APPLIED SCIENCE

Course No: AS ESDM 361 **Title: Environmental Science and Disaster Management**

Credit: 3 (2+1) **Semester: I**

Syllabus

Theory

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. 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. 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.

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.

Teaching Schedule – Theory with weightages (%)

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Lecture	Topic	Weightage (%)
1	***Environmental Studies:***Scope and importance.	03
2	Natural Resources: Renewable and non-renewable resources Natural resources and associated problems.	03
3& 4	a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.	03
5 & 6	b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.	03
7 & 8	c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.	04
9	d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.	05
10 & 11	e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.	06
12 to 14	f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.	04
15&16	Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.	06
	MID TERM	
17 & 18	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).	03
19	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.	05
20-21	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.	05
22	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.	05
23-24	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	03

	involved in enforcement of environmental legislation. Public awareness. Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme.	
25-26	Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.	03
27	***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.	03
28	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.	03
29-30	Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction.	03
31-32	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.	03

Practical Exercise

Ex. No.	Title
1	Case Studies and Field work.
2, 3&4	Visit to a local area to document environmental assets river/forest/grassland/hill/mountain
5& 6	Visit to a local polluted site-Urban
7	Visit to a local polluted Rural
8	Visit to a local polluted site- Industrial
9	Visit to a local polluted site- Agricultural
10	Study of common plants, insects, birds
11	Study of simple ecosystems-pond, river, hill slopes, etc
12	Expected impact of climate change on agricultural production and water resources, Mitigation Strategies, Economics of climate change
13	Disaster Management introduction, Natural and Manmade Disaster Studies

Course No: AS-AGRO 121 **Title: Principles of Agronomy**

Semester:II **Credit: 2 (1+1)**

14	Informatics for Disaster Management
15	Quantitative Techniques for Disaster Management Environmental Impact Assessment (EIA)
16	Disaster Management Policy Environmental Modelling

Suggested Readings:

Text Book:

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.

Reference Book;

1. Kaul S N, AshuthoshGautam. 2002. Water and Waste Water Analysis. Days Publishing House, Delhi.
2. Gupta P K. 2004. Methods in Environmental Analysis – Water. Soil and Air.Agro bios, Jodhpur.
3. Climate change.1995: Adaptation and mitigation of climate change-Scientific Technical Analysis Cambridge University Press, Cambridge.
4. Sharma, R.K. & Sharma, G. 2005.Natural Disaster. APH Publishing Corporation, New Delhi.
5. Husain Majid. 2013. Environment and Ecology: Biodiversity, Climate Change and Disaster Management. Online book.

Syllabus

Theory

Introduction and scope of agronomy in relation to agricultural engineering.Classification of crops, Effect of different weather parameters on crop growth and development.Principles of tillage, tilth and its characteristics.Crop seasons. Methods, time and depth of sowing of major field crops (Cereals: paddy, sorghum, maize, pearlmillet, wheat, Pulses: green gram, black gram, pigeonpea, chickpea Oilseeds: groundnut, soybean, sunflower, safflower Cash crop: cotton, sugarcane). Methods and time of application of manures and fertilizers.Organic farming; principle, concept, components, certification, residue management, energy generation.Sustainable agriculture; definition, principle, concept, components and indices. Soil water plant relationship, crop coefficients, water requirement of crops and critical stages for irrigation, weeds and their control, crop rotation, cropping systems, intercropping, Relay cropping.

Practical

Identification of crops and their varieties, seeds, manures, fertilizers and weeds; Fertilizer application methods; Different weed control methods; Practice of ploughing, Practice of Puddling, Practice of sowing, inter-cultivation, signs of maturity, harvesting and threshing.

Teaching Schedule – Theory with weightages %

Lecture No.	Topic to be covered	Weightages (%)
1-2	Scope of agronomy in relation to agricultural engineering. Classification of crops	09
3-4	Effect of different weather parameters on crop growth and development.	06
5-6	Principles of tillage, tilth and its characteristics.	06
7-10	Crop seasons. Methods, time and depth of sowing of major field crops (Cereals: paddy, sorghum, maize, pearlmillet, wheat, Pulses: green gram, black gram, pigeonpea, chickpea Oilseeds: groundnut, soybean, sunflower, safflower Cash crop: cotton, sugarcane).	48
11-12	Methods and time of application of manures and fertilizers.	09
13-14	Organic farming; principle, concept.	13
15-16	Sustainable agriculture; definition, principle, concept, components.	09
	Total	**100**

Practical Exercises

Ex. No.	Topic
1	Identification of crops plant and seed at different growth stages
2	Identification of important varieties of cereal and pulses crops
3	Identification of important varieties of oil seeds and cash crops
4	Study of manures, fertilizers and Fertilizer application methods
5	Practices of fertilizer application to different field crops
6	Calculations of plant population, seed rate and fertilizers doses.
7	Identification of weeds; Different weed control methods; calculation doses of different herbicides.
8	Study of primary tillage implements,.
9	Study of Practice of ploughing
10	Study of puddling implements and practices of puddling in rice
11	Study of different methods of sowing of field crops.
12	Study of different inter cultural implements and working with them.
13	Practice of interculture operation in different field crops
14	Signs of maturity of important field crops
15	Harvesting and threshing of cereals, pulses, oil seeds and cash crops.
16	Participation in on-going field operations and actual working in the field.

Suggested readings

Text Books:-

Reddy Yellamanda T and Shankar Reddy G H. 2011. Principles of Agronomy. Kalyani Publishers Ludhiana.

Reference Books:

William L Donn. 1965. Meteorology. McGraw-Hill Book Co. New York.
Arnon L. 1972. Crop Production in Dry Regions. Leonard Hill Publishing Co. London.
Yawalkar K S and Agarwal J P. 1977. Manures and Fertilizers. Agricultural Horticultural Publishing House, Nagpur.
Gupta O P. 1984. Scientific Weed Management in the Tropics and Sub- Tropics. Today and Tomorrow's Printers and Publishers. New Delhi.
Rao V S. 1992. Principles of Weed Science. Oxford and IBH Publishing Co. Ltd. New Delhi.
Reddy S.R. 2012. Principles of Agronomy
Chidda Singh, Prem Singh and Rajbir Singh. 2005. Modern techniques of raising field crops.
Organic farming Theory and Practice: Palaniappan SP and K.Anndurai 2012

Course No: AS-ECON 241 **Title: Entrepreneurship Development and Business Communication (Common Course)**

Semester: III **Credit: 2 (1+1)**

Syllabus

Theory

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) – 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– 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- 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

Teaching Schedule Theory with weightages (%)

Lecture No	Particulars	Weightages (%)
1& 2	Entrepreneurship- Meaning and Definition, Functions of Management- Planning-Organizing-Directing–Motivation–Ordering–Leading–Supervision-Communication and control.	9.5
3&4	Capital- Financial Management, Importance of financial statement, balance sheets, profit and loss statements. Analysis of financial statements- leverage ratios- Coverage ratios – turnover ratios – profitability ratios of Agro based industries.	11.5
5	Project – Meaning and Definition, project cycle Project appraisal and evaluation techniques,	04
6&7	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) and sensitivity analysis.	12.5
8	Importance and Scope of agribusiness in Indian economy	06
9	International Trade, WTO agreements, Provisions related to agreements in agricultural and food commodities. Agreements on agriculture (AOA),	12.5
10	Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS).	06
11	Development (ED): Concept of entrepreneur and entrepreneurship Assessing overall business environment in Indian economy	06

12	Entrepreneurial and managerial characteristics- Entrepreneurship development Programmes (EDP)- Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development.	6.5
13	Globalization and the emerging business entrepreneurial environment and importance of planning, budgeting, monitoring evaluation and follow-up managing competition. Role of ED in economic development of a country and overview of Indian social, political systems and their implications for decision making by individual entrepreneurs	06
14	Morals and ethics in enterprise management- SWOT analysis- Government schemes and incentives for promotion of entrepreneurship	12.5
15&16	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	07
	Total	100

Practical Exercises

Ex. No.	Topics
1.	Preparation of business – Strengths Weaknesses Opportunities and Threats (SWOT) analysis,
2.	Analysis of financial statements (Balance Sheet, Profit loss statement).
3.	Compounding and discounting and Break Even Analysis
4.	Visit to agro-based industries – I
5.	Visit to agro-based industries – II
6.	Time audit through planning
7.	Study of Agro-industries Development Corporation
8.	Ratio analysis – I
9.	Ratio analysis – II
10.	Application of project appraisal technique – I(Undiscounted measures)
11.	Application of project appraisal technique – I(Discounted measures)
12.	Formulation of project feasibility reports
13.	Farm Machinery Project proposals as entrepreneur – individual
14.	Farm Machinery Project proposals as entrepreneur group
15.	Visit to entrepreneurship development institute / Visit to District Small Scale Industry Development Corporation office
16.	Visit to entrepreneurs /case study of successful entrepreneurs (project report)

Suggested Reading

Text Books

1. Gittenger Price, J. 1989. Economic Analysis of Agricultural Projects. John Hopkins University, Press, London.

2. Thomas W Zimmer and Norman M Scarborough. 1996. Entrepreneurship. Prentice-Hall New Jersey.
3. Mark J Dollinger. 1999. Entrepreneurship Strategies and Resources. Prentice-Hall, Upper
4. Saddal Rover, New Jersey.
5. Khanka S S. 1999. Entrepreneurial Development. S. Chand and Co. New Delhi.
6. Mohanty S K. 2007. Fundamentals of Entrepreneurship. Prentice Hall India Ltd., New Delhi.
7. A.K.Singh, 2009. Entrepreneurship Development and Management. Lakshmi Publications Ltd.,
8. Vasanta Desai. 2000. Dynamics of Entrepreneurial Development and Management. Himalaya Publishing House, New Delhi.
9. Khanka S S. 1999. Entrepreneurial Development. S. Chand and Co. New Delhi.

Reference Books

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. K.K. Dewett and Adarsh Chand. Modern Economic Theory-Micro and Macro Analysis. Shamilal Charitable Trust, New Delhi-55.
5. SmitaDiwase, Agri. Business Management, Everest Publishing House, Pune 30
S.C. Jain. Management of Agricultural Finance

Course No: AS-EXTN 111 **Title: Communication Skill &Personality Development**

Semester: II **Credit: 2(1+1)**

Syllabus

Theory

Definition and Basics of Personality; Analyzing Strength and Weakness; Theories on Personality Development; Body Language; Preparation of Self-Introduction; Communication Skills: Listening Skills; Communication Skills: Communication Barriers; Overcoming these barriers; Building Self-Esteem and Self- Confidence; Attitudes: Assertive, Aggressive and Submissive; Introduction to Leadership; Leadership Styles; Group Dynamics;Team Building; Interpersonal Communication and Relationship;Conflict Management: Introduction, Levels of Conflict and Managing Conflict. Time Management: a. Concept b. Importance and Need c. Steps towards better Time Management. Public Speaking: a. Introduction b. Increasing Vocabulary c. Voice Modulation d. Social Graces and Email and Telephone Etiquettes

Practicals

One-on-One Sessions for Individual Personality Traits; Role Play and Impromptu Conversation/Public Speaking Practice focusing on Body Language; Vocabulary Practices: Developing a repertoire of words in various fields like Agriculture, Politics, Economics, Family, Personal Grooming etc. Role Play for Self Introduction in the class; Listening to recorded Short Speeches, Lectures and Conversations Practicing Dialogues, Speeches and Conversations by Students in the Class to illustrate that Communication Barriers can be overcome; Lecture and Questionnaires for Building Self-Esteem and Self Confidence; Case Studies based on Development of Attitudes; Case Studies on Leadership Development; Case Studies on Leadership Development; Group Games, Ice breakers, Warm-ups and Energizers Team Building Activities and Exercises and Trust Building Activities; Psychological Self awareness Exercises; Practice of Non-Verbal Communication Skills: Dumb Charades and Dubsmash Practice; Mutually Acceptable Proximity; and Eye Contact; Time Management Games to Practice and Experience the Importance of Planning / Delegating Work among them to properly manage time and complete the task in the shortest time possible; Public Speaking Games: (Introducing a friend with his/her life style; Describing a funny image provided by the teacher; Continuing a Story starting with one student and others try to continue with it and try to complete it Take any object available and try to make a commercial for it; Practice of Emails]

Teaching Schedule – Theory with weightages %

Lecture	Topic	Weightage (%)
1	Definition and Basics of Personality	05
2	Analyzing Strength and Weakness	05
3	Personality Development : Concept and Process	05
4	Body Language – Meaning, Definition, Use of body language - Gesture, Posture, Eye contact, facial expression	10
5	Preparation of Self -Introduction	05
6	Communication Skills: Listening, writing, speaking skills	10
7	Communication Barriers; Overcoming these barriers	05
8	Building Self-Esteem and Self- Confidence	05
9	Attitudes: Meaning, Types - Assertive, Aggressive and Submissive; Positive, Negative, Neutral	10
10	Introduction to Leadership; Leadership Styles; Group Dynamics	05
11	Team Building : Meaning, Steps	05
12	Interpersonal Communication and Relationship; Use of verbal and non verbal communication	10
13	Conflict Management: Introduction, Levels of Conflict and Managing Conflict	05
14	Time Management: Concept, Importance and Need, Steps towards better Time Management	05
15	Public Speaking: Introduction, Increasing Vocabulary, Voice Modulation, Social Graces	05
16	Email and Telephone Etiquettes	05

Practical Exercises

Exercise	Topic
1	One-on-One Sessions for Individual Personality Traits
2	Role Play and Impromptu Conversation/Public Speaking Practice focusing on Body Language
3	Vocabulary Practices: Developing a repertoire of words in various fields like Agriculture, Politics, Economics, Family, Personal Grooming etc
4	Role Play for Self Introduction in the class
5	Listening to recorded Shot
6	Questionnaires for Building Self-Esteem and Self Confidence
7	Case Studies based on Development of Attitudes
8	Case Studies on Leadership Development
9	Case Studies on Leadership Development
10	Group Games, Ice breakers, Warm-ups and Energizers Team Building Activities
11	Practice of Non-Verbal Communication Skills: Dumb Charades and Dubsmash

Exercise	Topic
	Practice
12	Exercise on Mutually Acceptable Proximity; and Eye Contact
13	Time Management Games to Practice and Experience the Importance of Planning / Delegating Work among them to properly manage time and complete the task in the shortest time possible
14	Public Speaking Games: (Introducing a friend with his/her life style; Describing a funny image provided by the teacher; Continuing a Story starting with one student and others try to continue with it and try to complete it Take any object available and try to make a commercial for it
15	Practice of Emails
16	Presentations by the students

Suggested readings

Text Books

1) Balasubramanian T. 1989. A Textbook of Phonetics for Indian Students. Orient Longman, New Delhi.

Reference Books

1 Balasubrmanyam M. 1985. Business Communication. Vani Educational Books, New Delhi.

2 Naterop, Jean, B. and Rod Revell. 1997. Telephoning in English. Cambridge University Press, Cambridge.

3 Mohan Krishna and Meera Banerjee. 1990. Developing Communication Skills. Macmillan India Ltd. New Delhi.

4 Krishnaswamy,. N and Sriraman, T. 1995. Current English for Colleges. Macmillan India Ltd. Madras.

5 Narayanaswamy V R. 1979. Strengthen your writing. Orient Longman, New Delhi.

6 Sharma R C and Krishna Mohan. 1978. Business Correspondence. Tata McGraw Hill publishing Company, New Delhi.

7 Carnegie, Dale. 2012. *How to Win Friends and Influence People in the Digital Age.* Simon & Schuster.

8 Covey Stephen R. 1989. *The Seven Habits of Highly Successful People.* Free Press.

9 Spitzberg B, Barge K &Morreale, Sherwyn P. 2006. *Human Communication: Motivation, Knowledge & Skills.* Wadsworth.

10 Verma, KC. 2013. *The Art of Communication*. Kalpaz.

11 Mamatha Bhatnagar and Nitin Bhatnagar. 2011. Effective Communication and Soft Skills. Person Education.

12 Meenakshi Raman, Sangeeta Sharma. Technical Communication Principles and Practice

13 Harold Wallace and Ann Masters. Personality Development. Cengage Publishers.

14 Andrea J. Rutherford. Basic Communication Skills for Technology. Pearson Education.

15 Carroll, B.J. 1986. English for College, Macmillan India Ltd. New Delhi
16 Hahn, "The Internet complete reference", TMH
17 Hornby, A.S. 1975. Guide to patterns and usage in English. Oxford University, NewDelhi.
18 Qurik, R and Green Baum, S 2002. A University Grammar

Course No: AS-HORT 121 **Title: Principles of Horticultural Crops and Plant Protection**

Semester: II **Credit: 2(1+1)**

Syllabus

Theory

Scope of horticultural. 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; 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, Garden tools, management of orchard, Extraction and storage of vegetables seeds. Major pests and diseases and their management in horticulture 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.

Teaching Schedule – Theory with weightages %

Lecture No.	Particulars	Weightages (%)
1	Scope of Horticultural crops.	05
2	Soil and climatic requirements for fruits ,vegetables and floriculture crops.	05
3	Criteria for sites selection, layout and planting methods, nursery raising.	10
4	Commercial Varieties, improved varieties / hybrids,	05
5-6	sowing and planting times and methods, seed rate and seed treatment for vegetable crops	10
7-8	Micro and Macro propagation methods in Horticultural crops. Methods of irrigation and irrigation management, fertigation	15
9	Training and Pruning in Horticulture crops, plant growing structures	10
10-11	Crop coefficients, water requirements and critical stages, fertilizer application,	10
12-13	harvesting, grading and packaging, post-harvest practices	10
14-15	Garden tools, management of orchard, extraction and storage of vegetable seeds	10
16	Major pests and diseases and their management in horticultural crops	10
		100

Practical Exercises

Exercise No	Title
1	Identification and description of Important fruit crops.
2	Identification and description of Important vegetable crops.
3	Identification and description of Important flower crops.
4	Study of different Garden tools.
5-6	Practices of training and pruning in Important fruit crops
7	Preparation of nursery bed.
8-9	Cultural operations for vegetable crops. (sowing, layout, fertilizer application, mulching, irrigation and weed control)
10	Study of seed viability and germination test.
11	Seed extraction techniques.
12	Judging maturity time for harvesting of horticultural crops.
13-15	Identification of different pests and diseases and their control.
16	Visit to commercial greenhouse/ polyhouse

Suggested Readings

Text books :

- Fundamental of horticulture by Edmond Et. al., Mc Grow Hill Book Company
- Horticulture in India. Bansal. P.C. 2008. CBS Publishers and Distributors, New Delhi.
- Fruits of India - Tropical and Subtropical by T.K. Bose
- Plant propagation principle & practices by Hartman H.T. and D.E. Kester, Prentice Hall of India, N. Delhi
- Vegetable crop in India by T.K. Bose and Som, Naya Prakash, Culcutta
- Textbook on floriculture & landscaping by N. Roychowdhary& H.P. Mishra

Reference books

- Introductory horticulture by Kumar N., Rajalaxmi Pub., Veepamodu (TN)
- Complete gardening in India by Kunte Y.H. & K.S. Yawalkar, G. Kasturirangan,Banglore
- Production technology of fruit crops by Shanmugavelu K.G., Oxford & IBH, Delhi
- Vegetable production in India by Chauhan D. V. S., Ramprasad& Sons, Agra
- Floriculture in India by Mukhopadhya A., Lyal book depot, Ludhiana
- Greenhouse construction & environment control by Pritam Chandra
- Green house Operation and management by Nelson Paul V.
- Diseases of Horticultural Crops. Arjunan, G., Karthikeyan, G, Dina Karan, D. and Raguchander, T. 1999. AE Publications, Coimbatore.
- Insect pest of South East Asia. by Dhaliwal and Arora.
- Hand Book of Horticulture, by Chadha K.L. 2003, ICAR.
- Postharvest management of Horticultural Crops. Saraswathy, S., T. L. Preethi, S. Balasubramanyan, J. Suresh, N. Revathy and S. Natarajan. 2007. Agrobios Publishers, Jodhpur.
- Postharvest diseases of horticultural crops ,Sharma Neeta and MashkoorAlam 1997,International Book publishing Co.UP

Course No: AS-SS 111 **Title: Principles of Soil Science**
Semester: I **Credit: 2(1+1)**

SYLLABUS

Theory

Nature and origin of soil; soil forming rocks and minerals, their classification and composition, soil forming processes, in classification of soils, soil taxonomy orders, important soil physical properties and their importance, soil particle distributions, soil inorganic colloid-their composition, soil inorganic colloids-their composition, properties and origin of charge, ion exchange in soil and nutrient availability, soil organic matter- its composition and decomposition, effect on soil fertility, soil reaction- acidic, saline and sodic soils, quality of irrigation water, essential plants nutrients- their functions and deficiency symptoms in plants, importance of soil testing, types and important inorganic fertilizer and their reaction in soils. Types of organic manures and their composition.

