series
26. Laurent's series
27. Singularities and zeros
28. Residue
29. Residue
30. Evaluation of real definite integrals, integration around the unit circle.
31. Integration around a small semicircle, integration around rectangular contours.
32. Indenting the contours having poles on the real axis.

**Practical schedule**

1. Infinite series and its convergence, Comparison tests.
2. Ratio test, Cauchy's root test, integral test, Raabes's test.
3. Fourier series, Euler's formulae.
4. Functions having points of discontinuity change of interval.
5. Even and odd functions, Half range series
6. Fourier integrals, Fourier sine and cosine transforms, Fourier transform , properties.
7. Charpit's method
8. Homogeneous linear equation with constant coefficients.
9. Method of separation of variables, application of partial differential equations (one dimensional wave equation)
10. Application of partial differential equations(heat flow equations), Two dimensional steady state heat flow equation
11. Complex integration, Cauchy's theorem, Cauchy's integral formula(problems)
12. Taylor series and Laurent's series
13. Singularities and zeros
14. Residue
15. Evaluation of real definite integrals, integration around the unit circle.
16. Integration around a small semicircle, integration around rectangular contours.

**Suggested Reading**


1. Narayan Shanti. 2004. A Text Book of Matrices. S. Chand and Co. Ltd. New Delhi.
2. Grewal B S. 2004. Higher Engineering Mathematics.Khanna Publishers Delhi.
3. Ramana B V. 2008. Engineering Mathematics. Tata McGraw-Hill. New Delhi.


## Sacs. 1207 Entrepreneurship Development and Business Management 3(2+1)

**Objectives**

- To familiarize students with various concepts used in understanding processes involved in entrepreneurship and business formation and development.
- To develop and strengthen entrepreneur qualities of students and understand the need for entrepreneur discipline.
- To equip students capable of analysing the environmental set up relating to small industry & small business and make them understand the procedure of small scale industries.
- To develop wide vision about the business and to inculcate in the minds of students the passion for honesty and integrity.

**Theory**

**Module I** **(6 Hours)**

Entrepreneurship, management – Management functions – planning- Organizing -Directing – motivation – ordering – leading – supervision-Communication and control – Capital – Financial management – importance of financial statements – balance sheet – profit and loss statement, Analysis of financial statements – liquidity ratios – leverage ratios, Coverage ratios – turnover ratios – profitability ratios, Agro-based industries – Project – project cycle – Project appraisal and evaluation techniques – undiscounted measures – payback period – proceeds per rupee of outlay, Discounted measures – Net Present Value (NPV) – Benefit-Cost Ratio (BCR) – Internal Rate of Return (IRR) – Net benefit investment ratio (N / K ratio)

**Module II** **(8 Hours)**

Sensitivity analysis-Importance of agribusiness in Indian economy International trade-WTO agreements – Provisions related to agreements in agricultural and food commodities. Agreements on agriculture (AOA) – Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS). Development (ED): Concept of entrepreneur and entrepreneurship assessing overall business environment in Indian economy

**Module III** **(9 Hours)**

Entrepreneurial and managerial characteristics- Entrepreneurship Development Programmes (EDP)- Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development- Globalization and the emerging business entrepreneurial environment- Managing an enterprise: Importance of planning, budgeting, monitoring evaluation and follow-up managing competition. Role of ED in economic development of a country-Overview of Indian social, political systems and their implications for decision making by individual entrepreneurs.

**Module IV** **(9 Hours)**

Economic system and its implications for decision making by individual entrepreneurs- Social responsibility of business. Morals and ethics in enterprise management- SWOT analysis- Government schemes and incentives for promotion of entrepreneurship. Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors- Venture capital (VC), contract farming (CF) and joint ventures (JV), public-private partnerships (PPP)- Overview of agricultural engineering industry, characteristics of Indian farm machinery industry.

**Practical**

Preparation of business – Strengths Weaknesses Opportunities and Threats (SWOT) analysis, Analysis of financial statements (Balance Sheet, Profit loss statement). Compounding and discounting, Break-even analysis Visit to agro-based industries – I, Visit to agro-based industries – II Study of Agro-industries Development Corporation , Ratio analysis – I, Ratio analysis – II, Application of project appraisal technique – I(Undiscounted measures), Application of project appraisal technique – II(Discounted Measures), Formulation of project feasibility reports – Farm Machinery Project proposals as entrepreneur – individual and group - Presentation of project proposals in the class.