Practical

Identification of rocks and minerals, examination of soil profile in the field, determination of bulk density, particle densityand porosity of soil COLE value, determination of organic carbon of soil, determination of nitrogen, determination of phosphorus and determination of potassium, identification of nutrient deficiency symptoms of crops in the field, determination of gypsum requirement of sodic soils. Determination of water quality parameters.

Teaching Schedule – Theory with weightages %

Lecture No.	Topics	Weightage marks
1	Nature and origin of soil, soil forming rocks, minerals and their classification and composition	05
2-3	Soil forming factors and processes, Soil classification, soil taxonomy orders and soils of Maharashtra	10
4	Soil physical properties, importance, soil particle distribution soil structure, bulk density, particle density, porosity soil consistency, soil colour, COLE value, infiltration rate, hydraulic conductivity, permeability, soil strength.	15
5	Soil inorganic colloids, properties of soil colloids, soil their composition, properties and origin of charge	06
6	Ion exchange in soil and nutrient availability	08
7-8	Soil organic matter, its composition, decomposition and their effect on soil properties	10
9	Soil reaction and its significance	05
10-11	Salt affected soil, Acid Soil and their characteristics and reclamation	10
12	Quality of irrigation water, characteristics and suitability	07
13	Essential plant nutrients and their function, Jamponance of soil testing	08
14	Deficiency symptoms of nutrients in crop plants.	06
15-16	Types and importance of inorganic fertilizer and their reaction in soil, types of organic manures and their composition	10
	Total	**100**

Practical Exercises

Exercises No.	Topic
1.	Preparation of standard solutions and reagents

2.	Identification of rocks and minerals
3.	Study of soil profile
4.	Determination of bulk density, particle density and porosity of soil
5.	Determination of pH and EC of the soil
6.	Determination of soil texture
7.	Determination of water holding capacity of soil (1/3 and 15 bar)
8.	Determination of calcium carbonate and organic carbon content of soil
9.	Determination of available nitrogen and potassium from soil
10.	Determination of available phosphorus from soil
11.	Analysis of irrigation water for pH, EC, cations and anions
12.	Determination of aggregate stability by Yoders apparatus
13.	Determination of organic carbon from soil
14.	Determination of gypsum/ lime requirement of soil
15.	Determination of soil strength, COLE value, soil compaction
16.	Interpretation of soil and water analytical data

Name of instrument/ equipment

1. pH meter
2. Conductivity meter
3. International pipette, mechanical stand
4. Pressure plate apparatus
5. Spectrophotometer
6. Flame photometer
7. Yoders apparatus

Suggested readings

Text books

1. Mehra, R.K. (2006). Text book of Soil Science, Directorate of Informtion and Publication of Agriculture, ICAR, Krishi AnusandhanBhavan, Pusa, New Delhi
2. Daji, A.J., Kadam J.R. and Patil, N.D. (2002). Text book of Soil Science.
3. SahaArun Kumar and SahaAnuradha (2014). Text book of Soil Physics, Kalyani Publisher, New Delhi.
4. Sushant Kumar Pal, 2016, Text Book of Soil Science, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi

Reference books

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 (2015). Soil Science-An Introduction, NASC complex, New Delhi.
3. Sehgal, J. (2015). Text book of Pedology Concept and Application. Kalyani Publisher, New Delhi.
4. Hillel, D. (1982). Introduction to Soil Physics. Academic Press, London.
5. Dilip Kumar Das (2015). Introductory Soil Science, Kalyani Publisher, New Delhi.

Course No: AS-STAT 121 Title: Statistical Methods Engineering

Credit: 2(1+1) Semester: II

Syllabus

Theory:- Definitions of Statistics and its applications in Agriculture Engineering, Limitations, Types ofdata, Classifications, Tabulation and Frequency distribution, Graphical presentation of data Histogram, Frequency curve, Frequency polygon, Cumulative frequency curve (Ogive curve)

Arithmetic Mean, Median, Mode, GM, HM, Weighted Average, Quartiles, Deciles, Characteristics of ideal measure, Merits and Demerits of various measures (Grouped and Ungrouped data),

Measures of Dispersion, Range, Mean deviation, Quartile deviation, Standard deviation and Variance and respective relative measures (Grouped and Ungrouped Data).

Concept of measures of Skewness and Kurtosis.

Definition of Correlation, types, Scatter Diagram. Karl Pearson's Coefficient of Correlation and its test of significance. Spearman's Rank Correlation Coefficient.

Concept of linear Regression equations, definition & properties of Regression coefficient, constant, fitting of Regression lines, its test of significance, comparison of Regression and Correlation Coefficients, Introduction to Non linear regression viz; Quadratic, Exponential and Gompertz curve.

Probability, Terminologies and Definitions of Trial, Random experiment, Events (simple, compound, equally likely, complementary, independent, dependant, mutually exclusive) Definitions of Probability (mathematical, statistical, axiomatic), Addition and Multiplication theorem (without proof). Laws of Addition of Probability (when events are mutually exclusive and events are not mutually exclusive).

Random variable, Discrete and Continuous Random variable, Probability Mass and Density function, Definition and properties of Binomial, Poisson and Normal distributions.

Definitions of Population, Sample, Parameter, Statistic, Need of sampling, Sampling versus complete enumeration and introduction to Simple Random Sampling method. Simple Random Sampling with and without replacement, Selection of random sample.

Introduction to test of significance, Null and Alternate Hypothesis, Types of errors, One tailed and Two tailed test, degrees of freedom, Level of Significance, Critical region, Steps in testing of hypothesis, One sample, Two sample, Paired 't' test and 't' test for testing significance of correlation coefficient, F test for testing equality of variances, Chi-square test of goodness of fit and Chi-square test of independence of attributes in 2×2 contingency table. Introduction to analysis of variance, Assumptions of ANOVA, analysis of one way classification.

Practical:- Graphical presentation : Histogram, Frequency Curve, Frequency Polygon, Cumulative Frequency Curve (Ogive Curve) Computations of Arithmetic Mean, Mode, Median, GM and HM, Quartiles, Deciles & Percentiles (Ungrouped data and Grouped data).Computations of Range, Mean Deviation, Quartile Deviation, Standard Deviation and Variance and respective relative measures (Ungrouped and Grouped data). Computations of Karl Pearson's Coefficient of Correlation with its test of significance, Computation of Spearman's Rank Correlation Fitting of simple Linear Regression equation with test of significance of Regression Coefficient. Problems on One sample, Two Sample, Paired t-test and 't' test for Correlation Coefficient, Chi-Square test of Goodness of Fit. and Chi-square test of independence of Attributes for 2×2 contingency table. Analysis of Variance one way and two way classification.

Teaching Schedule – Theory with weightages %

Lecture No.	Topic	Weightages %
1	**Introduction**: Definitions of Statistics and its applications in Agriculture Engineering, Limitations, Types of data, Classifications, Tabulation and Frequency distribution **Graphical presentation:** Histogram, Frequency curve, Frequency polygon, Cumulative frequency curve (Ogive curve)	08
2-3	**Measures of central tendency**: Arithmetic Mean, Median, Mode, GM, HM, Weighted average, Quartile, Deciles, Percentiles, Characteristics of ideal measure, Merits and Demerits of various measures (Grouped and Ungrouped data)	08
4-5	**Measures of Dispersion:** Range, Mean Deviation, Quartile Deviation, Standard Deviation and Variance and respective relative measures (Grouped and Ungrouped Data), Concept of measures of Skewness and Kurtosis.	08
6-7	**Correlation:** Definition of Correlation, Types, Scatter diagram. Karl Pearson's Coefficient of Correlation and its test of significance. Spearman's Rank Correlation coefficient.	10
8-9	**Regression**: Linear Regression equations, definition & properties of Regression coefficient, constant, fitting of Regression lines, its test of significance, comparison of Regression and Correlation coefficients. Non linear Regression viz; Quadratic, Exponential and Gompertz curve.	10
10	**Probability:** Terminologies and Definitions of Trial, Random experiment, Events (simple, compound, equally likely, complementary, independent, dependant, mutually exclusive) Definitions of probability (mathematical, statistical, axiomatic), Addition and Multiplication theorem (without proof). Laws of Addition of Probability (when events are mutually exclusive and events are not mutually exclusive).	06
11-12	**Probability distributions:** Random variable, Discrete and Continuous Random variable, Probability Mass and Density function, Definition and properties of Binomial, Poisson and Normal distributions.	10
13	**Sampling:** Definitions of population, Sample, Parameter, Statistic, need of Sampling, Sampling versus complete enumeration and Introduction to Simple Random Sampling methods. Simple Random Sampling with and without replacement, Selection of random sample.	05
14	**Test of significance** : Null and Alternate Hypothesis, Types of errors, One tailed and Two tailed test, Degrees of freedom, Level of significance, Critical region, Steps in testing of hypothesis,	10

15	One sample, Two sample, Paired 't' test, and 't' Test for Correlation Coefficient, F test for equality of variance	10
16	Chi-square test of goodness of fit and Chi-square test of independence of attributes in 2 ×2 contingency table and **Analysis of Variance:** Introduction to Analysis of Variance, Assumptions of ANOVA, Analysis of one way classification.	15
	Total	**100**

Practical Exercises

EX.No.	**Topic**
1	**Graphical presentation:** Histogram, Frequency curve, Frequency polygon, Cumulative frequency curve (Ogive curve)
2	**Measures of central tendency**: Computations of Arithmetic Mean, Mode, Median, GM and HM, Quartiles, Deciles & Percentiles (Ungrouped data).
3	Computations of Arithmetic Mean, Mode, Median, Quartiles, and Deciles & Percentiles (Grouped data).
4	**Measures of Dispersion:** Computations of Range, Mean Deviation, Quartile Deviation, Standard Deviation and Variance and respective relative measures (ungrouped Data).
5	Computations of Range, Mean Deviation, Quartile Deviation, Standard Deviation and Variance and respective relative measures (grouped data).
6-7	**Correlation:** Computations of Karl Pearson's coefficient of correlation with its test of significance
8	Spearman's Rank Correlation
9-10	**Regression**: Fitting of simple linear Regression equation with test of significance of Regression coefficient.
11-12	**Test of Significance:** Problems on One sample, Two Sample and Paired t-test. and test for correlation coefficient.
13	F test for testing equality of variance
14-15	Chi-Square test of Goodness of Fit. and Chi-square test of independence of Attributes for 2 ×2 contingency table.

16	**Analysis of Variance:** Analysis of Variance - One way classification.

Suggested readings

Text Books

1. A Text book of Agriculture Statistics by R. Rangaswami (2009)New Age International (P) Limited, Hyderabad.
2. Statistics for Agriculture Sciences by Nageshwar Rao G.(2007)New Delhi : BS Publications

Reference Books

1. Statistical methods for Agricultural workers by Panse V.G. Sukhatme P.V. (1985) Indian Council of Agricultural Research New Delhi
2. Statistical Methods by Snedecor GW. & Cochran WG. (1989).,Iowa State University Press.
3. Statistical Procedures for Agricultural Research by Gomez, K.A. and Gomez, A.A.(1984). John Wileyand Sons. New York.
4. Fundamentals of Applied statistics by V.K. Kapoor (2007) Sultan Chand and Sons, New Delhi- 110 002

BASIC SCIENCE

Course No. : BS-COMP 111 Course Title : Computer Programming and Data Structures

Semester:- I Credits : 2 (1+ 1)

Theory

Introduction to high level languages i.e. C Language, Primary data types and user defined data types, Variables, typecasting, Operators, Building and evaluating expressions, Standard library functions, Managing input and output, Decision making, Branching, Looping, Arrays, User defined functions, passing arguments and returning values, recursion, scope and visibility of a variable, String functions, Structures and union, Pointers, Stacks, Push/Pop operations, Queues, Insertion and deletion operations, Linked lists.

Practical

Familiarizing with Turbo 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.

Teaching Schedule with weightages (%)

Sr.No.	Unit	Topic	Lecture No.	Weightage to topics
1	I	**Introduction** to high level languages i.e. "C" language. Basic structure of C program, Character set, Variables, Constants	1, 2	30%
2		**Data types**: Primary data types and user defined data types, typecasting	3, 4	
3		**Operators:** Arithmetic, Logical, Relational, Building and evaluating expressions, Standard library functions	4, 5	
4	II	**Managing input and output** : Input/ Output statement, scanf( ), printf( ), getchar (), getch( ), putchar( )	5, 6	30%
5		**Decision making**, **Branching, Looping**:- **Conditional statements**: if, if-else, nesting of if, if-ladder. **Looping statement**: while( ), do .. while( ) and for( ) –looping statements	7,8	
6	III	**Arrays :** One dimensional, two dimensional and multi dimensional arrays	9	20%
7		**Functions:** Library Functions, User defined functions, passing arguments and returning values, recursion	10,11	
8	IV	**String functions:** strcat( ), strlen( ), strcpy( ), strcmp( ) etc.	12,13	20%
9		**Data structures:** Structures, Union and Pointers (Syntax and definition)	14	
10		Stacks, Push/Pop operations, Queues, Insertion and deletion operations, Linked lists.	15,16	
Total Theory Marks (40)				100%

Practical Exercises

Sr. No.	Name of the Experiment
1	Write a program to check odd or even number. Write a program to find the largest among two numbers.
2	Write a program to find the Area of Circle, by giving radius as input.
3	Write a program to find the square root of a given number. Write a program to find the roots of quadratic equation $AX^2+BX+C=0$
4	Write a program to find the right most digit of a given number.
5	Program to calculate the simple interest by giving, principal amount, rate of interest and period in months.
6	Write a program to convert number of days in to months & days.
7	Write a program to find the largest of three given numbers A, B, C.
8	Write a program to find the average/mean of given 10 numbers.
9	Write a program to print the following triangle. 1 12 123 1234
10	Write a program a program to generate the Fibonacci series up to given numbers N.
11	Write a program to print the given number in reverse order.
12	Write a program to find the sum of first fifty even numbers.
13	Write a program for addition, subtraction and multiplication of 3x3 matrix.
14	Write a program to arrange the given 10 numbers using selection sort method.
15	Write a program to determine if the given number is prime or not prime.
16	Write a program to find the factorial of a given number using function.

Suggested readings

Text and Reference books

Rajaraman V. 1985. Computer Oriented Numerical Methods. Prentice Hall of India. Pvt. Ltd., New Delhi.

Balagurusamy E. 1990. Programming in 'C'. Tata McGraw Hill Publishing Co. Ltd., 12/4 Asaf Ali Road, New Delhi.

Rajaraman V. 1995. Computer Programming in 'C'. Prentice Hall of India Pvt.Ltd., New Delhi.

Bronson G and Menconi S. 1995. A First Book of 'C' Fundamentals of 'C' Programming. Jaico Publishing House, New Delhi

Sahni S.. Data Structures, Algorithms and Applications in C++. University press (India) Pvt Ltd / Orient Longman Pvt. Ltd.

Michael T. Goodrich, R. Tamassia and D Mount. Data structures and Algorithms in C++. Wiley Student Edition, John Wiley and Sons.
Mark Allen Weiss. Data Structures and Algorithm Analysis in C++. Pearson Education.
Augenstein, Langsam and Tanenbaum. Data structures using C and C++. PHI/Pearson Education.
Drozdek Adam. Data Structures and Algorithms in C++. Vikas Publishing House / Thomson International Student Edition.
Agarwal, Ajay. The Complete Reference Guide: Data Structure through C. ISBN: 8178840448; Publisher: Cyber Tech Publications.

Course No: BS-COMP-122 **Course Title:-Web Designing and Internet Applications**

Semester:- II **Credits: 2(0+2)**

Practicals

Basic principles in developing a web designing, 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.

FLASH: Animation concept FPS, Understanding animation for web, Flash interface, Working with tools, 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, FTP UPLOADING SITE: Learning to use FTP, Setting FTP, Uploading of site, Using Control panel, GIF ANIMATION: Understanding gif animation interface, Knowing GIf file format, Creating basic web banners, Creating web banners with effects, Creating animated web buttons.

Practical Exercises

Practical no.	Practical topic
1-12	**HTML:** How to create web page (Textboxes, Button, Radio-Button, Checkboxes, List). **Creation of Simple Website using HTML**
13-17	**DREAM WEAVER**: Exploring Dreamweaver Interface, Planning & Setting Web Site Structure, Working with panels, Understanding and switching views, Using property inspector, Formatting text
18-20	**FLASH**: Animation concept FPS, Understanding animation for web, Flash interface, Working with tools.
21-27	**JAVA SCRIPT:** Working with alert, confirm and prompt, Understanding loop, arrays, Creating rollover image, Working with operator
28-30	**FTP UPLOADING SITE:** Learning to use FTP, Setting FTP, Uploading of site, Using Control panel.
31-32	**GIF ANIMATION:** Understanding gif animation interface, Knowing GIF file format, Creating basic web banners, Creating web banners with effects, Creating animated web buttons

Suggested readings

Text and Reference books

1) Jennifer Niederst Robbins. Developing web design latest edition.
2) Frain and 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) Text book on Web Designing and Internet Applications (Under publication)

On-line tutorial web site

http://www.tutorialpoint.com.

http://www.W3School.com.

www.htmlprograms.com.

Course No: BS-MATH 111 Title: Engineering Mathematics – I

Semester: I (New) Credit: 3 (2+1)

Syllabus

Theory

Matrices and its applications: Rank of a matrix, Inverse of Matrix by Gauss-Jordan method, Normal form, Applications: Consistency of linear system of equations; linear transformations, orthogonal transformations, Eigen values with properties and Eigen vectors, Cayley-Hamilton theorem(without proof), diagonalization of matrices, quadratic forms, nature of a quadratic form.

Differential calculus and its applications: Expansions of functions by Maclaurin's and Taylor's series; Indeterminate form.

Partial differentiation and its applications: Functions of two or more independent variables, partial derivatives, homogeneous functions and Euler's theorem, total derivatives: chain rule; differentiation of implicit functions, change of variables, Application: maxima and minima.

Integral calculus and its applications: Gamma and Beta functions, Volumes and Surface areas of revolution, double and triple integrals, change of order of integration, application of double and triple integrals.

Vector calculus and its applications: Scalar and Vector point functions, Derivative of vector function,vector differential operator Del, Gradient of a scalar point function, geometrical meaning of gradient, Applications of vector differentiation and gradient, Divergence and Curl of a vector point function and their physical interpretations, applications of divergence and curl, identities involving Del(without proof), second order differential operator(without proof); line integral, work done, surface and volume integrals, Green's, Stoke's, and Gauss divergence theorems (without proofs).

Practical

Applications of Matrices, Applications of Eigen values and Eigen vectors, Applications of Cayley-Hamilton theorem, diagonalization of matrices, quadratic forms, nature of a quadratic form, Applications of Taylor's and Maclaurin's series, Applications of Indeterminate forms, Applications of Partial differentiation, Maxima and minima, Applications of Beta and Gama functions, Tracing of Cartesian curves, Applications of Volume and surface revolution, Applications of Double and Triple Integrals, Applications: mass of lamina, centre of gravity, centre of pressure, moment of inertia, Applications of derivative of vector function, Gradient, Directional derivatives, divergence and curl, solenoidal and irrotational field, Applications of Line, surface and volume integrals, work done, Applications of Greens , Stokes and Gauss Divergence theorem.

Teaching Schedule –Theory with weightages (%)

Lecture No.	Topics to be covered	Weightages (%)
Matrices and its Applications		
1-9	Rank of Matrix Inverse of Matrix by Gauss- Jordan Reduction to normal form Applications: Consistency of linear system of equations Linear transformation Orthogonal transformation Eigen values and Eigen vectors Properties of Eigen Values Cayley Hamilton theorem(without proof) Reduction to Diagonal form, quadratic form, nature of quadratic form	30%
Differential Calculus and its Applications		
10-11	Maclaurin's series,	30%

	Taylor's series	
12-13	Indeterminate Forms: L'Hospital's Rule/ Cauchy Rule Forms: $\frac{0}{0}, \frac{\infty}{\infty}, \infty - \infty, 0 \times \infty, 0^0, 1^\infty, \infty^0$	
14-19	Partial Differentiation and its applications Function of two or more independent variables Partial derivatives Homogeneous function & Euler's Theorem Total derivative & Derivative of implicit function Change of variable Maxima and Minima	
Integral Calculus and its Applications		
20-28	Gamma and Beta Function Volume of solids of revolution Surface areas of revolution Double Integral: Definition, Evaluation Change of order of integration – Cartesian form Triple Integral: Definition, Evaluation	20%
Vector Calculus and its Applications		
29-31	Scalar and Vector point function Derivative of vector function Vector operator Del Gradient of scalar point function, geometrical meaning of gradient, Directional Derivative Divergence and Curl of Vector point function Physical interpretations of Divergence and Curl Solenoidal and Irrotational field Identities involving Del and second order differential operator(without proof)	20%
32-34	Vector Integration - Line integral, work done, surface integral, Green's Theorem (without proof) Stoke's Theorem(without proof) Volume integral Gauss divergence theorem (without proof)	

Practical Exercises

Exercise No.	Topic
1	Applications of Matrices
2	Applications of Eigen values and Eigen vectors
3	Applications of Cayley-Hamilton theorem, diagonalization of matrices, quadratic forms, nature of a quadratic form.
4	Applications of Taylor's and Maclaurin's series
5	Applications of Indeterminate forms
6	Applications of Partial differentiation
7	Maxima and minima
8	Applications of Beta and Gama functions
9	Tracing of Cartesian curves
10	Applications: Volume and surface revolution
11	Applications:To find area by double integral and to find volume of solids
12	Applications mass of lamina, centre of gravity, centre of pressure, moment of

	inertia
13	Applications of Vector differentiation, Gradient, Directional derivative
14	Applications of Divergence and Curl , solenoidal and irrotaional field
15	Applications of Line integral-work done, surface and volume integrals
16	Applications of Green's Theorem, Stoke's Theorem, Gauss divergence theorem.

Suggested Reading

Text Book

1. Dr. Shinde K. J. *et.al*., 2017; A Text Book of Agricultural Engineering Mathematics –I

Reference Books

1. Narayan Shanti, 2004; Differential Calculus. S. Chand and Co. Ltd. New Delhi.
2. Narayan Shanti, 2004; Integral Calculus. S. Chand and Co. Ltd. New Delhi.
3. Grewal B. S., 2015; Higher Engineering Mathematics. Khanna Publishers Delhi.(43rd Edition)
4. Narayan Shanti, 2004;A Text Book of Vector Calculus. S. Chand and Co. Ltd. New Delhi.
5. Narayan Shanti, 2004; A Text Book of Matrices. S. Chand and Co. Ltd. New Delhi.

Course No. BS-MATH 122 Title: Engineering Mathematics-II Semester: II (New) Credits 3(2+1)

Syllabus

Theory

Differential equations and its applications: Exact differential equations, equations reducible to exact form by integrating factors, Bernoulli's equation, Equations of first order and higher degree: Clairaut's equation, Linear differential equations with constant coefficients, methods of finding complementary functions and particular integrals, Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients

Functions of a Complex variable and its applications: Limit, continuity and derivative of f(z), Cauchy-Riemann equations, analytic functions, Harmonic functions.

Infinite series and its convergence: Series, conditions of convergence, Ratio Test, Raabe's Test, Logarithmic test, Alternating series, Power series, Convergence of exponential, logarithmic, binomial series.

Fourier series and its Applications: Euler's formulae, Dirichlet's conditions, functions having arbitrary period, even and odd functions, half range series.

Partial differential equations and its Applications: Formation of partial differential equations by elimination of arbitrary functions, solutions of partial differential equations. Linear equation of the first order, non-linear partial differential equations, application of partial differential equations (one dimensional wave and heat flow equations, Laplace Equation.)

Practical

Differential equations –Exact and Non-Exact, Bernoulli's Differential equations, Equations of first order and higher degree, Clairaut's equation, Applications of differential equations of first order, Applications of higher order linear differential equations, Applications of Cauchy's and Legendre's linear equations, Applications of Simultaneous linear differential equations with constant coefficients, Applications of Functions of a Complex variable, Infinite series and its convergence, Fourier series in the interval $[0,2\pi], [-\pi,\pi]$, Fourier series in the interval $[0,2l], [-l,l]$, Half range series, Harmonic analysis, Solutions of partial differential equations, Non-linear partial differential equations, Application of partial differential equations: one dimensional wave and heat flow equations, Laplace Equation

Teaching Schedule –Theory with weightages (%)

Lecture No.	Topics to be covered	weightage (%)
Differential Equations and its Applications		
1-10	Exact differential equation	**35%**
	Equations reducible to exact form by Integrating factor	
	Bernoulli's differential equation	
	Equations of the first order and higher degree: Clairaut's form	
	Applications of Differential Equations of first order	
	Linear differential equations with constant coefficients –Rules for finding complementary functions	
	Rules for finding the Particular integral	
	Method of variation of parameters	
	Simultaneous linear differential equations with constant coefficients	
Function of complex variable and its Applications		
11-15	Complex Function, Limit, continuity	**10%**
	Derivative of complex function	
	Cauchy- Riemann equation with proof	
	Analytic function	
	Harmonic functions	
Infinite Series and its convergence		
16-20	Tests of convergence: Ratio Test	**15%**
	Raabe's Test, Logarithmic test	
	Alternating series and Leibnitz rule	
	Power series	
	Convergence of exponential series, logarithmic series and binomial series.	
Fourier series		
21-27	Euler's formulae	**25%**
	Dirichlet's conditions	
	Fourier series in the interval $[0,2\pi]$	

	Fourier series in the interval $[-\pi, \pi]$	
	Fourier series in the interval $[0,2l]$	
	Fourier series in the interval $[-l, l]$	
	Half range series	
Partial differential equations and its Applications		
28-32	Formation of partial differential equations	**15%**
	Solutions of partial differential equation	
	Lagrange's linear equation	
	Non- linear equation of the first order	

Practical Exercise

1. Differential equations –Exact and Non-Exact
2. Bernoulli's Differential equations
3. Equations of first order and higher degree, Clairaut's equation
4. Applications of differential equations of first order
5. Applications of higher order linear differential equations
6. Applications of Cauchy's and Legendre's linear equations
7. Applications of Simultaneous linear differential equations with constant coefficients.
8. Applications of Functions of a Complex variable
9. Infinite series and its convergence
10. Fourier series in the interval $[0,2\pi], [-\pi, \pi]$,
11. Fourier series in the interval $[0,2l], [-l, l]$,
12. Half range series
13. Harmonic analysis.
14. Solutions of partial differential equations
15. Non-linear partial differential equations
16. Application of partial differential equations: one dimensional wave and heat flow equations, Laplace Equation

Suggested Reading

Text Book

1. Dr. Shinde K. J. *et.al*. A text book of Agricultural Engineering Mathematics-II

Reference Books

1. Narayan Shanti. 2004. A Text Book of Matrices. S. Chand and Co. Ltd. New Delhi.
2. Grewal B S. 2015. Higher Engineering Mathematics. Khanna Publishers Delhi.(43rd Edition)
3. Ramana B V. 2008. Engineering Mathematics. Tata McGraw-Hill. New Delhi.

Course No. BS-MATH 233 **Title: Engineering Mathematics-III**

Semester: III (New) **Credits 3(2+1)**

Syllabus

Theory:

Numerical Techniques :Finite differences, factorial notation, various difference operators and their relationships, interpolation with equal intervals- Newton's forward and backward interpolation formula. Bessel's and Stirling's difference interpolation formulae. Interpolation with unequal intervals-Lagrange's interpolation formula. Newton's divided difference formula.

Numerical differentiation and integration. First and second order derivative by using Newton's forward and backward interpolation, Maxima and Minima of tabulated function, Numerical Integration: by Trapezoidal rule and by Simpsons rule, applications of Simpson's rule

Difference equations and their applications. Difference equation, Order of difference equation, Solution of linear difference equation, Linear difference equations, Rules for finding complementary function, Rules for finding particular integral and applications

Numerical solutions of ordinary differential equations: by Picard's, Taylor's series, Euler's and modified Euler's method and Runge-Kutta method.

Laplace transformation: Laplace Transform and Inverse Laplace transform and its applications to the solutions of ordinary and simultaneous differential equations.

Practical

Applications of Interpolation with equal intervals, Applications of Interpolation with unequal intervals, Applications of Numerical differentiation, Applications : Maxima and Minima, Applications of Numerical integration, Applications of Homogeneous Difference equations, Applications of Non-homogeneous Difference equations, Applications of Numerical solution of ordinary differential equations-Picard's Method, Applications of Taylors method, Applications of Numerical solution of ordinary differential equations-Euler's, Applications of Runge-Kutta method, Applications of Laplace transformations, Applications of Inverse Laplace transformation, Applications of Convolution theorem, Application to solution of ordinary differential equations, Application to solution of simultaneous differential equations.

Teaching Schedule –Theory with weightages (%)

Lect. No.	Topics to be covered	weightages (%)
Finite Differences and Interpolation		17%
1-6	Finite differences	
	Factorial Notations	
	Various difference operator and their relationship	

	Newton's forward and backward interpolation formula	
	Lagrange's interpolation formulae for unequal intervals	
Numerical Differentiation & Integration		
7-12	First and second order derivative by using Newton's forward and backward interpolation	22%
	Maxima and Minima of tabulated function	
	Numerical Integration: by Trapezoidal rule and by Simpsons rule, applications of Simpson's rule	
Difference Equations and their Applications		
13-17	Difference equation, Order of difference equation, Solution of linear difference equation	15%
	Linear difference equations	
	Rules for finding complementary function	
	Rules for finding particular integral and applications	
Numerical Solution of Ordinary Differential Equations		
18-20	Picard's method	8%
	Taylor's series method	
	Euler's method	
Laplace Transforms		
21-33	Definition, Laplace Transform of elementary functions	38%
	Properties of Laplace Transforms	
	Laplace Transform of periodic function	
	Laplace Transform of derivatives	
	Laplace Transform of an integral	
	Laplace Transform of function multiplied by t^n	
	Laplace Transform of function divided by t	
	Inverse Laplace Transform	
	Convolution Theorem(Without Proof)	
	Applications of LT. Solving ordinary differential equations	
	Solving Simultaneous differential equations using Laplace Transformation.	

Practical Exercise

1. Applications of Interpolation with equal intervals
2. Applications of Interpolation with unequal intervals
3. Applications of Numerical differentiation
4. Applications : Maxima and Minima
5. Applications of Numerical integration
6. Applications of Homogeneous Difference equations
7. Applications of Non-homogeneous Difference equations
8. Applications of Numerical solution of ordinary differential equations-Picard's Method
9. Applications of Taylors method
10. Applications of Numerical solution of ordinary differential equations-Euler's
11. Applications of Runge-Kutta method
12. Applications of Laplace transformations
13. Applications of Inverse Laplace transformation

14. Applications of Convolution theorem
15. Application to solution of ordinary differential equations.
16. Application to solution of simultaneous differential equations

Suggested Reading

Text Book

1. Dr. Shinde K. J. *et.al.* A text book of Agricultural Engineering Mathematics-III

Reference Book

1. Grewal B S. 2015. Higher Engineering Mathematics. Khanna Publishers Delhi.(43rd Edition)

Course No: BS-PHY-242 **Title:** Applied Electronics & Instrumentation

Semester: IV (New) **Credits:** 2 (1+1)

UNIT	Topics to be covered	Book No.	Chapter No.	Weightage
I	**Semiconductor Physics** PN Junction, V-I characteristics of PN junction, Breakdown voltage, Knee voltage, Peak inverse voltage.	1	5	25%
	Semiconductor Diode: Semiconductor Diode, Rectifiers, Efficiency of HWR, Full wave rectifier & it's types, Ripple Factor, Filter circuits, Types of filter circuits. Clipper and clamper.	1	6	
II	**Transistors**: Transistor, Transistor action, Symbols, Transistor connections: Common Base, Common Emitter, Common Collector connection, Transistor as an amplifier in CE mode, Faithful amplification. Transistor biasing, stabilization.	1	8,9, 11,12	25%

	Transistor amplifier Single stage transistor amplifier, Practical circuit of transistor amplifier, Multistage transistor amplifier & it's important terms.	1	13, 14,15	
III	**Operational Amplifiers** Operational amplifier, Schematic symbol of op-amp, Electrical parameters of Op-Amp, Ideal Op-Amp Characteristics, Inverting and, non-inverting amplifier, Equivalent circuit of Op-Amp.	**1**	25	25%
	Digital Electronics Decimal to Binary Conversion, Binary to Decimal Conversion, Logic gates (AND, OR, NOT, NAND, NOR), NAND gate as universal gate, Boolean Algebra, Boolean Theorems.	**1**	26	
IV	**Instrumentation** Measurement and it's aim, Functional element of instrument, performance characteristics, static characteristics (Calibration, Accuracy, Precision, Repeatability, Reproducibility, Resolution, hysteresis, Sensitivity, dead zone, backlash, true value), static error, sources of error ,dynamic characteristics (speed of response, fidelity, lag, dynamic error) Measurement of displacement (LVDT, LDR, Capacitive and Inductive pick up), Temperature (Thermocouple, Thermistor, RTD).	**2**	1,7	25%

Practical Exercise:

1) To study V-I characteristics of PN junction diode
2) To study Half wave rectifier
3) Study of Centre tap Full wave and Bridge rectifier
4) To study transistor characteristics in CE configuration
5) To study Diode as Clipper
6) Study of working of diode as clamper
7) To Study frequency response of Single stage transistor amplifier
8) To study Op-Amp IC741 as Inverting amplifier
9) Study of Op-Amp as Non inverting amplifier

10) To study the function and implementation of logic gates i.e. AND, OR, NOT, NAND,NOR, EX-OR gates
11) Study of LVDT/ LDR.
12) Study of Thermocouple
13) Study of RTD
14) Study of Thermistor
15) Study of Capacitive pick up
16) Study of Inductive pick up.

Suggested readings

Text Books:

1) Principles of Electronics (11th edition) – V.K. Mehta, Rohit Mehta, S.Chand Co. New Delhi.
2) Industrial instrumentation and control (Third edition) -by S.K.Singh, Tata Mc-Graw Hill Pub.

Reference Books:

1) Op-Amps and Linear Integrated Circuits – Ramakant A. Gayakwad, PHI Pvt.Ltd. New Delhi, 4th Edition.
2) Linear Integrated Circuits – D.Roy Choudhary, Shail B. jain, New age Internatioal pub., 2nd Edition.
3) Electronic Instrumentation – S.K. Khedkar, Pune VidyarthiGriha Pub. 3rd Edition.
4) Electronic fundamentals and applications- John D. Ryder, PHI Pvt.Ltd. New Delhi
5) Electronic Devices and circuits – Sanjeev Gupta, Sontosh Gupta, DhanpatRai Pub.
6) Digital Principles and applications – Albert Malvino, Donald leach
7) Measurement of electronics and electronics Instrumentation – Sawhney A.K. Dhanpat Rai Pub. New Delhi.
8) Modern Digital Electronics – R.P.Jain, Tata Mc-Graw Hill Pub., IVth Edition

Course No: BS-PHY 111 **Title: Engineering Physics**
Semester: I (New) **Credits: 2 (1+1)**

UNIT	Topics to be covered	Book No.	Chapter No.	Weightage
I	**Magnetism** Classification of magnetic material: Dia, Para and Ferromagnetism, Langevin's theory of dia and Para magnetism. Curie-Weiss law	1	13	30%
	Surface Tension and Viscosity: Molecular forces, Molecular theory, Surface energy & tension, Pressure difference across liquid surface, Capillary rise method, Jaeger's method, Viscosity & coefficient of viscosity, Streamline & Turbulent flow, Reynold's number, Poseuille's equation, Stoke's Law & Terminal velocity	2	8	
II	**Semiconductor Physics**: Distinction between metals, Insulators & Semiconductors. Intrinsic & Extrinsic semiconductor, Effect of temp. on semiconductor.	2	60	35%
	Superconductivity Superconductivity, critical current strength, Meissner effect, Isotope effect & electron-Photon interaction, Type-I, II superconductors, Applications.	3	11	
III	**Lasers** Spontaneous & stimulated emission, Einstein A & B coefficients, Population inversion, He-Ne & Ruby Lasers, Concept of MASER	2	31	35%
	Fiber Optics & Illumination Optical fiber, Physical structure, Basic theory, Types of modes, Input output characteristics of optical fiber, Numerical Aperture, Applications of fiber optics. Laws of illumination, Luminous flux, Luminous intensity, Candle power, Brightness, transmission & reflection	2 2	32 24	

	coefficient.			
				100%

Practical Exercisec

1) To determine wavelength of Laser beam
2) To determine divergence of HE-Ne Laser
3) To find Numerical aperture of optical fiber
4) To set up the fiber optic analog and digital link
5) To find the frequency of AC supply using an electrical vibrator
6) To study induced emf as a function of velocity of magnet
7) To study phase relationship in LR circuit
8) To study LCR circuit
9) To determine Surface tension by capillary rise method
10) Determination of Surface tension by Jaeger's method
11) To determine Coefficient of Viscosity by Stokes method
12) Determination of Coefficient of Viscosity by Poiseuille's method
13) To study variation of thermo emf of Copper-Constantan thermo- couple with temp.
14) To determine energy band gap in semiconductor
15) To find wavelength of light by prism
16) To study the variation of magnetic field with distance along axis of a current carrying circular coil

Suggested readings

Text Books:

1) Solid state Physics – Saxena B.S. and Gupta R.C., Pragati Prakasah, 16th Edition
2) Engineering Physics- R.K.Gaur and S.L. Gupta, Dhanpat Rai Pub.New Delhi 8th Edition
3) Modern Physics for Engineers – S.P.Taneja, S.Chand Co. New Delhi , 10th Edition 2014

Reference Books:

1) Atomic Physics- J.B. Rajam, R.Chand New Delhi , 7th Edition 1999
2) Fundamentals of Molecular Spectroscopy – Colin Banwell, Mc Cash, Tata Mc Graw Hill, New Delhi,4th Edition
3) Elements of properties of matter – D.S.Mathur
4) Optical state Physics and Fiber optics- Sarkar Sabir Kumar,S.Chand New Delhi
5) Elements of Spectroscopy- Gupta S.L. Sharma R.C., Pragati Prakashan, Meeruth

6) Fundamentals of Magnetism and Electricity – Vasudeva D.N., S.Chand New Delhi
7) A Text Book of optics – Brijlal Subramaniyam, S.Chand Co. New Delhi , 24th Edition

FARM STRUCTURE

Course No.	**:**	FS-ELE-481	**Credits**	**:**	3(2+1)
Course Title	**:**	Green House Structures For Protected Cultivation	**Semester**	**:**	VIII

Syllabus

Theory:

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. 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.Economic analysis.

Practicals:

Estimation of material requirement for construction of greenhouse; Estimation of material requirement for preparation of root media; Root media preparation, bed preparation and disinfections; Study of different planting techniques; Greenhouse heating; Study of different greenhouse environment control instruments; Economic analysis of greenhouses and net houses; Visit to greenhouses.

Teaching Schedule

Lec. No.	Topics to be covered	Book No.	Article No.	Weightage, %
1	Greenhouse technology – historical background, global status of greenhouse, scope and importance.	1, 2, 3	General	25%
2-4	Constituents of greenhouse environment	1	3.1 to 3.6	
5-6	Classification of greenhouses	1	4.1 to 4.6	25%
7-10	Greenhouse construction	1	5.1 to 5.8	
11-12	Methods of greenhouse construction	2	3.3	
13-14	Greenhouse heating systems	1	6.1 to 6.3	25%
15-17	Greenhouse cooling systems	1	6.5 to 6.12	
18-20	Steady state analysis of a greenhouse	2	8.1 to 8.4	
21-22	Root media	1	7.1 to 7.6	25%
23-24	Root substrate pasteurization	3	-	
25-26	Instrumentation and automation for greenhouses	1	9.1 to 9.3	
27	Periodic maintenance of greenhouses	-	General	

Practical Exercises:

SN	Title
1.	Visit to commercial greenhouse complex / structure
2.	To measure greenhouse environmental parameters (temp., RH, Solar radiations, CO2, air velocity etc) and prepare profiles of these parameters.
3.	Problems on greenhouse light requirements
4.	Problems on CO2 enrichment.
5.	Problems on calculation of greenhouse heat requirements.
6.	Problems on design of fan pad system.
7.	Problems on design of winter cooling system.
8.	Problems on greenhouse root media.
9.	Problems on greenhouse steady state analysis.
10.	Structural design of simple rectangular gable type GI pipe greenhouse structure (i.e. To find sizes of purlins, rafters and columns for desired wind speed pressure).

Suggested readings

Author	Year	Title	Publisher
Text Book			
Vilas M. Salokhe	2006	Greenhouse Technology and	Agrotech publishing academy

and Ajay K. Sharma		Applications	Udaipur (Raj.)
G. N. Tiwari	2003	Greenhouse technology for controlled environment	Narosa publishing house, New Delhi / Mumbai
Paul V. Nelson	1998	Greenhouse operation and management	Prentice Hall, New Jersey – 07458
Reference Books			
Singh Brahma and Balraj Singh	2014	Advances in protected cultivation	New India Publishing Company, New Delhi
Sharma P.	2007	Precision Farming	Daya Publishing House New Delhi

Course No. : FS- ELE-482 Course Title : Rural Transport, Water Supply and Sanitation

Semester : VIII Credits : 3(2+1)

Syllabus

Theory

Introduction and scope of the subject, types of roads, planning of rural road, geometric design of roads, pavement design, material for construction of roads, source and characteristics of water supply, estimation of quantity for rural water supply, layout of distribution system intake works, capacity requirements of storage of water, water treatment methods, pipe network analysis, estimation and design of sewage systems, septic tanks.