**Lecture schedule**

1. Entrepreneurship, management – Management functions – planning- Organizing – Directing – motivation – ordering – leading – supervision
2. Communication and control -- Capital – Financial management – importance of financial statements – balance sheet – profit and loss statement.
3. Analysis of financial statements – liquidity ratios – leverage ratios, Coverage ratios – turnover ratios – profitability ratios,
4. Agro-based industries – Project – project cycle .
5. Project appraisal and evaluation techniques – undiscounted measures – payback period – proceeds per rupee of outlay, Discounted measures.
6. Net Present Value (NPV) – Benefit-Cost Ratio (BCR) – Internal Rate of Return (IRR) – Net benefit investment ratio (N / K ratio).
7. Sensitivity analysis-Importance of agribusiness in Indian economy International trade-WTO agreements .
8. Provisions related to agreements in agricultural and food commodities.
9. Agreements on agriculture (AOA) – Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures.
10. Trade related intellectual property rights (TRIPS).
11. Development (ED).
12. Concept of entrepreneur and entrepreneurship.
13. Assessing overall business environment in Indian economy.
14. Entrepreneurial and managerial characteristics.
15. Entrepreneurship development Programmes (EDP)-
16. Generation incubation and commercialization of ideas and innovations
17. Motivation and entrepreneurship development.
18. Globalization and the emerging business entrepreneurial environment
19. Managing an Enterprise.
20. Importance of planning, budgeting, monitoring evaluation and follow-up managing competition.
21. Role of ED in economic development of a country

22. Overview of Indian social, political systems and their implications for decision making by individual entrepreneurs.
23. Economic system and its implications for decision making by individual entrepreneurs
24. Social responsibility of business
25. Morals and ethics in enterprise management
26. SWOT analysis- Government schemes and incentives for promotion of entrepreneurship.
27. Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors
28. Venture capital (VC)
29. contract farming (CF)
30. joint ventures (JV),
31. public-private partnerships (PPP)
32. Overview of agricultural engineering industry. Characteristics of Indian farm machinery industry.

**Practical schedule**

1. Preparation of business
2. Strengths Weaknesses Opportunities and Threats (SWOT) analysis
3. Analysis of financial statements (Balance Sheet, Profit loss statement)
4. Compounding and discounting
5. Break-even analysis.
6. Visit to agro-based industries
7. I. Visit to agro-based industries
8. II. Study of Agro-industries Development Corporation.
9. Ratio analysis – I,
10. Ratio analysis – II,
11. Application of project appraisal technique – I(Undiscounted measures)
12. Application of project appraisal technique – II(Discounted Measures)
13. Formulation of project feasibility reports
14. Farm Machinery Project proposals as entrepreneur
15. Individual and group
16. Presentation of project proposals in the class.

**Suggested Readings**


1. Harsh, S.B., Conner, U.J. and Schwab, G.D. 1981.Management of the Farm Business. Prentice Hall Inc., New Jersey.
2. Joseph, L. Massie. 1995. Essentials of Management. Prentice Hall of India Pvt. Ltd., New Delhi.
3. Omri Rawlins, N. 1980. Introduction to Agribusiness. Prentice Hall Inc., New Jersey
4. Gittenger Price, J. 1989. Economic Analysis of Agricultural Projects.John Hopkins University, Press, London.
5. Thomas W Zimmer and Norman M Scarborough. 1996. Entrepreneurship. Prentice-Hall, New Jersey.
6. Mark J Dollinger. 1999. Entrepreneurship Strategies and Resources. Prentice-Hall, Upper Saddal Rover, New Jersey.
7. Khanka S S. 1999. Entrepreneurial Development. S. Chand and Co. New Delhi.
8. Mohanty S K. 2007. Fundamentals of Entrepreneurship. Prentice Hall India Ltd., New Delhi.

## Sacs. 1208 Principles of Horticultural Crops and Plant Protection 2(1+1)

**Objectives**

- To equip the students with the fundamental aspects of horticulture
- To acquaint them with the principles of propagation, production practices, harvesting, post harvest handling and value addition of horticultural crops
- To appreciate the economic importance of pests and diseases and discuss the management and control strategies of plant pests and diseases

**Theory**

**Module I** **(6 Hours)**

Scope of horticulture. Soil and climatic requirements for fruits, vegetables and floriculture crops, improved varieties. Criteria for site selection, layout and planting methods, nursery raising, commercial varieties/hybrids, sowing and planting times and methods, seed rate and seed treatment for vegetable crops.