Practicals

Design problems on geometric design of roads, Road pavement design problems, Estimation of quality of drinking water for a town, Water quality test, Design of overhead tanks, Design of sedimentation tanks for water treatment, Problems on Hardy Cross methods, Study of purification of rural water supply, Design of septic tanks, Design of sewage disposal for Rural areas.

Teaching schedule theory with weightages (%)

Lect. No.	Topic	Book No.	Article No.	Page No.
	Part-1 – Transportation			
1	Introduction Development of roads, modes of transportation ,advantages, importance ,requirements of ideal roads.	2		9 to 18
2-3	Geometrical Design of Road Road structure components	2		64 to 86
4-5	Low cost roads Classification earthen , kankar, murum roads	2		131 to 155
	Part-2 – Water Supply			
6-8	Introduction , Quantity of water , Sources of water , Conveyance of water	1		1-2,5-13,16-23,32-39
9-11	Quality of water , Purification of water , Distribution System	1		48 -56,61-65,96-103
12-15	Appurtenances in distribution system Water supply Arrangement in building	1		108 to 111 113-115
	Part-3- Sanitation			89-104
16-18	Sanitary Engineering , Quantity of Sewage	1		121 to 123 126-128

19-22	Sewerage system Sewage treatment and disposal	1		143 -147 177 -181
23-26	Solid waste disposal Drainage and sanitation in building	1		222 -226 227-223

List of practicals:

S.No.	Name of Practical
1	Visit to road site to study various components of road.
2	Design of rural road based on traffic density.
3	Collection of data and population forecasting and water demand.
4	Determine Ph, Turbidity of water, TDS of water
5	Visit to city water treatment plant to study various components of the plant.
6	Visit to farm building to study sanitary fittings.
7	Design of septic tank for farm building.
8	Design of soak pit for rural area.
9	Layout of grid iron system of water distribution system.
10	Study different valves on water supply line.

Suggested readings

Text Books:

1) Environmental Engineering , By A KAMALA DL KANTH RAO , Tata McGraw-Hill Delhi , 1998.

2) Highway Engineering , By RANGWALA , CHAROTAR PUBLISHING HOUSE , ANAND INDIA , 2007.

3) Environmental Engineering Volume 1 , Water supply Engineering , Dr. P.N. Modi , Standard Book house , New delhi 6 , First Edition 200

Course No. : FS-111 Course Title : Engineering Mechanics
Semester : I Credits : 3(2+1)

Syllabus

Theory:

Basic concepts of Engineering Mechanics. Force systems, Centroid, Moment of inertia, Free body diagram and equilibrium of forces. Frictional forces Analysis of simple framed structures using methods of joints, methods of sections and graphical method. Simple stresses. Shear force and bending moment diagrams. Stresses in beams. Torsion. Analysis of plane and complex stresses.

Practical:

Problems on composition and resolution of forces, moments of a force, couples, transmission of a couple, resolution of a force into a force & a couple; Problems relating to resultant of; Co-planer force system, collinear force system, concurrent force system, co-planer concurrent force system, co-planer non-concurrent force system, Non-coplaner concurrent force system, Non-coplaner non-concurrent force system, system of couples in space; Problems relating to centroids of composite areas; Problems on moment of inertia, polar moment of inertia, radius of gyration, polar radius of gyration of composite areas; Equilibrium of concurrent – co-planer and non concurrent – co-planer force systems; Problems involving frictional forces; Analysis of simple trusses by method of joints and method of sections; Analysis of simple trusses by graphical method; Problems relating to simple stresses and strains; Problems on shear force and bending moment diagrams; Problems relating to stresses in beams; Problems on torsion of shafts; Analysis of plane and complex stresses.

Teaching Schedule

Lect. No.	Topic	Book No.	Article No.	Page No.	Weightages %
1	Introduction	1	1.1 to 1.13	1-4	25%
2-3	Composition and Resolution of Forces	1	2.1 to 2.18	13-26	
4-6	Moments, Parallel forces and Couples	1	3.1-3.8, 4.1 to 4.6 and 4.8 to 4.14	28-33, 43-46 and 49-54	
7-8	Equilibrium of forces	1	5.1 to 5.10	55-74	25%
9-11	Centre of gravity	1	6.1 to 6.11	78-93	
12-14	Moment of Inertia	1	7.1 to 7.15	100 to 118	
15-16	Friction	1	8.1 to 8.11	124 to 131	25%
17-18	Principles of lifting machines	1	10.1 to 10.18	171 to 183	
19-22	Simple lifting machines – simple wheel and axle, differential wheel and axle, worm and worm wheel, single purchase crab winch, double purchase crab winch and simple screw jack.	1	11.1 to 11.5, 11.7 to 11.9 and 11.15	185 to 192	
23-25	Support reactions	1	12.1 to 12.23	217 to 242	25%
26-28	Analysis of perfect frames – Analytical	1	13.1 to 13.14	244 to 250	
29-30	Analysis of perfect frames – Graphical method	1	14.1-14.6	289-298	

Practical Exercises:

Sr. No	Title
1	Determination of magnitude and direction of resultant force of concurrent and non-concurrent forces by Graphical method.
2	Determination of magnitude and direction of resultant force of parallel forces by graphical method.
3	Verification Lami's theorem.
4	Verification the law of Triangle of forces.
5	Verification the law of Parallelogram of forces.
6	Verification of law of Polygon of forces.
7	Determination of C.G of given shapes.
8	Determination of coefficient of friction and angle of friction.
9	Determination M. A., V. R. and efficiency of simple wheel and axle.
10	Determination M. A., V. R. and efficiency of differential wheel and axle.
11	Determination M. A., V. R. and efficiency of single purchase crab winch.
12	Determination M. A., V. R. and efficiency of simple screw jack.
13	Determination of support reaction for a beam.
14	Analysis of perfect frame using analytical method.
15	Analysis of perfect frame using graphical method.

Suggested readings

Books:

Author	Year	Title	Publisher
Text Book			
R.S. Khurmi	2008	A text book of Engineering Mechanics	S. Chand and company ltd., Ramnagar, New Delhi
Reference Books			
Sundarajan V	2002	Engineering Mechanics and Dynamics	Tata McGraw Hill Publishing Co. Ltd., New Delhi.
Timoshenko S and Young D H	2003	Engineering Mechanics	McGraw Hill Book Co., New Delhi
Prasad I B	2004	Applied Mechanics	Khanna Publishers, New Delhi
Prasad I B	2004	Applied Mechanics and Strength of Materials	Khanna Publishers, New Delhi
Bansal R K	2005	A Text Book of Engineering Mechanics	Laxmi Publishers, New Delhi

Course No.	**:**	FS 122	**Course Title**	**:**	**Strength of Materials**
Semester	**:**	II	**Credits**	**:**	2 (1+1)

Syllabus

Theory:

Slope and deflection of beams using integration techniques, moment area theorems and conjugate beam method. Columns and Struts. Riveted and welded connections. Stability of masonry dams. 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 metal specimen (M.S., C.I.), 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, C.I., M.S. & Wood specimens and to determine various physical and mechanical properties; To perform the bending test on the specimens; M.S. Girder, Wooden beam, Plain concrete beams & R.C.C. beam, and to determine the various physical and mechanical properties; To determine Young's modulus of elasticity of beam with the help of deflection produced at centre due to loads placed at centre& quarter points; To study the behaviour of materials (G.I. pipes, M.S., C.I.) under torsion and to evaluate various elastic constants; To study load deflection and other physical properties of closely coiled helical spring in tension and compression; To perform the Rockwell, Vicker's and Brinell's Hardness tests on the given specimens; To perform the Drop Hammer Test, Izod Test and Charpay's impact tests on the given specimens; To determine compressive & tensile strength of cement after making cubes and briquettes; To measure workability of concrete (slump test, compaction factor test); To determine voids ratio & bulk density of cement, fine aggregates and coarse aggregates; To determine fatigue strength of a given specimen; To write detail report emphasizing engineering importance of performing tension, compression, bending, torsion, impact and hardness tests on the materials.

Teaching Schedule

Lect. No.	Topic	Text Book	Article No.	Page No.	Weight-age, %	Unit
1-2	Simple stresses and strains, Stresses and strains in bars of varying sections	1	2.1 to 2.11 and 3.1 to 3.5	12 to 18 and 25 to 39	25%	I
3-4	Elastic constants	1	6.1 to 6.13	86 to 100		
5-8	Bending moment and shear force	1	13.1 to 13.9 and 13.11 to 13.12	286 to 292 296 to 304	25%	III
9-10	Bending stresses in simple beams	1	14.1 to 14.10	344 to 363		
11	Direct and bending stresses	1	17.1 to 17.4 and 17.7	385 to 389 and 398 to 400	25%	III
12	Deflection of beams –by integration method	1	19.1 and 19.3 to 19.7	463 to 474		
13-14	Riveted joints	1	29.1 to 29.25	664-680	25%	IV
15-16	Columns and struts	1	32.1 to 32.5, 32.8 and 32.9 and 32.11 to 32.13	723-734		

Practical Exercises:

Sr. No	Title
1	To perform tension test on mild steel bar.
2	To perform impact test on course aggregate.
3	To determine crushing strength of concrete cube.
4	To determine flexural strength of timber.
5	To determine Young's Modulus of elasticity of wire.
6	Determination of stiffness of helical spring.
7	Determination of modulus of rigidity of steel rod by torsion test.
8	To determine hardness of various metals.
9	To determine shear strength of mild steel bars using UTM.
10	Problems on shear force and bending moment.
11	Problems on simple bending stresses.
12	Problems on deflection of beams.
13	Problems on stability of dam.

14	Problems on design of riveted joints.
15	Problems on design of welded joints

Suggested readings

Author	Year	Title	Publisher
Text Book			
R.S. Khurmi	2013	Strength of Materials (SI Units)	S. Chand and company ltd., Ramnagar, New Delhi
Reference Books			
S. Timoshenko and D.H. Young	2012	Elements of Strength of Materials	East-West press private limited, New Delhi
S. Ramamrutham	2012	Strength of Materials	DhanpatRai and Sons, New Delhi
Junarkar S.B	2001	Mechanics of Structures (Vo-I)	Charotar Publishing House, Anand

Course No. : FS-233 **Course Title** : **Theory of Structures**
Semester : III **Credits** : 2(1+1)

Syllabus

Theory

Loads and use of BIS Codes.Design of connections.Design of structural steel members in tension, compression and bending.Design of steel roof truss. Analysis and design of singly and doubly reinforced sections, Shear, Bond and Torsion. Design of Flanged Beams, Slabs, Columns, Foundations, Retaining walls and Silos.

Practical

Design and drawing of single reinforced beam, double reinforced beam, Design and drawing of steel roof truss; Design and drawing of one way, two way slabs, Design and drawing of RCC

building; Design and drawing of Retaining wall. To measure workability of cement by slump test.

Teaching Schedule

Lect. No.	Topic	Book No.	Article No.	Page No.	Weightage %
	Part-1 – Steel Structures				
1	Introduction Characteristic strength and characteristics load, partial safety factors for load & material.	1 2	1.1 to 1.3 1.1 to 1.9, 1.11 -1.12	1 to 3 1 to 23	20%
2-3	Tension members	1	4.1 to 4.4	54 to 71	
4-5	Compression member	1	5.1 to 5.7	77 to 92	20%
6-7	Industrial sheds	1	9.1 to 9.2	201 to 223	
	Part-2 – RCC Structures				
8-9	Analysis and design of singly (LSM) reinforced sections.	2	3.1 to 3.6	50 to 66	20%
10-11	Analysis and design of doubly reinforced sections	2	4.1 to 4.3	71 to 87	
12-13	Design of one way slab Design of two way slab	2	10.1 to 10.5	233 to266	20%
14-15	Design of axially loaded short columns	2	12.1 to 12.4	355 to 375	20%
16	Types of footing, design of Isolated RCC footing	2	13.1 to 13.5	419 to 440	

Practical Exercises:

SN	Title
1	To study standard rolled steel sections and use of steel table to find their properties.
2	Drawing of various types of trusses.
3	Design and drawing of industrial truss.
4	Problem on design wind pressure for sloping roof.
5	Design and drawing of tension members
6	Design and drawing of compression members
7	Design and drawing of RCC slab and beam of a farm house.
8	Design and drawing of column and footing of farm house.
9	Drawing of various retaining wall.
10	Design and drawing of silos.

Suggested readings

Author	Year	Title	Publisher
Text Book			
L. S. Negi	2012	Design of steel structures	TataMcgraw-hill, New Delhi
V. L. Shah & S. R. Karve	2008	Illustrated Reinforced Concrete Design	Structures publications, Pune
Reference Books			
T.P. Ojha and A.M. Michael	2003	Principles of Agricultural Engineering Volume-I	Jain Brothers, New Delhi
V. L. Saha& Dr. S.R. Karve	2012	Limit state theory and design of reinforced concrete	Structures publishers, Pune
N. KrishanRaju and R.N. Pranesh	2012	Reinforced concrete design (IS 456-2000) Principles and practice	New Age International
N.C. Sinha and S.K. Roy		Fundametals of reinforced concrete	S. chand and company
S.K. Duggal	2011	Design of steel structure	Tata Mcgraw-hill, New Delhi.
M. Raghupati	2011	Design of steel structure	TataMcgraw-hill, New Delhi
Ramchandra	2010	Design of steel structure	Dhanpatrai and sons Publication Company, New Delhi
Sushilkumar	2000	RCC design	Standard book house , New Delhi
M.G.Shah and C.M.Kale	1984	RCC Theory and design	MACMILLAN , Delhi

Course No. : FS-244 Course Title : Building Construction and Cost Estimation
Semester : IV Credits : 2(1+1)

Syllabus
Theory:

Building Materials: Rocks, Stones, Bricks Properties and varieties of Tiles, Lime, Cement, Concrete, Sand. Glass, Rubber, Plastics, iron, Steel, Aluminium, Copper, Nickle. Timber. Building components: Lintels, Arches, stair cases, Different types of floors, Finishing: Damp Proofing and water proofing, Plastering, pointing, white washing and distempering – Painting, Building design, Design procedures, Technology, building construction, Types of

agricultural buildings and related needs, application of design theory and practice to the conservation, sloped and flat roof buildings, construction economics: Preliminary estimates, Detailed Estimates of Buildings source of cost information, use of cost analyses for controlling design, Factors affecting building costs; cost evaluation of design and planning alternatives for building and estate development, Measurement and pricing, Economic methods for evaluating investments in buildings and building systems: cost-in-use, benefit-to-costs and savings-to-investment ratios, rate of return, net benefits, payback.

Practical:

Testing of stones, bricks, cement, sand, aggregates, workability of cement, timber, components of agriculture structures, material and cost estimation of agriculture structures.

Teaching Schedule

Lect. No.	Topic	Book No.	Article No.	Page No.	Weightage %
1	Stones- Classification, uses, Quarrying, Characteristics	1	1.1 to 1.5	1-8	25%
2	Bricks – Preparation, types, classification, testing	1	2.1 to 2.13	15-23	
3	Cement – types, grades, storage, testing	1	5.5 to 5.10	38 – 48	
4	Cement concrete – ingredients, water cement ratio, specifications, properties, mixing, placing, curing	1	11.1 to 11.7	85 – 89	25%
5	Aggregates	1	7.1 to 7.3 8.1 to 8.4	55-56 62-64	
6	Rubber – Natural, polymer/synthetic, vulcanization, uses	1	23.1 to 23.7	182-184	
7	Plastics – polymerization, classification, properties	1	24.1 to 24.5	185-188	25%
8	Building components- Arches Lintels	 2 2	 -	 286-292 302-304	
9	Roofs Floors	 2	-	391-396 425-430	
10	Doors and windows – types, ledged doors	2	-	309-316	
11	Pointing and plastering	2	-	689-693	25%
12-13	Painting and distempering	2	-	707-717	
14	Methods of estimates	3 4	 2.1, 4.1	4-6 2-4, 32-33	
15	Factors considered during preparation of estimates	4	2.9	77	

Practical Exercises:

SN	Title
1.	Study of different types of rocks.
2.	Study of water absorption of stone and brick materials.
3.	Determination of soundness of cement by Lechatelier apparatus.
4.	To determine fineness of cement.
5.	Test of adhesiveness of mortar to building units.
6.	To determine standard consistency of cement.
7.	To determine initial setting time of cement.
8.	To test workability of cement by Slump cone method.

9.	To test workability of cement by Compaction factor method.
10.	Determination of Bulking of sand and silt content in the sand.
11.	To determine void ratio and bulk density of fine aggregate and course aggregate.
12.	Study of market forms of timber.
13.	Measurement of components of an agricultural structure.
14.	Preparation of an estimate of agricultural structure.
15.	Visit to a construction site and to brick kiln / cement factory/ stone quarry / other building material.

Suggested readings:-

Author	Year	Title	Publisher
Text Book			
P.C. Verghese	2005	Building Materials	PHI Learning Private Limited, M-97, Connaught Circus, New Delhi – 110001
S.C. Rangwala	2007	Building Construction	Charotar Publishing House, Oppo. Amul Dairy, Court road, Anand – 388001
B.N. Dutta	1993	Estimating and Costing in Civil Engineering – Theory and Practice	UBS publishers' Distributors Ltd., 5 Ansari Road, New Delhi – 110002
M. Chakraborti	2012	Estimating, Costing, Specification and Valuation in Civil Engineering	Monojit Chakraborti, 21 B, Bhabananda, Kolkatta – 700026
Reference Books			
Punmia B.C. Ashok Kumar Jain and Arun Kumar Jain	2000	Building Construction	Laxmi Publications (P) ltd., New Delhi
Duggal S K	2000	Building material	New Age International Publishers
Sane Y.S	2000	Planning and Designing of Buildings	Charotar Publishing House, Anand
Rangwala S C	1994	Engineering Materials	Charotar Publishing House, Anand

Course No. FS-355	**Course Title** :- Agricultural Structures, Storage Engineering and Environmental Control
Semester:- V	**Credits:-** 3(2+1)

Syllabus

Theory

Planning and layout of farmstead. 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. Design, construction and cost estimation of farm structures; animal shelters, compost pit, fodder silo, fencing and implement sheds, barn for cows, buffalo, poultry, etc. 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. 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 structures.

Teaching schedule theory with weightages(%)

Lect. No.	Topic	Book No.	Article No.	Page No.	Weightage
1	Farmstead planning- introduction, location, size and arrangement. Defects in traditional houses	1	-	568 to 572	25%
2	Improved farm house design.	1	-	572 to 576	
3-4	Dairy barn- types and equipments.	1	-	606 to 613	
5	Milking center- milking parlour and milk room	2	-	546 to 550	
6	Types of poultry houses	1	12.8	617 to 623	
9-10	Housing for pullet rearing and boiler production, site selection and building design, environmental control, brooder	2	-	579-584	25%

	and growing house operation, laying house operation, lighting and miscellaneous features.				
11	Sheep housing	1	-	627 to 630	
12-13	Hay, grain and silage storage.	2	-	447 to 461	
14-15	Causes of spoilage, water activity for low and high moisture food	1			
16-17	Feed storage, existing grain storage methods, Requirements of good storage structures, bag storage structures; indigenous storage structures – Bukhari, Morai and Kothar; CAP, hermetic storage, Grain bins – cylindrical, rectangular and Pusa bin.	1	13.4 to 13.10	661 to 674	
18-19	Moisture and temperature changes in grain bin, Shallow and deep bin, calculation of pressure in bins	1			25%
20	Farm Machinery storage structures	1	-	700 to 701	
21-22	Fencing types, farm gates, fencing post.	1	-	590-599	
23-25	Sources of water supply (in brief); Standard of quality of water and bacteriological standards; Water treatment process – impurities in water, objects of treatment, treatment process; Disinfection of rural water supplies.	3	3.7 to 3.10, 6.19 to 6.20, 11.1 to 11.4 and 18.6	46 to 54, 176 to 178, 290 to 293 and 437 to 442	
26-27	Rural sanitation – heads, latrines or privies; Septic tanks- domestic and municipal, design of septic tank.	3	25.1 to 25.3, 22.1 to 22.5	430 to 437 and 387 to 392	25%
28-29	Effects of thermal and gaseous environmental on livestock - Introduction, homoeothermy, energy balance and effects of temperature, humidity, air velocity and air contaminants.	4	-	121 to 156	
30-31	Quantity of air flow for livestock ventilation – fundamental equations, moisture balance, selection of values, and problems on minimum, medium and maximum ventilation rate.	4	-	169 to 190	

List of practicals:

1 Study of different instruments for measurement of environmental parameters.
2 Problems on quantity of air flow for livestock ventilation.
3 Planning and layout of dairy buildings.
4 Planning and layout of poultry buildings.
5 Planning and layout of sheep / goat house.
6 Design of farm fencing system.
7 Design of pit silo for fodder storage.
8 Design of trench silo for fodder storage.
9 Design of bag storage structure.
10 Planning and layout of implement shed.
11 Visit report on local dairy / poultry site.

List of Books:

1. Principles of Agricultural Engineering Volume-I, by T.P. Ojha and A.M. Michael, Jain Brothers, New Delhi-110005 (Fourth edition, 2003)
2. Agricultural Buildings and Structures, by James A. Lindley and James H. Whitakar, The Society for Engineering in Agricultural, Food and Biological Systems (ASAE), USA. Revised Edition of 1996.
3. Water Supply and Sanitary Engineering, by Gurucharan Singh, Standard Publishers Distributors, Delhi. (Fifth Edition, 1999).
4. Ventilation of Agricultural Structures, by Mylo A Hellickson and John N. Walker, An ASAE monograph number 6 in a series published by ASAE, USA (1983).

Reference Books:

1. Pandey, P.H. Principles and practices of Agricultural Structures and Environmental Control, Kalyani Publishers, Ludhiana.
2. Ojha, T.P and Michael, A.M. Principles of Agricultural Engineering, Vol. I, Jain Brothers, Karol Bag, New Delhi.
3. Nathonson, J.A. Basic Environmental Technology, Prentice Hall of India, New Delhi.
4. Venugopal Rao, P. Text Book of Environmental Engineering, Prentice Hall of India, New Delhi.
5. Garg, S.K. Water Supply Engineering, Khanna Publishers, New Delhi-6.
6. Dutta, B.N. Estimating and Costing in Civil Engineering, Duttta & CO, Lucknow.
7. Khanna, P.N. Indian Practical Civil Engineer's Hand Book, Engineer's Publishers, New Delhi.
8. Banerjee, G.C. A Text Book of Animal Husbandry, Oxford IBH Publishing Co, New Delhi.

VIIIthSemester

Module-III	**: Design and Development of Advanced Agricultural Structures.**
Course No.	**:**
Course Title	**: Design and Development of Advanced Agricultural Structures.**
Credit	**: 10 (0+10)**
Nodal Department	**: Farm Structures.**

Objectives:

1. To acquaint the students in the field of Farm Structures & Environmental Control.
2. To acquaint the students for different Structural Design operations.
3. To estimate the cost operations of different Structural Designs.
4. Economic analysis of different Farm Structures and Instruments.

Outline of the Course:

- The students will be trained to Design different types of Farm Structures in various region, and Estimate the Cost of structures.
- Different Structures like construction of poly house, Green-house, Construction of Dairy barn by using hallow tumbler tiles as roofing material and Construction of Low cost housing by using tumbler tiles as roofing materials for farmers. Also design and development of hydroponic Structures, Design of different types of grain Storage Structures. Practically students will do Construction of these structures in field.

- Construction of structural operations like layout, Excavation, Concreting, Fixing of Net, Errection of shadenet. Preparation of Design and drawings for structures like Hydroponics aeroponics,Shadenet,polyhouse,dairy barn and Errection and Layout these structures will be taught.

- The different equipments /machines like Compression testing machine and Handling Universal testing machine, CO2 analyser ,P^H Meter for testing quality of irrigation water, weighing balance, R_H meter, Lux meter for measuring light intensity. Theseequipment's will also be demonstrated and evaluated for their performance.]

INDEX

	Difference locking wires from all side.	
7	**Door frame**: □ Use, function, type, adjustment and their field operation. □ Use, function of Providing and fixing door frame of approved size for entrance area of shadenet house.	36-40
8	**Concrete for foundation**:- Importance, use, function of Providing and casting in situ CC 1:2:4 of trap metal for foundation and bedding.	41-50
9	**Main pipes and Internal pipes**: □ Use, function, type, construction, importance ,providing and fixing of G.I pipes 50mm dia having ISI mark. Providing Internal pipes 40mm dia G.I pipes with hold fast 16cm length with necessary welding.	51-60
10	□ **Insect proof Film** Importance and necessity of Providing Insect proof film for net house.	
11	**Purlins at Top:** □ Function and strength of Providing purlins medium gauge of 32mm dia. for bracing with necessary bending joint.	61-65
12	**Fogger system**: □ Application of four way antileakfoggers with 28lph,pvc pipes of 6kg/cm^2 pressure ratings of various sizes,common disc fiIterpvc ball valves,flush valve for flushing of sub mains. Drip system Pvc pipes 4kg/cm2, fittings. Providing electric motor of 1Hp. Proving 6 feet desert cooler and exhaust fan.	66-70
13	**Anticorrosive paint** Importance, function, application of Providing and applying anticorrosive colour wash of approved colour and shade in 3 coats to new surface of main pipes of nethouse.	71-75
14	Periodical maintenance of Net house polyhouse and dairy barn Structures.	76-80
15	**Design and Maintenance of Storage Structure** Types, Importance , Limitation Design of Various Storage Structure, Silo, Bag Storage , Godowns, Warehouses and it Study Selection of materials for construction of shadnet.	81-85
16	Hydroponic structures- Types, importance, limitation, status in India.	86-90
17	Study of Hydroponic structures	91-95

	Nutrition requirements, automation system. Use, function, construction, demonstration and its important.	
18	Designing of Hydroponic structures for vidhrabha region.	96-100
19	Study of cropping pattern inside a shednet.	111-115
20	Estimation of Construction cost of Structure, Hydroponic System and Storage Structure	116-120
21	Preparation of bank loan proposal for Construction of Structure, Hydroponic System,Shadenethouse,polyhouse and Storage Structure.	121-125
22	Record keeping at Storage Structure	126-130
23	Visit to Farm Structures Construction Material manufacturing industries.	131-135
24	Information regarding various government schemes related to farm Structures.	136-160
25	Preparation of information for bulletins, leaflets, posters etc. Demonstration of Different farm Structure and Hydroponic System to the farmers	161-165
26	Report writing and Semester End Examination	166-170

VIIIthSemester

Module-III : Production of Tiles
Course No. :
Course Title : Production of Tiles
Credit : 10 (0+10)
Nodal Department : Farm Structures.

Scope:

Agricultural engineering education is the bridge between engineering and agricultural science. The application of the technological knowledge helps in enhancement of agricultural production and productivity in the country. Agricultural Structures are playing very important role in Indian agriculture by providing control atmospheric condition for proper growth of crop, better quality produce and increase yield and economic growth of Farmer. Agricultural engineering graduates have to play a major role in improvement in country's agricultural picture by increasing productivity, production and economic returns to the farmers. The knowledge of Farm Structures is applicable to the entrepreneurship as well as to the end users. Hence the students offering agricultural engineering courses should be trained in such a way that their practical knowledge in the discipline of Farm Structures will be applied to the industry sector, entrepreneurship development, increasing job opportunities to the graduates and also in farming sector.

The Dr PDKV,Akola has been involved in developing the different structures and low cost housing roofing materials for farmers. More than Three structures are recommended by this university. Most of the Structures are made available to the farmers of Maharashtra through Govt. subsidy program. Taking the advantages of infrastructural facilities of college Laboratory and strengthening them, the construction activities of the Structures viz.Preparation ofdifferent hallow tumbler tiles, their shapes, sizes and different composition by using agricultural residue will be taken as an experience learning if the students of B.Tech(Agril.Engg) final year are given exposure to work on the floor of construction. It will help to the students to build up their confidence, facilitate skill development through experiential learning and will be useful in becoming job provider rather than job seeker. With this view experience learning program for the students of the final year of B.Tech (Agril. Engg.) Students for six months are planned. The objectives of the same are as listed below.

Objectives:

1. To impart practical knowledge, aspect of design, low cost construction roof by manufacturing tumbler tiles.
2. To impart training and entrepreneurial skills in construction of diary barn structures and low cost structures, storage structures for self-reliance.

Credit hours and syllabus

S.No	Contact Units	Particular of lecture practical
A		**Basic of design andmanufacturing of tumbler tiles.**
1	02	Basic information about different low cost structures, raw Material (agriculture residue), their specifications.
2	01	
3	02	
B		**Design and Construction of Dairy Barn roofing Material.**
1	02	Collection of Soil and Agricultural Residue saw dust,grount nut shell,ricehusk,coconutfiber as raw material.
2	02	Mixing soil and agriculture residue with proper proportion.
3	04	Manufacturing of different sizes of tumbler tiles.
4	02	Preparation of roof for dairy barn structure.
5	02	Mortaring the Gap between the tumbler tiles.
6	04	Curing of Roof
7	02	Quality inspection and lab testing
C		**Design and Construction of Storage Structure.**
1	02	Designing
2	04	Location
3	02	Construction
4	04	Flooring with glass wool as insulting material
5	03	Quality inspection.
D		**Design and Construction of roof for Low Cost Housing.**
1	06	Foundation
2	05	Errection of Structure
3	02	Manufacturing of tumbler tiles for roofing material
4	03	Sides wall by using hollow bricks
5	02	Labour cost and mis. Items
6	02	Quality inspection and lab testing
		Report preparation and Examinations
1	04	Report preparation
2	01	Report preparation
Total	106	

* Contact unit: 1 unit =8 hrs

A		**Design and Construction of shadenet.**
1	02	Foundation

2	03	Errection of Structure
3	02	Cladding(Covering) Material
4	02	Net Fixing Devices
5	01	Labour cost and mis. Items
B		**Design and Construction of polyhouse.**
1	02	Foundation
2	03	Errection of Structure
3	02	Cladding(Covering) Material
4	02	Net Fixing Devices
5	01	Labour cost and mis. Items
C		**Design and Construction of Hydroponic Structure.**
1	05	Designing
2	01	Foundation
3	02	Assembly
4	02	Fogger, Mister,Electric Pump and Water tank Fitting
5	04	Placing of Trays
6	01	Quality inspection and lab testing

Model Performa for Experiential Learning

Testing of Engineering Materials

1	**Name of University**	:	Vasantrao Naik Marathwada Krishi Vidyapeeth ,Parbhani(Maharashtra)
2	**Title of Unit**	:	**Testing of Engineering Materials**
3	**Name of College and Address**	:	College of Agricultura l Engineering and Technology, VNMKV,Parbhani, Maharashtra
4	**Organisational set up :**		

Chief Executive Officer	Dr. A.S.Kadale	The Associate Dean and Principal College of Agricultural Engineering and Technology, Parbhani	Arrange for registration, Monthly Monitoring	

Managing Director/Testing Officer	Er. S.D.Vikhe	Asstt.Professor of Civil Engineering, Department of Farm Structures, College of Agricultural Engineering and Technology, Parbhani	Orientation, Person identification, twice in a week monitoring	

5. **Scope and Objectives**

Scope:

Quality of building materials could be achieved through proper testing. Engineering materials such as stones, bricks, plastics, concrete, cement, soil, steel, various components of green house and shade net houses need to be test for various quality parameters because now a days govt. sanction lot of grants for farmers for protected cultivation.

Objectives:

1. To conduct hands on training on testing procedure for various materials.
2. To create awareness regarding quality of material among stakeholders

6. **Production Plan and Activity : ----**

7a. Infrastructure required with cost (Head: *Up-gradation and strengthening of facilities)*

S.No.	Particulars	Cost (Rs.)	Justification
1	Equipments	30,00,000	Develop lab facility for 20 students
2	Furniture	5,00,000	
3	Miscellaneous	1,00,000	
Total		36,00,000	

7b. List of equipment / machinery required (Head: *Equipments and machinery – requiring modernization and fresh purchases)*

7c. Other infrastructure facilities required with cost (Head: *Up-gradation and strengthening of facilities)*
(such as storage space / cold storage facility / power supply equipments, etc

may be listed along with the cost

S.No.	Particulars	Cost (Rs.)
1	Power Generator	10,00,000
2	Inverters	2,00,000

	Total	12,00,000

7d. Recurring contingency required (Head: *Running costs and contractual support*)

S.No.	Particulars	Cost (Rs.)
1	Hardware material	1,00,000
2	Contractual Services	1,00,000
	Total	2,00,000

7e. Total budget required

SN	Particulars	Head	Cost (Rs.)
6a	Infrastructure	Up-gradation and strengthening of facilities	36,00,000
6b	Equipment/Machineries	Equipment and machinery	12,00,000
6c	Other Infrastructures (eg. Power units)	Up-gradation and strengthening of facilities	2,00,000
6d	Recurring contingencies	Running cost and contractual support	6,00,000
		Total	**56,00,000**

8. Production Targets :

Testing of all engineering materials including green house components

9. **Economics (Tentative):**

Tentative expected Profit and loss Statement is as follows:

SN	Activity Production	Cost/ Expenditure, Rs.	Gross Income through sales, Rs.	Net Profit	Profit share of students	
					Students	Department
1	Testing	2,00,000	4,00,000	2,00,000	1,00,000	1,00,000
Total		2,00,000	4,00,000	2,00,000	1,00,000	1,00,000

<table>
<tr><td>10.</td><td colspan="3">Marketing Strategy/Plan :
Customer will be beneficiary farmers of green house/shade net.
PWD, Z.P, Rural water supply department, University Engineering Office</td></tr>
<tr><td>11.</td><td colspan="3">Risk Assessment:</td></tr>
<tr><td></td><td colspan="3">1. Searching of customer.
2. Skilled technitian</td></tr>
<tr><td>12.</td><td>Monitoring and Evaluation of the EL Unit:
(Give details of inbuilt mechanism)</td><td>:</td><td>The EL unit will be continuously monitored by the CEO, MD and Manager. Proper documentation will be maintained. Production line will work in co-ordination of Marketing team.</td></tr>
<tr><td>13.</td><td>Student Evaluation:
(Attendance, Targets etc)</td><td>:</td><td>The criteria of minimum 85% attendance will be followed. Monthly attendance will be reported to CEO. Daily production targets will be given to students.</td></tr>
<tr><td>14.</td><td>Credit hours /Syllabus</td><td>:</td><td>
<table>
<tr><th>EL Activity</th><th>Credits</th></tr>
<tr><td>Developing a Business Plan</td><td>1</td></tr>
<tr><td>Plan for the Production/testing</td><td>1</td></tr>
<tr><td>Production & Sales/testing</td><td>12</td></tr>
<tr><td>Sales/testing</td><td>5</td></tr>
<tr><td>Documentation and Reports, Presentation and Oral Examination</td><td>1</td></tr>
<tr><td>Total Credits</td><td>20</td></tr>
</table>
</td></tr>
<tr><td>15.</td><td>Prospective private enterprises for proposed partnership</td><td>:</td><td>NIL</td></tr>
<tr><td>16.</td><td>Product, production and marketing</td><td>:</td><td>NA</td></tr>
</table>

	related legal aspects, if any		
17.	**Budgetary requirements (For Five Years duration) :**		

SN	Particulars	Qty.	Rate (Rs.)	Amount (Rs.)
1.	**Recurring Contingencies**	1	LS	5,00,000
2.	**Non-recurring**	1	LS	80,00,000
3	**Miscellaneous** (labour, repairing, office expenses, POL, advanced training skills, honorarium, Institutional charges etc.)	1	LS	15,00,000
4	**Revolving Fund**	-	-	
			Grand Total	**1,00,00,000**
	(In Figures) – Rs. 1,00,00,000 **(In Words) – Rs. One Crore only**			

18.	**Proposed funding from other sources**	**:**	**NIL**
19.	**Attach a brief profile of the core faculty with reference to this programme:**	**:**	Er. S D Vikhe, Asstt.Professor of Civil Engineering, Department of Farm Structures, College of Agricultural Engineering and Technology, Parbhani, has 25 years experience in related field moreover he has also worked as testing officer for materials .He is also handling additional charge of Deputy University Engineer in VNMKV,Parbhani.
20.	**Any other information**	**:**	• The resource persons would be called from PWD department ,SGGS College Nanded and Govt.College of Engg,Aurangabad • **Output of the Experimental Learning Unit** • Quality material will be selected for construction hence life of structure will increase. • Students will familier with testing procedure and

			IS provisions. • Revenue will be generated.

S D Vikhe
Asstt.Professor of Civil Engineering, Department of Farm Structures, College of Agricultural Engineering and Technology, Parbhani

Dr. A.S.Kadale
The Associate Dean
College of Agricultural Engineering and Technology, Parbhani

Director of Instructions
VNMKV,Parbhani

Date: 13/07/2017

Place : Parthian

FMPE

Course No: ELE- FMPE 481 **Course Title: Testing of Agril. Equipment and Machinery**
Semester:- VIII **Credit: 3 (1 + 2)**

Syallabus

Theory

Introduction of BIS and RNAM testing systems, their functions, activities, advantages of certification. General guidelines on use test code. Types of testing systems currently invoke in country. Testing and evaluation of tillage machinery, Testing and evaluation of seed drill and transplanter. Testing and evaluation of harvesting and threshing machinery, Testing and evaluation of plant protection equipment's, Testing and evaluation of Agril.Tractor.

Practical

Testing of bullock/tractor drawn M.B.plough, disk harrow, tractor drawn cultivator, tractor drawn rotavator, bullock/tractor drawn seed drill/Planter, bullock/tractor drawn pudler, preparation of nursery for paddy transplanting. Testing of self propelled power tiller operated paddy transplanter, manually operated weeders, (dryland/ paddy), manually operated fruit harvesters, sickle, manually operated knapsack sprayer, portable engine operated sprayer, self propelled reaper, power thresher, stationary engine, visit to tractor testing centre.

Teaching schedule- Theory with weightages (%)

Unit No.	Lect. No	Topic/s	Weightages%
I	1	Introduction of BIS and RNAM testing systems, General guidelines on use of test code	25

	2	Types of testing systems	
	13-16	Tractor testing general regulations, terminology, testing procedure, PTO performance, drawbar performance, hydraulic lift, safety test.	
II	3	Testing of tillage machinery. Introduction, testing procedure, laboratory test, and field test of plough and cultivator.	25
	4	Testing of rotavator and puddler, testing procedure. Laboratory test, and field test.	
III	5	Testing of sowing, planting machinery, types of test. General condition, testing procedure, laboratory test, and field test of tractor drawn planter.	25
	6	Testing of paddy transplanter. Scope, terminology.	
	7	Testing of manually operated weeders, general condition, testing procedure, laboratory test, and field test.	
IV	10-11	Testing of plant protection equipments: type of test for sprayer, testing methods, laboratory test, and field test.	25
	8-9	Testing of harvesting equipments, sickles and reapers, testing procedure, laboratory test, and field test.	
	12	Testing of power thresher, terminology, type of tests. Performance test.	

Practical Exercises

Exercises No.	**Title**
1-2	Testing of bullock/tractor drawn M.B. Plough
3-4	Testing of disc harrow
5-6	Testing of tractor drawn cultivator
7-8	Testing of tractor drawn rotavator
9-10	Testing of bullock/tractor drawn seed drill/Planter
11-12	Testing of bullock/tractor drawn pudler
13	Preparation of Nursery for paddy transplanter
14-15	Testing of self propelled power tiller operated paddy transplanter
16	Testing of manually operated weeders, (dryland/paddy)
17	Testing of manually operated fruit harvesters
18	Testing of sickle
19-20	Testing of manually operated knapsack sprayer
21-22	Testing of portable engine operated sprayer
23-24	Testing of self propelled reaper
25-26	Testing of power thresher
27-28	Testing of stationary engine
29-32	Visit to tractor testing centre

Suggested readings
Text Books:

1. Testing and evaluation of Agril. Machinery by M.L.Mehta, S.R.Verma, S.K. Mishra and V.K.Sharma. Daya publishing house, Delhi-2005 edition.
2. RNAM Test Codes and Procedures for Farm Machinery, Technical Series No.12, 2nd Edition, 1995.
3. I.S. Specifications for Animal Drawn Puddler. UDC : 631. Manak Bhavan, 9, BahadurShahaZafar Marg. New Delhi-1, February 1966.

Course No. : - ELE- FMPE 482 **Course Title:-Human Engineering and Safety**
Credit:-3 (2+1) **Semester:- VIII**

Syllabus

Theory: Human factors in system development- Basic processes in system development, Separation of system function, Concept of systems,Performance reliability, Human performance, Information input process, Visual displays- major types & use of displays, Auditory & Tactual displays, Speech communications, Biomechanics of motion- types of movements, range of movements, strength & endurance, Speed & accuracy, Human control of systems, Human motor activities, Controls, tools & related devices, Anthropometry- arrangement & utilization of work space, Atmospheric conditions - heat exchange process & performance, Air pollution, Dangerous machine (Regulation) act. Rehabilitation and compensation to accident victims, Safety gadgets for spraying, threshing chaff cutting and tractor & trailer operation.