**Module II** **(6 Hours)**

Macro and micro propagation methods, plant growing structures, pruning and training, crop coefficients, water requirements and critical stages, fertilizer application, fertigation, irrigation methods, harvesting, grading and packaging, post harvest practices.

**Module III** **(4 Hours)**

Garden tools, management of orchard, Extraction and storage of vegetables seeds. Major pests and diseases and their management in horticulture crops. Post harvest handling and value addition of major horticultural crops.

**Practical**

Judging maturity time for harvesting of crop; Study of seed viability and germination test; Identification and description of important fruits, flowers and vegetable crops; Study of different garden tools; Preparation of nursery bed; Practices of pruning and training in some important fruit crops, visit to commercial greenhouse/ polyhouse; cultural operations for vegetable crops (sowing, fertilizer application, mulching, irrigation and weed control); seed extraction techniques; identification of important pests and diseases and their control. Post harvest handling of major horticultural crops.

**Lecture schedule**

1. Horticulture-definition- scope-major classes of horticultural crops with examples
2. Soil and climatic requirements for fruits, vegetables and floriculture crops
3. Site selection and layout, important varieties/commercial hybrids of horticultural crops
4. Seed rate, seed treatment, raising of nursery and production of quality planting materials of horticultural crops
5. Seed rate, seed treatment, raising of nursery and production of quality planting materials of horticultural crops
6. Main field planting or sowing, planting time and planting methods
7. Macro and micro propagation methods of horticultural crops
8. Macro and micro propagation methods of horticultural crops
9. Crop coefficients, critical stages of crop growth, irrigation methods
10. Manuring and fertilizer application in horticultural crops-dose, time and method of application
11. Pruning, training and other management practices in horticultural crops

12. Harvesting and post harvest handling-value addition- grading and packing
13. Garden tools and management of orchard
14. Extraction - storage of vegetable seeds, criteria for quality vegetable seed productio
15. Pests and diseases of horticultural crops and their management
16. Pests and diseases of horticultural crops and their management

**Practical schedule**

1. Judging maturity time for harvesting of crop
2. Study of seed viability and germination test
3. Identification and description of important fruits, flowers and vegetable crops
4. Study of different garden tools
5. Preparation of nursery bed
6. Practices of pruning and training in some important fruit crops
7. Practices of pruning and training in some important fruit crops
8. Practices of pruning and training in some important fruit crops
9. Visit to commercial greenhouse/ polyhouse
10. Cultural operations for vegetable crops (sowing, fertilizer application, mulching, irrigation and weed control)
11. Seed extraction techniques
12. Identification of important pests and diseases
13. Control of important pests and diseases
14. Post harvest handling of major horticultural crops
15. Post harvest handling of major horticultural crops
16. Post harvest handling of major horticultural crops

**Suggested reading**


1. S. Prasad and U. Kumar. 2010. Principles of Horticulture. Agrobios, New Delhi.
2. S.S. Singh. 1985. Principles and Practices of Agronomy. Kalyani Publishers, Ludhiana.
3. T. R. Gopalakrishnan. 2007. Vegetable Crops. New India Publishing Agency, Pitampura, Delhi.
4. T. Radha and L. Mathew. 2007. Fruit Crops. New India Publishing Agency, Pitampura, Delhi.
5. T. Yellamanda Reddy and G.H. Shankar Reddy. 1995. Principles of Agronomy. Kalyani Publishers, Ludhiana.


## Sacs. 1209 Physical Education 0(0+0)

**Objectives**

- The physical education program will develop and reinforce cooperative behavior
- The physical education program will teach the students to establish lifelong fitness goals

**Practical**

Introduction to physical education: Definition, scientific machine principles,objectives, scope,history, development and importance; Physical training and health; Fartlek training and circuit training; Body mechanism and body type: Kretchmark's and Sheldon's classification; Theories of learning; Exercises for good posture; Exercises to develop physical fitness, growth., flexibility-components, speed, strength, endurance, power, flexibility, agility, coordination and balance; Test and measurement in physical education; Physical fitness test, motor fitness test, ability test, cardiovascular efficiency test and physical fitness index;

Calisthenics, weight training, aerobic and anaerobic exercises; interval training, pressure training and resistance training; Importance of Asanas, free hand exercises and yoga; Recreation: Definition, agencies promoting recreation, camping and re-recreation; Governance of sports in India; Organization of tournaments; National and international events; Drawing of fixtures; Rules and regulations; Coaching and fundamentals of skill development of major games, coaching and tactic development of athletic events.

## Sacs. 2110 Engineering Mathematics III 3(2+1)

**Objectives:**

- Testing of hypothesis in statistics is necessary in doing the project analysis and research methodology.
- Numerical methods are very useful in agricultural related subjects.

**Theory**

**Module I** **(11 Hours)**

Numerical analysis and Laplace transformation: finite differences, various difference operators and their relationships. Factorial notation, Interpolation with equal intervals, Newton's forward and backward interpolation formula. Bessel's and Stirling's difference interpolation formula. Interpolation with unequal intervals, Newton's divided difference formula, Lagrange's interpolation formula. Laplace transformation and its application to the solutions of ordinary and simultaneous differential equation.

**Module II** **(8 Hours)**

Numerical differentiations, Numerical integrations, Difference equations and their solutions. Numerical solutions of ordinary equations by Picard's method, Taylor series method, Euler's method, Modified Euler's method., Runge Kutta method.

**Module III** **(6 Hours)**

Measures of central tendency, Measures of dispersion, Correlation, Regression, Normal distribution and standard normal distribution, its properties, Fitting of distributions.

**Module IV** **(7 Hours)**

Testing of hypothesis(introduction), level of significance, degrees of freedom, statistical errors, Large sample test(z test), Small sample t test(one tailed, two tailed, paired t test), Testing of significance through variance(F test)- One way ANOVA, Two way ANOVA. Chi square test-goodness of fit, Contigency table.

**Practical**

Interpolation, Numerical differentiation and integration solutions of difference equations, numerical solution of ordinary differential equations of first order and first degree, Laplace and inverse Laplace transformations and their application to solution of ordinary and simultaneous differential equations. Problems on One Sample, Two sample Z-tests when Population S.D. is known and unknown, Problems on one sample, Two sample and paired t-test Chi-Square test – 2x2 and m x n, Calculation of Correlation coefficient and its testing, Contingency Table and F-test.

**Lecture schedule**

1. Finite differences.
2. Various difference operators and their relationships.
3. Factorial notation
4. Interpolation with equal intervals, Newton's forward .
5. Backward interpolation formula.
6. Bessel's difference interpolation formula.
7. Stirling's difference interpolation formula
8. Interpolation with unequal intervals, Newton's divided difference formula.
9. Lagrange's interpolation formula
10. Laplace transformation and its application to the solutions of ordinary differential equation.
11. Simultaneous differential equations
12. Numerical differentiations
13. Numerical integrations, Trapezoidal rule.
14. Simpson's rules.
15. Difference equations and their solutions
16. Numerical solutions of ordinary equations by Picard's method.
17. Taylor series method
18. Euler's method.
19. Modified Euler's method. RungeKutta method
20. Measures of central tendency.
21. Measures of dispersion.
22. Correlation.
23. Regression
24. Normal distribution and standard normal distribution, its properties.
25. Fitting of distributions
26. Testing of hypothesis(introduction), level of significance, degrees of freedom, statistical errors
27. Large sample test(z test).
28. Small sample t test(one tailed, two tailed, paired t test)
29. Testing of significance through variance (F test)- One way ANOVA.
30. Two way ANOVA.
31. Chi square test- goodness of fit.
32. Contigency table

**Practical schedule**

1. Interpolation
2. Numerical differentiations
3. Numerical integrations.
4. Solutions of difference equations.
5. Numerical solutions of ordinary equations of first order and first degree
6. Laplace transforms.
7. Inverse Laplace transformation
8. Application of Laplace and inverse Laplace transformation to solutions of ordinary differential equations.
9. Application of Laplace and inverse Laplace transformation to solutions of simultaneous differential equations
10. Problems on one sample, two sample z test when population S.D is known

11. Problems on one sample, two sample z test when population S.D is unknown
12. Problems on one sample, two sample and paired t test
13. Chi-square test- 2x2 and mxn
14. Calculation of correlation coefficient and its testing
15. Contingency table
16. F test.

**Suggested Readings**


1. Chandel SRS. A Hand book of Agricultural Statistics. AchalPraskasamMasndir, Kanpur.
2. Agarval B L. Basic Statistics. Wiley Eastern Ltd. New Age International Ltd.
3. NageswaraRao G. Statistics for Agricultural Sciences. BS Publications.
4. Rangaswamy R. A Text Book of Agricultural Statistics. New Age International Ltd.
5. Gupta S. C. Fundamental Applied Statistics.
6. B.S. Grewal. 2004. Higher Engineering Mathematics. Khanna Publishers, Delhi.