Practical: Collection of Anthropometric measurements of a selected group of farm workers and its statistical analysis, application of anthropometric and strength data in farm equipment design, Use of heart rate monitor.Study of computerized bicycle ergometer and calibration of the subject in laboratory using bi-cycle ergometer.Study and Calibration of the subject in laboratory using mechanical tread mill, Study of general fatigue of the subject using Blink ratio method, Familiarization with electro-myograph equipment, Familiarization with the noise & vibration equipment, Optimum work space layout and locations of controls for different tractors. Familiarization with safety gadgets for various farm machines.

Teaching schedule- Theory with weightages (%)

Unit	Lecture No.	Topic	Weightage
1	1 & 2	**Human factors in system development** Basic processes in system development	**10**
	3	**Separation of system function**	
	4	**Concept of systems**	
2	5	**Performance reliability** Human performance	**10**
	6	Information input process	
3	7	**Visual displays** major types & use of displays	**10**
	8 and 9	**Auditory & Tactual displays**	
4 and 5	10& 11	**Speech communications**	**10**
	12, 13 and 14	**Biomechanics of motion** types of movements range of movements strength & endurance	
	15	**Speed & accuracy**	
6	16 and 17	**Human control of systems**	**10**
	18 and 19	**Human motor activities**	
7	20,21 and 22	**Controls, tools & related devices**	**10**
8	23, 24 and 25	**Anthropometry** Arrangement & utilization of work space	**10**
9	26	**Atmospheric conditions** heat exchange process & performance	**10**
	27	**Air pollution**	
	28	**Dangerous machine (Regulation) act.**	
10	29	**Rehabilitation and compensation to accident victims**	**10**
	30,31,32	**Safety gadgets** for spraying, threshing chaff cutting and tractor & trailer operation	

Teaching Shedule

Sr. No.	Lecture No.	Topic	Weightage of marks, %	Book No.	Chap. No.	Page No.
1.	1 & 2	Human factors in system development Basic processes in system development	10	1	2	17-29
2	3	Separation of system function		1	2	19-22
3	4	Concept of systems	5	1	1	5-6
4	5	Performance reliability Human performance	5	1 1	2 2	31-32 35-37
5	6	Information input process	5	1	4	83-87
6	7	Visual displays major types & use of displays	10	1	5	129 to133
7	8 and 9	Auditory & Tactual displays	5	1	6	185 to 194 195 to 199
8	10& 11	Speech communications	5	1	7	201 to 211
9	12, 13 and 14	Biomechanics of motion types of movements range of movements strength & endurance	10	1	10	300 to 301 303 to 310
10	15	Speed & accuracy		1	10	310 to 313
11	16 and 17	Human control of systems	5	1	9	251 to 261
12	18 and 19	Human motor activities	5	1	10	283 to 290
13	20,21 and 22	Controls, tools & related devices	5	1	11	335 to 346 and 374 to 379
14	23, 24 and 25	Anthropometry Arrangement & utilization of work space	10	1	12	385 to 391 392 to 395
15	26	Atmospheric conditions heat exchange process & performance	5	1	15	479 to 487
16	27	Air pollution		1	15	500 to 510

17	28	Dangerous machine (Regulation) act.	5	3		1-14
18	29	Rehabilitation and compensation to accident victims	5	2	7	33 to 34
19	30,31,32	Safety gadgets for spraying, threshing chaff cutting and tractor & trailer operation	5	2	5	29 to 30

Practical Exercises

Exercises No.	Topic
1 & 2	Collection of Anthropometric measurements of a selected group of farm workers and its statistical analysis.
3	Anthropometric considerations in Tool/Equipment design and the application of anthropometric and strength data in farm equipment design
4	Use of heart rate monitor.
5& 6	Study of computerized bicycle ergometer and calibration of the subject in laboratory using bi-cycle ergometer as loading device and energy measurement device (k4b2)
6 & 7	Study of mechanical tread mill and Calibration of the subject in laboratory using mechanical tread mill as loading device and energy measurement device (k4b2)
8	Study of general fatigue of the subject using Blank ratio method.
9	Study of electromyography.
10 & 11	Study of noise and vibration and Familiarization of the noise & vibration equipment,
12 & 13	Study of optimum work space layout and locations of controls for different tractors.
14	Ergonomical consideration in workplace design
15 & 16	Assessment of postural discomfort by subject rating scales

Suggested readings

Text Books:

Sr. No. **Name of Book and Publisher**

1 Human Factors Engineering and Design
by Ernest J. Mc. Cormick, 4th Edition (1976)
Tata McGraw-Hill Publishing Company Limited, New Delhi

2 Package of Farm Safety Measures in Madhya Pradesh (2012)
AICRP on Ergonomics & Safety in Agriculture, CIAE, Bhopal

3 The Dangerous Machines (Regulation) Act, 1983 (35 of 1983), Ministry of Law, Justice and Company Affairs, Government of India.

4 Anthropometric and Strength Data of Indian Agricultural Workers for Farm Equipment Design
By L.P.Gite, J Majumder, C.R.Mehta and AbhijitKhadatkar,
AICRP on Ergonomics & Safety in Agriculture, CIAE, Bhopal

Reference Books

Sr. No.	Name of Book and Publisher
1	Fitting the task to the man- An Ergonomic Approach By E. Grandjean, Taylor & Francis Limited, London (Reprint-1982)
2	Ergonomics – Man in his working Environment By K.F.H. Murrell. Chapman & Hall Limited, London (1965)
3	Human Factors Engineering and Design by Mark S. Sanders &Ernest J. Mc. Cormick, (1993) Tata McGraw-Hill Publishing Company Limited, New Delhi
4	Textbook of Work Physiology. By Astrand P. &Rohahl K. (1997). Tata McGraw-Hill Publishing Company Limited, New Delhi

Course No: FMPE 123 **Course Title: Workshop Technology**

Credit: 1+1=2 **Semester- II**

Syllabus

Theory

Iron carbon phase diagram, lattice type, ferrous and non-ferrous metals and their alloys, Heat treatment: Introduction, purpose, method, Annealing, Normalizing, Hardening, case hardening, carburizing, nitriding, cyniding, flame hardening, quenching. Introduction to welding, types of welding, Oxyacetylene gas welding, types of flames, welding techniques and equipment.

Principle of arc welding, equipment and tools. Casting processes; Classification, constructional details of center lathe, Main accessories and attachments. Main operations and tools used on center lathes. Types of shapers, Constructional details of standard shaper. Work holding devices, shaper tools and main operations. Types of drilling machines. Constructional details of pillar types and radial drilling machines. Work holding and tool holding devices. Main operations. Twist drills, drill angles and sizes. Types and classification. Constructional details and principles of operation of column and knee type universal milling machines. Plain milling cutter. Main operations on milling machine.

Practical

Preparation of simple joints: Cross half Lap joint and T-Halving joint; Preparation of Dovetail joint, Mortise and tenor joint; Jobs on Bending, shaping etc.; Jobs on Drawing, Punching, Rivetting. Introduction to tools and measuring instruments for fitting; Jobs on sawing, filing and right angle fitting of MS Flat; Practical in more complex fitting job; Operations of drilling,, reaming, and threading with tap and dies; Introduction to tools and operations in sheet metal work; Making different types of sheet metal joints using G.I. sheets. Introduction to welding equipment, processes tools, their use and precautions; Jobs on ARC welding – Lap joint, butt joint; T-Joint and corner joint in Arc welding; Gas welding Practice – Lab, butt and T-Joints; Introduction to metal casting equipment, tools and their use; Mould making using one-piece pattern and two pieces pattern; Demonstration of mould making using sweep pattern, and match plate patterns; Introduction to machine shop machines and tools; Demonstration on Processes in machining and use of measuring instruments; Practical jobs on simple turning, step turning; Practical job on taper turning, drilling and threading; Operations on shaper and planer, changing a round MS rod into square section on a shaper; Demonstration of important operations on a milling machine, making a plot, gear tooth forming and indexing; Any additional job.

Lesson Plan

Lec. No.	Topic	Book	Chapter	Article no.	Page no
1	Types of lattice, Iron carbon equilibrium diagram	A	2	2.3 2.12-2.13	23-24 36-39
2-3	Ferrous metal and alloys	A	4	4-2, 4.4-	61-63,

4	Nonferrous, metal and alloys	A	5	4.6 5-2-5.10	64-74 103-112
5-6	Heat treatment: Introduction, purpose, method, Annealing, Normalizing, Hardening, case hardening, carburizing, nitriding, cyniding, flame hardening, quenching.	A	6	6.5 - 6.18	125 - 149
7-8	Foundry: Pattern making tools, types of pattern, pattern making. Allowances, types of molding sand, making of greensand mould, defects in casting	A	11	11.3-11.5 11.13, 11.21, 11.36	311-322 341 357-359 419-422
9	Welding: Arc welding methods. Defects in welding and precautions	A C	9 9	9.10 9.54	223-241
10-11	Lathe machine: Types and classification	B	3	3.1-3.4	83-88
12-13	Shaper: types and classification shaper operation	B	7	7.1-7.2, 7.7	297-299, 315-319
14-15	Milling machine- types and classification, operation	B	11	11.1-11.2	399-400
16	Drilling machine and classification operation	B	5	5.1-5.10	227-233

Teaching schedule- Theory with weightages (%)

Unit No.	Lectures No.	Topic	Weightages (%)
I	1	Types of lattice, Iron carbon equilibrium diagram	20
	2-3	Ferrous metal and alloys	
	4	Nonferrous, metal and alloys	
II	5-6	Heat treatment: Introduction, purpose, method, Annealing, Normalizing, Hardening, case hardening, carburizing, nitriding, cyniding, flame hardening, quenching.	30
	7-8	Foundry: Pattern making tools, types of pattern, pattern making. Allowances, types of molding sand, making of greensand mould, defects in casting	
III	9-10	Welding: Arc welding methods. Defects in welding and precautions	10
IV	11-12	Lathe machine: Types and classification	40
	13-14	Shaper: types and classification shaper operation	
	15	Milling machine- types and classification, operation	
	16	Drilling machine and classification operation	

Practical

Sr. No.	Practical No.	Title of practical
	Jobs on Lathe Machine	
1.	1-2	Study of facing operations on the given job.
2.	3	Study of step turning operation on the given job.
3.	4	Study of taper turning operation on the given job.
4.	5	Study of knurling operation on the given job.
5.	6-7	Study of internal and external threading operation on the given job.
6.	8	Introduction and demonstration to CNC machine.
	Jobs on Shaping Machine	
7.	9	Study of surface planning operation on shaping machine.
8.	10-11	Study of slotting operation for making key slot on the given job.
9.	**Jobs on Milling Machine**	
10.	12-13	To make hexagonal head on given job with the milling machine.
	Jobs on Drilling Machine	
11.	14-15	Jobs on drilling, reaming, internal threading and countersunk operations.
12.	16	Visit to manufacturing industry.

Suggested readings

A. Elements of workshop technology, VOl I: manufacturing process by S.K. Hajra Choudhary, A.K.Hajra Choudhary, Nirjhar Ray, In collaboration with Prof. D.C, Bhattacharya (Fifteenth Edition) Media Promotors and Publishers Pvt. Ltd.

B. Elements of workshop technology, VOl II: Machine Tools by S.K. Hajra Choudhary, A.K.Hajra Choudhary, Nirjhar Ray, In collaboration with Prof. D.C, Bhattacharya (Fifteenth Edition) Media Promotors and Publishers Pvt. Ltd.
C. Production technology by R.K. Jain, Khanna Publishers Delhi. (Fifteenth Edition).

Course No: FMPE-246 **Title: Tractor Systems and Controls**
Sem: IV **Credit: 2 (1+1)**

Theory:
Classification of tractors. Study of transmission systems, clutch- need, gear box, differential and final drive mechanism Familiarization of brake mechanism. Steering system, types, steering gear box, Ackerman and hydraulic steering and hydraulic systems. Tractor power outlets: P.T.O., belt pulley, drawbar, etc. Tractor chassis mechanics and design for tractor stability. Introduction to tractor testing Ergonomic considerations and operational safety.

Practical: Introduction to transmission systems and components; Study of clutch functioning, parts , 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 systems, types, steering gear box, principles of operations, Steering geometry and adjustments; Study of hydraulic systems in a tractor, hydraulic trailer; Traction performance of a tractor wheel; Finding C.G. of a tractor by weighing technique; Finding CG of a tractor using suspension/balancing techniques; Finding moment of Inertia of a tractor; Ergonomic considerations and operational safety.

Lesson Plan

Sr. No.	Lecture No.	Topic	Art. No./Page
1.	1 - 2	Classification of tractors. Study of transmission system-Clutch: Function, principle of operation, clutch system, working of single plate system, detail of components, working of dual clutch plate & clutch adjustment Types of clutch system, multiple plate clutch, cone clutch, dog clutch, fluid coupling	J-11.1 to 11.7 S-141to 143
2.	3	Gear Box : Introduction, principle of gearing, types of gar box.	J-12.1 to 12.3
3.	4	Differential : Need, function, principle of operation, operational details and differential lock, Final Drive	J-13.1 to 13.4, 13.6
4.	5-6	Brake : General classification of brake, mechanical, hydraulic brake	J-15.1 to 15.3.2
5.	7-8	Steering systems- requirement, qualities of steering system, types, main parts of steering system, types of steering boxes, steering geometry, Toe in, Ackerman steering, Toe out on turns, Toe out negative camber, king pin inclination, spindle bearing load, caster angle.	N- 18-23 N- 27-33
		Types: Single drop, double drop, Power Steering	J-173, J-14.1.5
6.	9-11	Hydraulic system of tractor, principle, main components, functions, working, implement control-draft and position	J-17.1 to 17.5
7.	12	Tractor power outlet- P.T.O., Tractor pulley, drawbar	O-4.6-4.7, 4.8
		Tyres, tubes, construction, specification and wheel ballasting	J- 16.1- 16.7
8.	13-14	Introduction to traction, terminologies, forces acting on pneumatic tyre	S-169- 173
		Tractor chassis mechanism, stability, weight transfer methods CG determination	B-307-315
10	15	Introduction to tractor testing	J-21.1-21.7
11.	16	Ergonomic and safety in tractor design. Spatial, visual and control requirement of the tractor operator	SM-12.1, 12.2, 12.4, 12.5

Teaching schedule- Theory with weightages (%)

Unit No.	Topic	Weightage, %
I	Classification of tractors. Study of transmission system-Clutch: Function, principle of operation, clutch system, working of single plate system, detail of components, working of dual clutch plate & clutch adjustment Types of clutch system, multiple plate clutch, cone clutch, dog clutch, fluid coupling	30
	Gear Box : Introduction, principle of gearing, types of gear box.	
	Differential : Need, function, principle of operation, operational details and differential lock, Final Drive	
II	Brake : General classification of brake, mechanical, hydraulic brake	35
	Steering systems- requirement, qualities of steering system, types, main parts of steering system, types of steering boxes, steering geometry, Toe in, Ackerman steering, Toe out on turns, Toe out negative camber, king pin inclination, spindle bearing load, caster angle.	
	Types: Single drop, double drop, Power Steering	
	Hydraulic system of tractor, principle, main components, functions, working, implement control-draft and position	
III	Tractor power outlet- P.T.O., Tractor pulley, drawbar Introduction to tractor testing	10
IV	Introduction to traction, terminologies, forces acting on wheel. Tyres, tubes, construction, specification and wheel ballasting.	25
	Tractor chassis mechanism, stability, weight transfer methods CG determination	
	Ergonomic and safety in tractor design. Spatial, visual and control requirement of the tractor operator	

List of Practicals :

1	Introduction to transmission system and components.
2 - 3	Study of clutch system
4 -5	Study of different types of gear box
6 -7	Study of brake system
8-9	Study of differential and final drive system.
10-11	Study of steering system, geometry and adjustments.
12-13	Study hydraulic system in tractor.
14	Introduction to tractor tyre and ballasting .
15	Appraisal of various controls of tractor in relation to anthropometric measurement.
16	Visit to Tractor repair workshop and spare part agencies.

Text Book :

1 Farm Tractor Maintenance and Repair by SC Jain & CR. Rai (J) 2nd Ed 1999.
2 Elements of Agril. Engineering by Dr. Jagdiswar Sahay (S) Third edition 1992.
3 Farm Machines & Equipment by CP Nakra, Dhankpat Rai & Sons (N) Edition 1990.
Principles of Agricultural engineering, Vol-I by T.P.Ojha and, A.M. Michael, Sixth Ed, Jain Brothers, 2012 (O)
4 Tractor and their power unit by E.L. Barger et. al. (B) (4 authors book 1st Edition, 1951).
5 Tractor and their power unit by Liljedhal J.B. et. al. (L) (4 authors book 4th Edition, 2004).
6 Design of Agricultural Tractors, by D.N. Sharma and S. Mukesh. (SM) Jain Brothers, 2010.

Course No: FMPE 111 **Title:** Engineering Drawing

Credit: 2 (0+2) **Semester: I**

Syllabus

Practical

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. Different methods of dimensioning. Concept of

sectioning. Revolved and oblique sections. 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. Nomenclature, thread profiles, multi start threads, left and right hand threads. Square headed and hexagonal nuts and bolts. Conventional representation of threads. Different types of lock nuts, studs, machine screws, cap screws and wood screws. Foundation bolts. Forms of screw threads, representation of threads, Bolts- headed centre, stud screws, set screws, butt, hexagonal and square; keys-types, taper, rank taper, hollow saddle etc.

Practical Exercises

Practical No.	Title of Sheet
1-2	**Introduction to** **Drawing Instruments , Sheet Layout ,Name plate ,Types of lines**
3-6	**Planes** Principles of orthographic projections; References planes; Points and lines in space and traces of lines and planes
7-8 9-10 11-12 13-17	**Solids a1nd Solid Surfaces** Projections of solids. Section of solids and Interpenetration of solid surfaces; Development of surfaces of geometrical solids; Isometric projection of geometrical solids
18-20	**Exercises** Preparation of working drawing from models and isometric views. Sectional drawing of simple machine parts.
21-22	**Rivets and Riveted Joints** Types of rivet heads and riveted joints. Processes for producing leak proof joints
23	**Weld Joints** Symbols for different types of welded joints.

24	**Threads** Nomenclature, thread profiles, multi start threads, left and right hand threads. Forms of screw threads, representation of threads,
25-27	**Nuts and Bolts** Square headed and hexagonal nuts and bolts Different types of lock nuts Foundation bolts
26	**Screws** cap screws and wood screws, stud screws, set screws,
27	**Keys** Types of Keys. taper, rank taper, hollow saddle etc.
28-32	**Exercise** on detail drawings of agricultural machinery assembly and equipment

Text /Reference Books

1. Bhat N D. 2010. Elementary Engineering Drawing. Charotar Publishing House Pvt. Ltd., Anand.
2. Bhatt N D and Panchal V M. 2013. Machine Drawing. Charotar Publishing House Pvt. Ltd., Anand.

Course No: FMPE 112 **Title: Workshop Practice**

Semester: I **Credit: 1(0+1)**

3. Narayana K L and Kannaiah P. 2010. Machine Drawing. Scitech Publications (India) Pvt. Ltd., Chennai.

5. Syllabus

6. Practical

7. Preparation of simple joint (wood working); Cross half Lap joint and T-Halving joint; Preparation of Dove tail joint. Mortise and tenor joint; Introduction to Smithy tools and operations; Jobs on Bending. Shaping etc; Jobs on drawing, punching. Reverting; Introduction to welding equipment; process tools ,jobs on Arc welding- lap joint ,butt joint ,Tee joint ;Introduction to tools and measuring instruments for fitting; Jobs on sawing, filing and right angle fitting of MS Flat; Practical in more complex fitting job Operations of drilling, reaming, and threading with tap and dies; Practical test; Introduction to tools and operations in sheet metal work; Making different types of sheet metal joints using G.I. sheets.

8. Practical Exercises

Exercises No.	Title
1	Study of carpentry tools, sawing and planning practice

2-3	To make (a) Butt joint (b) Tee joint by using carpentry tools
4	Introduction to hot and cold smithy tools
5-6	To make (a)Screw driver (b) Ring by using hot and cold smithy tools
7-8	Study of different welding method and their tools.
9-10	To make (a)Lap joint (b) Butt joint by using an arc welding method
11	Study of fitting tools and their uses
12-13	To make (a)Square flat (b) Triangle cut by using fitting tools
14	Study of sheet metal working tools
15-16	To make (a) Funnel (b) Cylinder

10. Suggested readings

Course No: FMPE- 234 **Titles: Farm Power and Automotive Engines**
Sem: III (New) **Credit: 2 (1+1)**

Theory:

Sources of farm power -conventional & non-conventional energy sources. Classification of tractors and IC engines. Review of thermodynamic principles of IC (CI & SI) engines and deviation from ideal cycle. Indicator diagram. Study of engine components their construction, operating principles and functions. Study of engine stroke and comparison of 2 stroke and 4 stroke engine cycle and CI and SI engines. Study of engine valve systems, valve mechanism, valve timing diagram and valve clearance adjustment. Study of importance of air cleaning system. Study of types of air cleaners. Study of fuel supply system. Study of Fuel, properties of fuels, calculation of air fuel ration. Study of tests on fuel for SI and CI engines. Study of detonation and knocking in IC engine. Study of carburetion system, carburetors and their main components. Study of fuel injection system-injection pump, their types, working principles. Fuel injector nozzles, their types and working principles. Engine governing- need of governor, governor types. 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 and properties. Study of ignition system of SI engines. Study of electrical system including battery, starting motor, battery charging, cut-out etc.