## Sacs. 2111Web Designing and Internet Applications 2(1+1)

**Objective**

To introduce the novel web technologies to the students and enable them to create website and publish the technology/information gained during their studies/career.

**Theory**

**Module I** **(7 Hours)**

Basic principles in developing a web design, Planning process, Five Golden rules of web designing, Designing navigation bar, Page design, Home Page Layout, Design Concept. Basics in Web Design, Brief History of Internet, World Wide Web , creation of a web site, Web Standards, Audience requirement. Understanding basic HTML tags.

**Module II** **(8 Hours)**

Introduction to JavaScript, variables & functions, Working with alert, confirm and prompt, Understanding loop, arrays, Creating rollover image. Working with operator.

**Module III** **(1 Hours)**

Connectivity of Web pages with databases; ASP connection string.

**Practical**

DREAM WEAVER: Exploring Dreamweaver Interface, Planning & Setting Web Site Structure, Working with panels, Understanding and switching views, Using property inspector, Formatting text, JAVA SCRIPT: Working with alert, confirm and prompt, Understanding loop, arrays, Creating rollover image, Working with operator, GIF ANIMATION: Learning to use FTP, Setting FTP, Uploading of site, Using Control panel, FTP UPLOADING SITE: Understanding gif animation interface, Knowing Gif file format, Creating basic web banners, Creating web banners with effects, Creating animated web buttons.

**Lecture Schedule**

1. Basic principles in developing a web design, Planning process, Five Golden rules of web designing.
2. Design Concept, Designing navigation bar, Page design, Home Page Layout.
3. Basics in Web Design, Brief History of Internet, World Wide Web, Creation of a web site, Web Standards, Audience requirement.
4. HTML tags – formatting, lists, bullets
5. HTML tags –add images, tables
6. HTML tags – forms and events
7. HTML tags- Audio, video, panels
8. Introduction to JavaScript, variables, operators
9. If –else, Switch –case
10. While loop. For loop
11. JavaScript functions –alert, prompt, Page redirect
12. Mid-term Examination
13. Objects, creating rollover image.
14. Arrays, Strings
15. For ---in
16. Connectivity of Web pages with databases –ASP connection string to Ms -Access

**Practical Schedule**

1. DREAM WEAVER: Exploring Dreamweaver Interface
2. Planning & Setting Web Site Structure
3. HTML tags
4. JAVA SCRIPT: Working with variables, operators
5. Understanding loop, while loop
6. For loop
7. alert, confirm and prompt
8. Creating rollover image
9. Gif animation: Understanding gif animation interface, Knowing GIf file format
10. Gif animation: Creating basic web banners, Creating web banners with effects
11. Creating animated web buttons.
12. Learning to use FTP, Setting FTP
13. Uploading of site
14. Project
15. Project
16. Project

**Suggested Readings**


1. Jennifer Niederst Robbins. Developing web design latest edition.
2. Frainand Ben. Responsive Web Design with HTML5
3. Nicholas c.Zakas. Java Script for Web Developers.
4. George Q. Huang, K. L Mak. Internet Applications in Product Design and Manufacturing. ISBN:3540434658.
5. Dan Donault et al., ASP 3.0 Programmers Reference, Wrox Press.

## Sacs. 2112Communication Skills and Personality Development 2(1+1)

**Objectives**

- To develop effective communication skills.
- To develop effective presentation skills and acquire grooming techniques.
- To make students self-confident individuals by mastering inter-personal skills, team management skills, and leadership skills
- To develop all-round personalities with a mature outlook to function effectively in different circumstances.
- To bring about personality development with regard to the different behavioural dimensions that has far reaching significance in the direction of organizational effectiveness.

**Theory**

**Module I** **(4 Hours)**

Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and non-verbal communication.

**Module II** **(6 Hours)**

Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles.

**Module III** **(6 Hours)**

Precis writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion, Organizing seminars and conferences.

**Practical**

Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precis writing, summarizing, abstracting; individual and group presentations.

**Lecture schedule**

1. Communication Skills:
2. Structural and functional grammar;
3. Meaning and process of communication,
4. Verbal and non-verbal communication.
5. Listening and note taking
6. Writing skills
7. Oral presentation skills
8. Field diary.
9. Lab record
10. Indexing,
11. Footnotes
12. Bibliographic procedures
13. Reading and comprehension of technical articles, technical writing
14. Summarizing, abstracting- individual and group presentations
15. Impromptu presentation, public speaking
16. Group discussion. Organizing seminars and conferences

**Practical schedule**

1. Listening and note taking.
2. Writing skills, oral presentation skills
3. Field diary and lab record
4. Indexing, footnote and bibliographic procedures
5. Reading and comprehension of general and technical articles
6. précis writing,
7. Summarizing, abstracting
8. Individual and group presentations.