Practical:

Introduction to different systems of IC engine; Engine parts and functions, working principles etc; Valve system – study, construction and adjustments;

Air cleaning system; Fuel supply system of SI engine; Diesel injection system & timing; Cooling system, governor; Lubricating system & adjustments; Ignition system; electrical system; Calculation on diff.

horse power and cylinder pressure , specific fuel consumption and power requirement & efficiencies, air fuel ratio etc.

Lesson Plan

Lecture, No.	Topic	Book/Art.No./Page No.
1	Sources of Farm power, Conventional & non Conventional energy	M: 1.1-1.7 S:2.1-2.6
2-3	Classification of tractors, Otto cycle & diesel cycle, their efficiencies Causes for deviation from Ideal & PV diagram, & their problems, Air cycles.	L:1-8 L:37:45 M-2.1, J-1.1
4	Principle & working of four stroke & two-stroke cycle engine	J-1.3
5	IC engine components, operating principle, their function and their construction	J-1.2
6	Valve and valve mechanism, Valve arrangement, Firing order, firing interval, power balance and firing order of engines, valve timing diagram	S: 3.9 J: 4.2-4.5 J: 5.11.5
7	Intake & exhaust system, types of air cleaners	J:9.1-9.8
8-9	Fuel system : Fuel supply in petrol engine- Carburetor & it's working principle	M: 88-90 S:5.3
	Fuel supply system of diesel engine, fuel filter, injector nozzles, their types and working principles.	J-6.3 to 6.4 (75-83), 6.51-6.53
	Fuel injection system, Combustion chamber,	S:5.5-5.6
10	Cooling system: Cooling methods and main functional components	J-8.1-8.3
11	Lubrication system- needs, types, functional components. Splash & forced feed system. Combination of both, oil filters & other accessories.	J: 7.6-7.8
12	Ignition systems: Battery ignition & its components Magneto ignition, other methods of ignition	S: 8.1-8.6
13	Engine principles of governor Introductions of Principles of governor Classifications of governing system, hit & miss & throttle leave system. (Centrifugal governor, pneumatic & hydraulic governor) Governor regulations & governor hunting.	S: 6.1-6.5 M: Fig 3.20
14	Electrical system including battery chemical activity, battery charging, starting motor, cut-out etc. (in brief)	J:20.1.1-20.1.07 20.2.1- 20.2.2.1,20.2.2.2; 2.2.3-2.2.4 2.3.2-2.3.4
15	Fuel properties & qualities of fuel, tests on fuel for SI and CI engine, Detonation of IC engine	L-Pg 54-75 S-5.1
16	Properties of coolants, anti freeze material, anti corrosion materials,	L: Pg.175-178
	Types of lubricants, Oil tests Physical properties, additives and their application.	S:Pg.111-112 J-7.4-7.5

Teaching shedule theory with weightages (%)

Unit	Lecture, No.	Topic	Weightage %
I	1	Sources of Farm power, Conventional & non Conventional energy	15
	2-3	Otto cycle & diesel cycle, their efficiencies Causes for deviation from Ideal & PV diagram, & their problems, Air cycles.	
II	4	Principle & working of four stroke & two-stroke cycle engine	30
	5	IC engine components, operating principle, their function and their construction	
	6	Valve and valve mechanism, Valve arrangement, Firing order, firing interval, power balance and firing order of engines, valve timing diagram	
III	7	Intake & exhaust system, types of air cleaners	20
	8-10	Fuel properties & qualities of fuel, tests on fuel for SI and CI engine, Detonation of IC engine	
		Fuel system :Fuel supply in petrol engine- Carburetor & it's working principle	
		Fuel supply system of diesel engine, fuel filter, injector nozzles, their types and working principles. Fuel injection system, Combustion chamber,	
	11	Engine principles of governor Introductions of Principles of governor Classifications of governing system, hit & miss & throttle leave system. (Centrifugal governor, pneumatic & hydraulic governor) Governor regulations & governor hunting.	
IV	12	Properties of coolants, anti freeze material, anti corrosion materials,	20
		Cooling system: Cooling methods and main functional components	
	13-14	Types of lubricants, Oil tests Physical properties, additives and their application.	
		Lubrication system- needs, types, functional components. Splash & forced feed system. Combination of both, oil filters & other accessories.	
V	15-16	Ignition systems: Battery ignition & its components Magneto ignition, other methods of ignition Electrical system including battery chemical activity, battery charging, starting motor, cut-out etc. (in brief)	15

Practical Exercises

Ex. no	Title
1	To study working principle of two and four stroke engines
2-4	Dismantling and assembling of diesel engine
5	To study valve operating system, FI & FO valve timing diagram, valve clearance adjustment.
6	To study intake and exhaust of IC engine
7	To study fuel system of Spark Ignition engine
8	To study fuel system of Compression Ignition engine
9	To study cooling system of tractor
10	To study lubrication system of tractor engine
11	To study ignition system of IC engine
12	To study diff. types of governors and methods of governing
13	To study electrical system of tractor.
14-15	To study engine terminology, Calculation on diff. horse power and cylinder pressure specific fuel consumption and power requirement & efficiencies, air furl ratio
16	To study the physical properties of oil, fuel

Suggesteed reading

Text Book:

1. Elements of Agril. Engineering by Dr. Jagdiswar Sahay-(S) fourth edition 2004
2. Farm tractor maintenance & repair by SC. Jain & C R.Rai (J) second Reprint, 1999
3. Principles of Agril. Engineering Vol-I By AM Michael and TP Ojha (M)-2nd Edn.
4. Tractor and their power unit by JB Liljedahl & et al. (L) (4 authors books 1st Edn.1997)

Reference Book :

1. Farm machines and Equipment by C. P. Nakra, Dhankpat Rai & Sons (N) Edition 1990.
2. Fundamentals of IC Engines by Paul W. Gill, James H. Smith Eugene Ziury-(G) (revised 4thEdn)

Course no: FMP-235	**Title : Theory of Machines**
Sem : III (New)	**Credit : 2 (1+1)**

Syllabus

Theory:

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. Types of gears. Law of gearing, velocity of sliding between two teeth in mesh. interference and

undercutting. Introduction to helical, spiral, bevel and worm gear. Simple, compound, reverted and epicyclic trains. Determining velocity ratio by tabular method. Turning moment diagrams, co-efficient of fluctuation of speed and energy, weight of flywheel, flywheel applications. Types of governors, constructional details and analysis of Watt. Porter, Pronell governors, Balancing of rotating masses in one and different planes. Partial primary balancing of reciprocating masses.

Practical:

Demonstration in mechanisms study using models; Analysis of 4-bar mechanism, slides crank mechanism and their inversions; Determination of velocity and acceleration using graphical (relative velocity and acceleration) method with examples. Study of gears and gear trains and motion analysis of some practical complex compound gear train; Motion analysis Epicyclic gear trains using tabular and formula methods; To design a compound gear train and epicyclic gear train for a desired speed ratio; Practical test; To study the flywheel and governor action in laboratory; To graphically synthesize the cam profile for a desired standard follower motion; Study on the cam follower demonstration machine for follower displacement as a function of cam rotation angle and phenomenon of follower jump; Demonstration of static and dynamic balancing in the laboratory.

Lesson Plan

Sr. No.	Lecture No.	Topic	Art.No.	Page No.
1	1 to 3	Element, link, pairs, Kinematics and mechanism, classification of pairs and mechanisms, lower and higher pairs, four bar chain, slider crank chain and their inversion (related problems)	5.2-5.8 5.11 5.15-5.22	94-97, 101-102 105-115
2	4 and 6	Types of gears, law of gearing, velocity of sliding between two teeth in mesh, involutes and cycloid profile for gear teeth, nomenclature, interference and under cutting. Introduction to spiral, bevel and worm gear. (related problems.)	12.4-12.11 12.17 -12.19	384-393 396-397 405-406
3	7 and 8	Simple, compound, reverted and epicyclic gear trains. Determination of velocity ratio by tubular method. (related problems.)	13.2-13.11	428-463
4	9 and 10	Turning moment diagram, coefficient of fluctuations of speed and energy, weight of flywheel, flywheel application. (related problems)	16.3, 16.5 to 16.10	567 568-573
5	11 and 13	Types of governor, constructional details and analysis of watt, Proter and Proell governor (related problems.)	18.2 - 18.7	653-678
6	14 and 15	Balancing of rotating masses (related problems)	21.2 - 21.5	833-839
7	16	Balancing of reciprocating masses (related problems)	22.2 t-22.3	859-861

Practical

Sr. No.	Practical No.	Name of practical
1	1- 2	Study of four bar and slider crank mechanism and their inversion
2	3-6	Determination of velocity and acceleration in mechanism (relative velocity method). Determination of velocity in mechanism (instantaneous centre method).
3	7 - 9	Determination of train values of different types of gear trains
4	10 -12	Study of governor and flywheel in laboratory
5	13 - 15	Construction of cam profile for different motions of follower
6	16	Problem on balancing of rotating and reciprocating masses

Teaching schedule- Theory with weightages (%)

Unit No..	Lecture No.	Topic	Weightages
1	1 to 3	Element, link, pairs, Kinematics and mechanism, classification of pairs and mechanisms, lower and higher pairs, four bar chain, slider crank chain and their inversion (related problems)	15
2	4 and 6	Types of gears, law of gearing, velocity of sliding between two teeth in mesh, involutes and cycloid profile for gear teeth, nomenclature, interference and under cutting. Introduction to spiral, bevel and worm gear. (related problems.)	40
	7 and 8	Simple, compound, reverted and epicyclic gear trains. Determination of velocity ratio by tubular method. (related problems.)	
3	9 and 10	Turning moment diagram, coefficient of fluctuations of speed and energy, weight of flywheel, flywheel application. (related problems)	15
4	11 and 13	Types of governor, constructional details and analysis of watt, Proter and Proell governor (related problems.)	15
5	14 and 15	Balancing of rotating masses (related problems)	15
	16	Balancing of reciprocating masses (related problems)	

Note: The theory paper is to be set on the basis of 60 % theory and 40 % numeric (problems)

Suggested readings

Text Book:

1. Theory of Machines – R.S. Khurmi and J.K. Gupta (14^{th} Edition, 2010)

Reference books:

1. Theory of Machines – Thomas Beven
2. Theory of Machines – Balaney P L
3. Theory of Mechanism and Machines – JagdishLal
4. Theory of Machine – Rattan S B
5. Mechanism and Machine Theory- Rao J S and Dukkipatti R V

Course No: FMPE-247 **Title: Machine Design**

Sem: IV **Credit: 2 (1+1)**

Syllabus

Theory:

Meaning of design, Phases of design, design considerations, mechanical properties. Types of loads and stresses, theories of failure, factor of safety, selection of allowable stress. Stress concentration. Elementary fatigue and creep aspects. Cotter joints, knuckle joint, turnbuckle. Design of welded joints subjected to static loads. Design of shafts under torsion, bending and combined bending and torsion. Design of keys. Design of muff, sleeve, and rigid flange couplings. Design of helical and leaf springs. Belt: Introduction, selection of belt, types of belt drive, types of belt, material used for belt, types of flat belt drive. Design of flat belt and V-belt drives. Chain drive: Chain drives, Advantages and disadvantages over belt drive, terms used in chain drives, relation between pitch and pitch circle diameter, classification of chains, hoisting chain, conveyor chain, power transmitting chain. (related problems). Selection of anti-friction bearings.

Lesson Plan

Lec. No.	Topic to be covered	Book. No.	Art. No.	Page No.
1	Meaning of design, Phases of design, design considerations, mechanical properties.	1	1.1-1.4, 2.1-2.5	1-3 16-20
2	Types of loads and stresses, theories of failure, factor of safety	1	4.1-4.14	87-102
3-4	Cotter joints and knuckle joint	1	12.1-12.4 12.12-12.15	431-439 455-462
5-6	Design of welded joints subjected to static loads	1	10.1 to 10. 11, 10.16- 10.17, 10.19	341-345, 349-350, 353
7-8	Design of shafts under torsion, bending and combined bending and torsion.	1	14.1 to 14.11	509-517
9-10	Design of helical spring	1	23.1 to 23.9	819-831
11	Design of keys.	1	13.1-13.10	470-478
12-13	Design of muff, and flange couplings	1	13.11-13.17	478-498
14	Design of levers	1	15.1 to 15.5	558-568
15-16	Belt drives and Chain drive Design of flat belt and V-belt drives	1	11.1-11.6 11.29 -11.32, 11.35 - 11.38 18.1to 18.4 18.6 to 18.9 18.13-18.14, 18.18 20.1, 20.4-20.5	325-330 369-371 373-375 677-679 680 686-687692-693 727-728 730-731

Lesson Plan with weightages

Unit No.	Topic to be covered	Weightage, %
1	Meaning of design, Phases of design, design considerations, mechanical properties.	10
	Types of loads and stresses, theories of failure, factor of safety	
II	Cotter joints and knuckle joint	20
	Design of welded joints subjected to static loads	
III	Design of shafts under torsion, bending and combined bending and torsion.	30
	Design of keys.	
	Design of muff, and flange couplings	
IV	Design of helical spring	20
	Design of levers	
V	Belt drives and Chain drive Design of flat belt and V-belt drives	20

Note: The theory paper is to be set on the basis of 60 % theory and 40 % numeric (problems)

Practical:

Numerical Problems based on above topics

Suggested readings

Text Books

1) Khurmi R S and Gupta J K. 2014. A Text Book of Machine Design. S. Chand & Company Ltd., New Delhi.
2) Jain R K. 2013. Machine Design. Khanna Publishers, 2-B Nath Market, NaiSarak, New Delhi.
3) Element of workshop technology vol.1 by S.K. Hajara Chaudhary and A.K. HajaraChaudhari

Course No : FMPE-358 **Course Title: Farm Machinery and Equipment-I**

Credits: 2(1+1) **Semester:- V**

Theory

Introduction to farm mechanization. Classification of farm machines. Unit operations in crop production. Identification and selection of machines for various operations on the farm. Introduction to machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage. Measurement of draft of tillage tools and calculations for power requirement for the tillage machines. Introduction to tillage machines like mould-board plough, disc plough, chisel plough, sub-soiler, harrows, cultivators, Identification of major functional components. Attachments with tillage machinery. Hitching systems and controls of farm machinery. Calculation of field capacities and field efficiency. Calculations for economics of machinery usage, comparison of ownership with hiring of machines. Introduction to seed-bed preparation and its classification. 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. Study of types of furrow openers and metering systems in drills and planters. Calibration of seed-drills/ planters. Adjustments during operation. Fertilizer application equipment. Weed control machineries. Familiarization with land reclamation and earth moving equipment.

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. Study of weeding equipments manual wheel hoe, bullock drawn and power operated inter-row cultivator and their use. Study of earth moving equipment.

Lesson Plan

Lecture No.	Topic	Book No.	Chapter, Art. No.	Page No.
1, 2	Objectives of farm mechanizations. Classifications of farm machines.	1	1.5	6-9
3	Principles of operation and selection of machines used for production of crops.	2	24	7-15
4, 5, 6, 7	Primary and secondary tillage equipment, Problems	3	3.1-3.6	59-81
8, 9	Forces acting on tillage tools, Hitching systems and controls. Draft measurement of tillage equipments. Field capacities & economics	1 7	13.14 3.3.3	235-236 6-7
10, 11, 12	Sowing planting and transplanting equipment, their calibration and adjustments. Problems	5	3	36-70
13	Fertilizer application equipment	2	14	270-284
14	Weed control	6	11	81-91
15, 16	Earth moving equipment, their construction & working principles viz. Bulldozer, Trencher, Elevators	4	22	313-318, 320-321
	Total			

Lesson plan with weightages (%)

Unit No.	Topic	Weightages,%
I	Objectives of farm mechanizations. Classifications of farm machines.	15
	Principles of operation and selection of machines used for production of crops.	
II	Primary and secondary tillage equipment, Problems	40
	Forces acting on tillage tools, Hitching systems and controls. Draft measurement of tillage equipments. Field capacities & economics	
III	Sowing planting and transplanting equipment, their calibration and adjustments. Problems	35
	Fertilizer application equipment	
	Weed control	
IV	Earth moving equipment, their construction & working principles viz. Bulldozer, Trencher, Elevators	10
	Total	100

Practical Exercises

Exercises No.	Title
1.	Introduction to various farm machines, visit to implements shed.
2, 3, 4	Study of constructional details, adjustments and working of M.B. plow and disc plow.
4	Study of constructional details, adjustments and working of disc plow.
5, 6	Study of constructional details, adjustments and working of disc harrow and secondary tillage tools.
7	Measurement of draft and fuel consumption for different implements under different soil conditions.
8	Measurement of Field capacity and field efficiency for at least two machines/implements for field machine and crop machine.
9, 10	Study of construction and working of rotavators and other rotary tillers, measurement of speed and working width.
11,12	Study of working of seed-cum-fertilizer drills, planters and their calibration in field.
13, 14	Study of working of transplanters and operation.
15	Study of weeding equipments manual wheel hoe, bullock drawn and power operated inter-row cultivator and their use.
16	Study of earth moving equipment.

Suggested readings

Text Books:

1) Elements of Agricultural Engineering by Jagdishwar Sahay.
2) Farm Machinery and Equipments by Smith and Wikes (1983 edition)
3) Elements of Farm Machinery by A. C. Shrivastav (1990 edition)
4) Farm Machinery by Kulpin C.
5) Farm Machinery and approach by S. C. Jain, Grace and Philip.
6) Practical farm machinery vol. 1 and 2 by Bhattacharya.
7) RNAM Test codes and Procedures for Farm Machinery

Reference Books:

1. Principles of farm machinery by Kepner, Bainer and Barger CBS Publisher and distributor, Delhi (1987) Indian edition.
2. Principles of Agricultural Engineering Vol. 1 by A. M. Michael and T. P. Ojha.
3. Agricultural Engineering through worked example by Radheylal (1971 edition).

Course Code: FMPE – 359 **Course Title : CAD Applications**
Credits: 1(0+1) **Semester:- V**

Syllabus

Practical

Application of computers for design. CAD- Overview of CAD window – Explanation of various options on drawing screen. Study of draw and dimension tool bar. Practice on draw and dimension tool bar. Study of OSNAP, line thickness and format tool bar. Practice on OSNAP, line thickness and format tool bar. Practice on mirror, offset and array commands. Practice on trim, extend, chamfer and fillet commands. Practice on copy, move, scale and rotate commands. Drawing of 2 D- drawing using draw tool bar. Practice on creating boundary, region, hatch and gradient commands. Practice on Editing polyline- PEDIT and Explode commands. Setting of view ports for sketched drawings. Printing of selected view ports in various paper sizes. 2D- drawing of machine parts with all dimensions and allowances- Foot step bearing and knuckle joint. Sectioning of foot step bearing and stuffing box. Drawing of hexagonal, nut and bolt and other machine parts. Practice on 3-D commands- Extrusion and loft. Practice on 3-D commands-on sweep and press pull. Practice on 3-D Commands- revolving and joining.