**Suggested Readings**


1. Balasubramanian T. 1989. A Text book of Phonetics for Indian Students. Orient Longman, New Delhi.
2. Balasubrmanyam M. 1985. Business Communication.Vani Educational Books, New Delhi.
3. Naterop, Jean, B. and Rod Revell. 1997. Telephoning in English. Cambridge University Press, Cambridge.
4. Mohan Krishna and Meera Banerjee. 1990. Developing Communication Skills. Macmillan India Ltd. New Delhi.
5. Krishnaswamy,. N and Sriraman, T. 1995. Current English for Colleges.Macmillan India Ltd. Madras.
6. Narayanaswamy V R. 1979. Strengthen your writing. Orient Longman, New Delhi.
7. Sharma R C and Krishna Mohan. 1978. Business Correspondence. Tata McGrawHill publishing Company, New Delhi.


## Sacs. 2213Applied Electronics and Instrumentation 3(2+1)

**Objectives**

- To provide an overview of the principles, operation and application of the building blocks like diodes, BJT, OP-amps, Feedback amplifiers, oscillators etc for performing various functions.
- To understand the internal structure of all instruments that are used in measuring parameters related to electronics and to understand how different bridge networks are constructed and balanced for find out values of capacitance , resistance and inductance.
- To understand about different transducers, that are used for measurement purpose and their working principles.

**Theory**

**Module I** **(6 Hours)**

Semiconductors, P-N junction, V-I characteristics of P-N junction, effect of temperature on Barrier voltage, Junction Breakdown, Zener breakdown, avalanche breakdown-Junction capacitance, diode as a circuit element, Half wave rectifier, centre tap Full wave rectifier & bridge rectifiers- efficiency of half wave & full wave rectifiers.

**Module II** **(8 Hours)**

Voltage regulators, Zener diode voltage regulator, transistor series regulator, clipper, clamper, voltage multiplier, filter circuits Diode circuits for OR and AND (both positive and negative logic) bipolar junction transistor:, various biasing methods (fixed, self, potential divider), Hartley oscillator, colpitts oscillator, phase shift oscillator , Wein bridge oscillator.

**Module III** **(8 Hours)**

OP-AMP, ideal OP-AMP characteristics, linear and non-linear applications of OP-AMP, integrator, active rectifier, comparator, differentiator, OP-AMP voltage regulators; binary adders, Half adders, Full adders, subs tractors

**Module IV** **(10 Hours)**

Generalized instrumentation systems-Transducers-sensors vs transducer, measurement of displacement, velocity, force measurement using load cells, strain gauge, pressure measurement, low pressure medium and high pressure measurement, Temperature measurement, bimetal strip thermocouple, thermistor-pyrometers.

**Practical**

To study V-I characteristics of p-n junction diode: To study half wave. full wave and bridge rectifier: To study transistor characteristics in CE configurations: To design and study fixed and self bias transistor: To design and study potential divider bias transistor: To study a diode as clipper and clamper: To study a OP-AMP IC 741 as inverting and non- inverting amplifier: To study a OP-AMP IC 741 as differentiator and integrator to study a differential amplifier using two transistor: To study a OP-AMP IC 741 as differential amplifier: To study a zener regulator circuit: To study a OP-AMP IC 741 as a active rectifier: To study a OP-AMP IC 741 as a comparator: To familiarize with various types of transducers.

**Lecture schedule**

1. Semiconductors-Types of semiconductors-Intrinsic semiconductors-Extrinsic semiconductors-Majority and Minority carriers-Mobile charge carriers and immobile ions- Current in Intrinsic semiconductors-Intrinsic conduction-Conventional problems
2. PN Junction-Formation of depletion Layer-Barrier voltage-effect of temperature on Barrier Voltage
3. Forward biased PN Junction- Forward V-I Characteristics- reverse biased PN Junction-reverse V-I characteristics- Combined forward and Reverse V-I characteristics
4. Junction Breakdown-Zener breakdown-avalanche breakdown-Junction capacitance-problems.
5. PN Junction diode-Zener diode- Zener voltage regulator
6. Transistor series voltage regulator-photo diode-LED
7. Clippers-positive and negative clipper
8. Biased clipper-combination clipper-clampers
9. Voltage multiplier-Half wave and full wave voltage doubler-voltage tripler –Voltage Quadrupler
10. Filters-LC filter-pi filter
11. Logic Gates-OR - AND gate-
12. diode OR and AND circuits
13. XOR-NOR-NAND-XNOR gates
14. Bipolar junction transistor-NPN and PNP transistor
15. Transistor biasing-CB configuration-static characteristics
16. CE configuration- relation between $\alpha$ and $\beta$- static characteristics
17. CC configuration- relation between transistor currents
18. DC load line-Q point
19. Different methods of transistor biasing- base bias-base bias with emitter feed back-base bias with collector feedback-voltage divider bias.

20. Oscillators-colpits-Hartley
21. Phase shift-wein bridge oscillator
22. Op-Amps-virtual ground and summing point- ideal OP-AMP characteristics
23. Linear amplifier-unity follower-adder-.OP-Amp-sub tractor-integrator-.OP-AMP differentiator-comparator.
24. OP-AMP voltage regulators
25. Generalized Instrumentation system.
26. Transducers-functional elements of a measurement system
27. Measurement of displacement using electrodynamics transducer- LVDT-variable inductance transducer-proximity type electromagnetic transducer.
28. Measurement of acceleration using eddy current transducer.
29. Force measurement- hydraulic load cell-pneumatic load cell-strain gauge.
30. Pressure measurement-manometers-McLeod Gauge-Pirani Gauge-Ionization Gauge-Knudsen Gauge
31. Temperature measurement- resistance thermometer, thermo electric sensors
32. Total radiation Pyrometer-selective absorption pyrometer.

**Practical schedule**

1. To study V-I characteristics of p-n junction diode
2. To study half wave. full wave and bridge rectifier
3. To study transistor characteristics in CE configurations
4. To design and study fixed and self bias transistor
5. To design and study potential divider bias transistor
6. To study a diode as clipper and clamper
7. To study a OP-AMP IC 741 as inverting
8. To study a OP-AMP IC 741 as non- inverting amplifier
9. To study a OP-AMP IC 741 as differentiator
10. To study a OP-AMP IC 741 as integrator
11. To study a OP-AMP IC 741 as differential amplifier using two transistor
12. To study a OP-AMP IC 741 as differential amplifier
13. To study a Zener regulator circuit
14. To study a OP-AMP IC 741 as a active rectifier
15. To study a OP-AMP IC 741 as a comparator
16. To familiarize with various types of transducers

**Suggested Readings.**


1. A. Anand Kumar. 2014. Fundamentals of Digital Circuits. PHI Pvt. Ltd., New Delhi.
2. A.K. Sawhney. 2010. Course in Electrical and Electronics Measurements and
3. Instrumentation.DhanpatRai Publications (P) Limited, New Delhi.
4. V.K. Mehta and Rohit Mehta. 2008. Principles of Electronics. S. Chand and Co., New Delhi.
5. D. Choudhury Roy. 2003. Linear Integrated Circuits. John Wiley International, NY.
6. sanjeev Gupta. 2002. Electronic Devices and Circuits. DhanpatRai Publications (P) , Limited, New Delhi.

## Sacs. 3214Computer Programming and Data Structures 3(1+ 2)

**Objective**

To provide exposure to develop small programs in C language and thus equip them to solve problems in their chosen field of study using computer program.

**Theory**

**Module I** **(7 Hours)**

Introduction to high level languages - Introduction to C - History of C – Development environment of C- structure of C program- C tokens & keywords- Primary data types, Variables, constants, character constants, length of data types, header files – use of header files. C operators, building and evaluating arithmetic expressions, type conversions, type casting; Relational operators, logical operators. Standard library functions. Input statement, output statement, formatted output; importance of documentation. Decision making – branching, if statement, Nested if, switch statement, go to statement. Looping – while, do- while, nested loops, for loop, nested for loop, break, continue statements.

**Module II** **(5 Hours)**

Arrays, one dimensional array representation, sorting, searching. Two dimensional arrays – matrix representation, matrix operations. String arrays, representing strings, string operations, string library functions. User defined functions, passing arguments, returning values, recursive functions, storage class, scope and visibility of variables, local & global variables. User defined data types, structures, unions, arrays of structures, structures in user defined functions.

**Module III** **(4 Hours)**

Introduction to pointers, passing arguments by address using pointers- pointer representation of arrays, Dynamic Memory allocation functions, self-referential structures, Linked lists, Insertion, deletion operations of linked lists, applications of linked lists, Stacks, push/pop operations, Queues – deletion/insertion of queues.

**Practical**

Familiarizing with C IDE; Building an executable version of C program; Debugging a C program; Developing and executing simple programs; Creating programs using decision making statements such as if, go to & switch; Developing program using loop statements while, do & for; Using nested control structures; Familiarizing with one and two dimensional arrays; Using string functions; Developing structures and union; Creating user defined functions; Using local, global & external variables; Using pointers; Implementing Stacks; Implementing push/pop functions; Creating queues; Developing linked lists in C language; Insertion/Deletion in data structures.

**Lecture Schedule** .

1. Introduction to C - History of C – Development environment of C- structure of C program- C tokens & keywords- Primary data types, Variables, constants, character constants, length of data types, header files – use of header files
2. C operators, building and evaluating arithmetic expressions, type conversions, type casting; Relational operators, logical operators. Standard library functions. Input statement, output statement, formatted output; importance of documentation.
3. Decision making – branching, if statement Nested if statements
4. switch statement, go to statement.

5. Looping – while, do- while,
6. for loop, nested for loop, break, continue statements.
7. Nested loops –nesting of while, do-while and for loops
8. Arrays, one dimensional array representation, sorting, searching.
9. Two dimensional arrays – matrix representation, matrix operations.
10. String arrays, representing strings, string operations, string library functions.
11. User defined functions, passing arguments, returning values, recursive functions, storage class, scope and visibility of variables, local & global variables
12. User defined data types, structure, union, arrays of structures, structures in user defined functions.
13. Introduction to pointers, passing arguments by address using pointers, pointer representation of arrays.
14. Dynamic Memory allocation functions, self referential structures
15. Linked lists, Insertion, deletion operations of linked lists,
16. Applications of linked lists- Stacks, push/pop operations. Queues – deletion/insertion of queues.

**Practical Schedule**

1. Simple C programs using operators and output statements
2. Programs using input statement and mathematical equations
3. Programs with library functions and if statements
4. Development of programs with if statement
5. Development of programs with nested if
6. Programs with switch statements
7. Illustrating type casting, go to statement
8. While loop example programs
9. Do-while loop programs
10. Standard programs in C
11. Nested loops with while, do-while statements
12. Programs with for loops
13. Nested for loop illustration programs
14. Break, continue statements
15. One dimensional array creation and calculations and printing
16. Array sorting – selection sort
17. Searching of array
18. Programs with Two dimensional arrays
19. Matrix addition, Transpose, Matrix multiplication
20. String manipulation programs
21. Creating User defined functions with return types
22. Functions of various return types and parameters
23. Programs with structures
24. Programs with unions
25. Programs to illustrate pointers
26. Functions passing parameters by address
27. Functions passing structures as parameters
28. Manipulating arrays with pointers
29. Dynamic memory allocation functions -Self referential structures
30. Linked lists – insertion/deletion of linked lists
31. Stacks- Push/pop operations
32. Queues – insertion deletion operations

**Suggested Readings**


1. Rajaraman V. 1985. Computer Oriented Numerical Methods. Prentice Hall of India. Pvt. Ltd., New Delhi.
2. Balagurusamy E. 1990. Programming in 'C'. Tata McGraw Hill Publishing Co. Ltd., 12/4 Asaf Ali Road, New Delhi.
3. Rajaraman V. 1995. Computer Programming in 'C'. Prentice Hall of India Pvt.Ltd., New Delhi.
4. Bronson G and Menconi S. 1995. A First Book of 'C' Fundamentals of 'C' Programming. Jaico Publishing House, New Delhi
5. SahniS.. Data Structures, Algorithms and Applications in C++. University press (India) Pvt Ltd / Orient Longman Pvt. Ltd.
6. Michael T. Goodrich, R. Tamassia and D Mount. Data structures and Algorithms in C++. Wiley Student Edition, John Wiley and Sons.
7. Mark Allen Weiss. Data Structures and Algorithm Analysis in C++. Pearson Education.
8. Augenstein, Langsam and Tanenbaum. Data structures using C and C++. PHI/Pearson Education.
9. Drozdek Adam. Data Structures and Algorithms in C++. Vikas Publishing House / Thomson International Student Edition.
10. Agarwal, Ajay. The Complete Reference Guide: Data Structure through C. ISBN: 8178840448; Publisher: Cyber Tech Publications.