Practical Exercises

Exercises No.	Title of practical
1	Introduction to basic structure of CAD software. Study of draw and dimension tool bar.Practice on draw and dimension toolbar.
2	Practice on trim, extend, chamfer and fillet commands.
3	Practice on copy, move, scale and rotate commands.Practice of OSNAP, line thickness and format tool bar.
4	Practice on mirror, offset and array commands.
5	Drawing of 2 D- drawing using draw tool bar.
6	Practice on creating boundary, region, hatch and gradient commands.
7	Practice on Editing polyline- PEDIT and Explode commands.
8	Setting of view ports for sketched drawings
9	Printing of selected view ports in various paper sizes.
10-11	2D drawing of machine parts with all dimensions and allowances- 1. Foot step bearing and printing 2. knuckle joint and printing
12	Sectioning of foot step bearing and stuffing box.
13-14	Drawing of hexagonal, nut and bolt and other machine parts and printing
15-16	Practice on 3-D commands

Teaching Schedule – Theory with weightages (%)

Unit	Practical No.	Title of practical	Weightages (%)
1	1	Study of overview of CAD window and various options on drawing screen. Study of draw and dimension tool bar. Practice on draw and dimension toolbar.	10
	2	Practice on trim, extend, chamfer and fillet commands.	
2	3	Practice on copy, move,scale and rotate commands. Practice of OSNAP, line thickness and format tool bar.	10
	4	Practice on mirror, offset and array commands.	
3	5	Drawing of 2 D- drawing using draw tool bar.	10
4	6	Practice on creating boundary, region, hatch and gradient commands.	10
	7	Practice on Editing polyline- PEDIT and Explode commands.	
5	8	Setting of view ports for sketched drawings	10
	9	Printing of selected view ports in various paper sizes.	
6	10	2D drawing of machine parts with all dimensions and allowances- Foot step bearing and printing	10
	11	2D- drawing of machine parts with all dimensions and allowances- knuckle joint and printing	
7	12	Sectioning of foot step bearing and stuffing box.	10
8	13	Drawing of hexagonal, nut and bolt and other machine parts and printing	10
9	14	Practice on 3-D commands	10
	15	Practice on 3-D commands	
10	16	Working of CNC machine. Demonstration of simple problems on it.	10

Suggested readings

Reference Books:

1 Rao P.N..2002. CAD/CAM Principles and Applications. McGraw-Hill Education Pvt. Ltd., New Delhi.

2 SareenKuldeep and Chandan Deep Grewal. 2010. CAD/CAM Theory and Practice. S.Chand& Company Ltd., New Delhi.

3 Zeid Ibrahim. 2011. Mastering CAD/CAM with Engineering. McGraw-Hill Education Pvt. Ltd., New Delhi.

Course Code: FMPE-3510 **Course Title : Field operation and Maintenance of Tractor and Farm Machinery**

Credits: 1(0+1) **Semester:- V**

Syllabus

Unit	Practical No.	Title
1	1-2	Familiarization with different make and models of tractors Study of different tools required for repair and maintenance of tractor
2	3	Identification of functional system of tractor, Familiarization with different controls on tractor
3	4	Driving practice of tractor, safety rules and precautions, trolley forwarding and reversing, fuel saving tips
4	5	Hitching and De-hitching of mounted and trailed type implements
5	6-7	Tractor maintenance schedule -precautionary and break down maintenance. Tractor starting with low battery charge.
6	8-9	Field operation with M.B. plough, Disc plough, Rotavator, cultivator etc.
7	10-11	Field operation with self-propelled machine viz. reaper, mower
8	12-13	Familiarization with different controls of power tiller and driving practice
9	14-15	Repair and maintenance of different agricultural equipments and machinery
10	16	Replacement criteria for parts of machine

Reference Books :

1. Farm Tractor Maintenance and Repair. By S.C. Jain and C.R. Rai. Tata Mc Graw Hill Pub. Co. Ltd., 12/4 Asaf Ali Road, New Delhi.
2. Farm Machinery Equipment By C.P. Nakra, Dhanpat Rai & Sons, 1962, Nai Sarak Delhi.
3. Elements of Farm Machinery By A.C. Srivastava Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, Bombay.
4. Farm Power Machinery Management by Donel Hunt. Lowa state Univ. Press. Ames Low. The operation care and repairs of Farm machinery, Deere and Company.
5. A Workbook of Practical Farm Machinery, Volume I and Volume 2 by Dr. T.K. Bhattacharya, Saroj Prakashan, 646 Katra, Allahabad – 211 002.

Course No. : FMPE-3611 **Title: Farm Machinery and Equipment-II**
Sem:-VI **Credits: 2(1+1)**

Syllabus:

Theory

Introduction to plant protection equipment – sprayers and dusters. Classification of sprayers and sprays. Types of nozzles. 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. 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. 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. Study of root crop diggers – principle of operation, blade adjustment and approach angle, and calculation of material handled. Study of potato and groundnut diggers. Study of Cotton harvesting – Cotton harvesting mechanisms, study of cotton pickers and strippers, functional components. Study of maize harvesting combines. Introduction to vegetables and fruit harvesting equipment and tools.

Practical:

Familiarization with various Farm machines related to harvesting, threshing, root. harvesting, combine etc; Study of various types of mowers, constructional details, materials and working; Study of various types of reaper, constructional details, materials and working & performance; Study of various types of reaper binder, constructional details, materials and working; Study of various types of potato harvesters, constructional details, materials and working; Study of various types of groundnut harvesters, constructional details, materials and working & performance; Study of various types of forage harvester, constructional details, materials and working; Study of various types of sugarcane harvester, constructional details, materials and working; Study of various types of maize sheller, constructional details, materials and working & performance; Study of various types of threshers, constructional details, materials and working & performance; Study of various types of cotton pickers and strippers, constructional details, materials and working; Study of various types of harvester tools, constructional details, materials and working; Study of various types of combine harvester, constructional details, materials and working; Study of various types of straw combines, constructional details, materials and working; Study of various types of fruit harvester equipment, constructional details, materials and working.

Teaching schedule- Theory with weightages (%)

Lecture No	Topic	**Book No.**	**Chapter, Art. No.**	**Page No.**
1 . 2	Plant protection equipment- Sprayers and duster their calibration selection. Constructional features of different components and adjustments.	5	6.1-6.5	114-135
3	Principle and types of cutting mechanisms	7	14.3-14.10	315-321
4 - 9	Crop harvesting machinery: Harvesting and threshing equipments Threshing mechanics. Combine harvester: components, functions and flow chart, grain losses Sugarcane harvester: components, functions and flow chart	5 7 4 4	4.1,4.2, 17 17.9-17.14, 33 6.13 33	71-85 400-409 438-450 453-454 460-461
10 - 11	Forage chopping and handling equipment Chaff cutter	7 1	16.1-16.7 16.15-16.16 18.1	368-374 383-384 371-376
12	Root crop harvesting equipment: components, functions and flow chart of Potato harvester and Peanut harvester.	4 2	33	462-463 372-376
13,14	Cotton harvesting machinery: components, functions and flow chart	7	19.1-19.10	446-455
15	Testing of farm machines test code procedures, interpretation of test results	8	1	2-15
16	Selection of tractor and matching implements	5	Annex-I	219-228

Teaching schedule- Theory with weightages (%)

Lecture No	Topic	Weightages %
I	Plant protection equipment- Sprayers and duster their calibration selection. Constructional features of different components and adjustments.	20
II	Principle and types of cutting mechanisms	35
	Crop harvesting machinery: Harvesting and threshing equipments Threshing mechanics.	

III	Combine harvester, grain losses Sugarcane harvester	35
	Forage chopping and handling equipment Chaff cutter	
	Root crop harvesting equipment Potato harvesting Peanut harvesting	
	Cotton harvesting machinery	
IV	Testing of farm machines test code procedures	10
	Selection of tractor and matching implements	

Practical Exercises

Exercises No.	**Topics**
1	To study different types of pesticides application equipments
2	To study different types of spray nozzles
3	To study different types of dusters
4	Study of various types of movers, constructional details, materials and working
5	Study of various types of repairs, constructional details, materials and working
6	Study of grain crop combine harvesters constructional details, materials and working
7-8	To study different types of threshers constructional details, materials and working and performance
9	Study of maize sheller
10	Study of sugarcane harvester
11	Study of chaff cutter
12	Study of Potato harvester
13	Study of Peanut harvester
14	Study of cotton harvesting machinery
15	Study of various types of fruits harvesting equipments, constructional details, materials and working
16	Study of various types of forage harvesters, constructional details, materials and working

Suggested readings

Text Books

01 Elements of Agril. Engineering by Dr. Jagdiswar sahay.
02 Farm machinery and Equipment by Smith and Wikes, TMH Publ.(1984 edition)
03 Elements of Farm Machinery by A.C. Shrivastav (1990 edition)
04 Farm Machinery & Equipment by CP Nakra, Dhankpat Rai & Sons Edition 1990
05 Farm machinery and approach by S. C. Jain, Grace Philip
06 Practical Farm Machinery Vol.2 By Bhattacharya, Saroj Prakashan, 1999 Ed.
07 Principles of Farm Machinery by Kepner, Bainer and Barger, CBS Publishers and Distributer, Delhi (1987) Indian Edition.
08 RNAM Test Codes and Procedures for Farm Machinery.

Course No:- FMPE 3612	**Title :-Tractor and farm machinery design**
Semester:-VI	**Credit- 3 (2 + 1)**

Syllabus

Theory:-

Design of power transmission components and system in agril. Machines, Design paramaters of agril. Implements, Force analysis of primary tillage tools and their hitching systems. Considerations of Reapers, Mowers, Harvesters and threshing equipments. Application of design method to the system of selected farm machinery, cost estimation of designed machinery. Procedure for design and development of agricultural tractor. Design of Ackerman Steering and tractor hydraulic systems. Study of special design features of tractor engines and Design of seat and controls of an agricultural tractor.

Practical:

Problems on Power transmission, Design consideration of seed drills/planters, inter culture tools, reaper/mower/harvester and thresher. Application of computer aided design methods of the selected farm machinery. Design problems of tractor engine & power transmission.

Lesson Plan- Theory with weightages (%)

Sr. No.	Lect. No.	Topic	Book No.	Chapter No.
1.	1-4	Procedure for design of tractor engine parts: cylinder, cylinder head, piston, ring, Crank shaft, valve, connecting rod etc.	6	1.3 (complete)
2.	5-7	Lubrication system and cooling system of tractor	6	5.1-5.5 6.1- 6.6
3.	8-10	Design of tractor hydraulic systems: hydraulic cylinder, pump	6	9.1-9.5
4.	11-12	Design of seat and controls of an agricultural tractor	6	12.4.3-12.4.5
5.	13-17	Study of parameters for balanced design of tractor for stability & weight distribution	2	Chapter-11
6.	18-19	Theoretical Design of power transmission components in Agril. Machinery- Clutches	3	24 (24.9 to 24.11)
7.	20	Design considerations of Agricultural Implements	6	1
8.	21-24	Design of tillage tool	5	4.1-4.5
9.	25-27	Design of sowing and planting machines	5	5.1 to 5.2
10.	28	Design of intercultural tools and implements	5	6.1
11.	29-30	Design of sprayers	4	Chapter 17 complete
12.	31-32	Design of harvester & Threshing machines	5	7.1 to 7.2 8.1 to 8.2

Lesson Plan- with weightages (%)

Unit No.	Lect. No.	Topic	Weigtage, %
I	1-4	Procedure for design of tractor engine parts: cylinder, cylinder head, piston, ring, Crank shaft, valve, connecting rod etc.	20
	18-19	Theoretical Design of power transmission components in Agril. Machinery- Clutches	
II	5-7	Lubrication system and cooling system of tractor	20
	8-10	Design of tractor hydraulic systems: hydraulic cylinder, pump	
III	11-12	Design of seat and controls of an agricultural tractor	20
	13-17	Study of parameters for balanced design of tractor for stability & weight distribution	
IV	20	Design considerations of Agricultural Implements	20
	21-24	Design of tillage tool	

	25-27	Design of sowing and planting machines	
V	28	Design of intercultural tools and implements	20
	29-30	Design of sprayers	
	31-32	Design of harvester & Threshing machines	

Practical Exercises

1 to 16 : Numerical on design of tractor and farm machinery as per theory lesson plan.

Text Books:

1. Engineering material science By-Cedric W. Rechards,Prentice- Hall of INDIA (PVT) Ltd (1965)
2. Design of agricultural Machinery By- Gary Krutzs&others,Johnwiley& sons
3. A text Book of Machine Design By-R.S. Khurmi& J.K. Gupta
4. Agricultural machines by klenin&popov
5. Farm Machinery Design : principal & problem ,Sharma D.N. &Mukesh S. Published by Jain Brothers
6. Design of Agril. Tractor principles & problems- D.N.Sharma, S.Mukesh-Jain Publication
7. Theroy ,construction and calculations of Agril.MachinesVol.I by E.S.Bosaietloxoninan press pvt.ltd new delhi

Ref. Books:

1) The Mechanics of Tractor- Implement Performance *Theory and Worked Examples* R.H. Macmillan
2) ASAE Distiguished lecture series on Tractor Design
3) Machine Design- Pandya& Shah, R.S. Khurmi

Module-I : Farm Mechanization
Course No. : GAE-477-1
Course Title : Farm Mechanization
Credit : 10 (0+10)

Objectives :

1. To acquaint the students in the field of farm implements and machinery.
2. To acquaint the students for different field operations.

3. To estimate the cost operations of different field operations.
4. Economic analysis of different farm implements and equipments.

Outline of the Course:

- The students will be trained to drive tractor and attach implements to the tractor. Hitching and unhitching of the tractor and trolley reversing.
- Different implements like M.B. Plough (Fixed and reversible), Standard Disc Plough, Disc harrow, Cultivator, ridger, leveler, Rotavator, Seed cum fertilizer drill, planter, power weeder, Reaper, Mower, Combine harvester and Threshers will be operated in the field and practically students will do field operations for different crops.
- The field operations like Transplanting, Weeding and Harvesting of paddy and Transplanting of vegetables will be taught through video clippings if wet fields/ facilities are not available.
- The different equipments/machines like pulverizer cum grinder, chaff cutter, leaf shreader, Post hold digger, cotton gin and Urea briquetting machine will also be demonstrated and evaluated for their performance.

INDEX

	Use, function, construction and their field operation.	
19	Study of Transplanting Equipments (Paddy and Vegetable Transplanted) Use, function, construction, demonstration and its important.	91-95
20	Self propelled weeders and its operation : Pre and after starting checks, importance of gauges, controls and safety precautions while driving power weeder . Field operation of power Tiller with different attachments.	96-100
	Operation with plant protection equipments 1.Human operated 2. Bullock operated 3.Tractor operated 4. preparation of solutions	101-110
21	Study of cropping pattern of the region ,agronomical consideration in various crops and adjustments accordingly	111-115
22	Estimation of maintenance cost of tractor, power tiller and other implements	116-120
23	Preparation of bank loan proposal for purchasing tractor, power tiller and other machineries	121-125
24	Record keeping of tractor, power tiller and machineries	126-130
25	Study of machineries and tools, practices in fruit and vegetable crops.	131-135
26	Visit to tractor and implement manufacturing industries and service centres.	136-160
27	Information regarding various government schemes related to farm mechanization.	161-165
28	Preparation of information for bulletins, leaflets, posters etc.	166-170
29	Demonstration of farm implements and machineries to the farmers	171-190
30	Report writing and Semester End Examination	191-200

Module-II : Manufacturing of Agricultural Tools and Implements
Course No. : GAE-475
Course Title : Manufacturing of Agricultural Tools and Implements
Credit : 10 (0+10)

	Scope: Agricultural engineering education is the bridge between engineering and agricultural science. The application of the technological knowledge helps in enhancement of agricultural production and productivity in the country. Agricultural machinery are playing very important role in Indian agriculture by reducing drudgery, timeliness in agricultural operation, better

	quality work and reduction in cost of operation. Agricultural engineering graduates have to play a major role in improvement in country's agricultural picture by increasing productivity, production and economic returns to the farmers. The knowledge of Farm Machinery and Power is applicable to the entrepreneurship as well as to the end users. Hence the students offering agricultural engineering courses should be trained in such a way that their practical knowledge in the discipline of Farm Machinery and Power will be applied to the industry sector, entrepreneurship development, increasing job opportunities to the graduates and also in farming sector. Agricultural Universities has been involved in developing the different tools and equipments for farmers. Most of the equipments are made available to the farmers of Maharashtra through Govt. subsidy program. Taking the advantages of infrastructural facilities of college workshop and strengthening them, the manufacturing activities of the equipments viz. toothed spade, hand operated coconut dehusker, stubble remover, Japanese weeder, dryland weeder will be taken as an experience learning if the students of B.Tech (Agril.Engg) final year are given exposure to work on the floor of production unit. It will help to the students to build up their confidence, facilitate skill development through experiential learning and will be useful in becoming job provider rather than job seeker. With this view experience learning program for the students of the final year of B.Tech (Agril. Engg.) Students for six months are planned. The objectives of the same are as listed below. **Objectives:** 1. To impart practical knowledge, aspect of design, production technology. **2.** To impart training and entrepreneurial skills in manufacturing of tools and equipments for self reliance.

Credit hours and syllabus

S.No	Contact Units	Particular of lecture practical
		Basic of Production and manufacturing Technology
1	02	Basic information about different tools, equipments raw material, their specifications
2	01	Metallurgical aspects of raw material
3	02	Manufacturing process in details
4	02	Drawing of different components, different view and assembly drawing with Auto Cad of Japanese weeder

5	02	Drawing of different components, different view and assembly drawing with Auto Cad of dryland weeder
6	02	Drawing of different components, different view and assembly drawing with Auto Cad of coconut dehusker
7	01	Drawing of different components, different view and assembly drawing with Auto Cad of stubble remover
8	01	Drawing of different components, different view and assembly drawing with Auto Cad of toothed spade
A		**Manufacturing of toothed spade**
1	02	Cutting of MS sheet for blade pipe for handle
2	03	Making of teeth and handle notch using press
3	02	Bending
4	02	Welding of handle to cutting blade
5	01	Quality inspection and lab testing
B		**Manufacturing of stubble remover**
1	01	Marking and cutting of M.S. flat for blade
2	01	Twisting and bending
3	01	Pipe cutting for handle
4	02	Welding of handle to blade
5	01	Quality inspection and lab testing
C		**Manufacturing of coconut dehusker**
1	05	Foot rest preparation
2	01	Fabrication of stand pipes
3	02	Fabrication of handle
4	02	Blade cutting
5	04	Fitting of handle to pipe
6	01	Quality inspection and lab testing
D		**Manufacturing of dryland weeder**
1	02	Fabrication of blade and tynes
2	02	Fabrication of handle
3	04	Fabrication of pipes frame with handle
4	02	Preparation of pegs
5	02	Preparation of shaft and bush pipe
6	04	Fabrication of peg wheel
7	02	Assembly of weeder
8	02	Quality inspection and lab testing
E		**Manufacturing of Hand rake /grubber**
1	02	Cutting of material
2	04	Sharpening of tynes
3	02	Preparation of handle
4	04	Fabrication of rake/grubber
5	03	Quality inspection and lab testing
F		**Manufacturing of Cono weeder**
1	06	Fabrication of cone, teeths, plates, central shaft
2	05	Fabrication of main frame

3	02	Fabrication of float
4	03	Fabrication of frame supporting to float and rear cone
5	02	Assembling of components
6	02	Quality inspection and lab testing
G		**Sales and Marketing of agril. tools and equipments**
1	02	Training and tips from experts
2	02	Trial sale demonstrations
3	02	Exhibitions and sale
4	10	Field sales and marketing
H		**Report preparation and Examinations**
1	04	Report preparation
2	01	Report preparation
Total	120	

* contact unit : 1 unit =8 hrs

** The equipments to be manufactured can be decided as per the local need.

IDE

ELE-IDE-482 Course Title:- Geo-informatics for land and water management
Semester:- VIII Credit:- 3 = 2+1

Syllabus:

Theory:

Remote Sensing : Definition, stages in Remote Sensing, Remote Sensing systems, Remote Sensing Sensors and Resolutions, Remote Sensing Platforms, Electro Magnetic Radiation, Concept of Signature & Multispectral Concept, Spectral Reflectance of Vegetation, Soil and Water, Introduction to Visual Image Interpretation : Fundamental of Visual Image Interpretation and Elements of Image Interpretation, Digital Image Processing: Introduction, Image Rectification and Restoration, Image Enhancement, Contrast Manipulation, Image Classification: Supervised Classification and Unsupervised Classification.

Introduction of GIS : GIS definitions, components of GIS, GIS software's and their products, GIS data types and structures, Data input and editing, Attribute data management, Co-ordinate system, data and map projections, GIS data analysis : vector based and raster based, GPS: Introduction and applications, Applications of Remote Sensing for Land cover and land use mapping and water resources.

Modeling : Simulation and Modeling use in water resource management: What is Model, Simulation, Application in water Recourse management: Types of models: Physical models, Mathematical models,

Conceptual model, Hybrid Models, Introduction to some models, Study of SWAT Model : Introduction, Overview , Land phase of Hydrological cycle (component list only) ,Routing Phase of the Hydrological cycle (component list only), Model input Overview (list of input), Model output Overview (list of output) , Study of CROPWAT Model :Description of CropWat MODEL, Input /output of Model, Calculation method used by model, Study of Aqua Crop Model: Introduction to AquaCrop, The AquaCrop model , Practical applications, The calculation scheme of AquaCrop, Input requirement and Limitations.

Practical:

Introduction to Remote Sensing software, Introduction to GIS software, Study of GPS and DGPS systems, LULC mapping using RS and GIS, Estimation and mapping of WR of different crops using RS and GIS, Estimation of evapotranspiration: conventional methods and RS based methods, Water feature mapping using RS, Application of SWAT Model for Irrigation Management, Estimation of crop-water requirement and Irrigation requirement using CROPWAT model, Application of Aqua-Crop Model for Planning and management in Agriculture.

Teaching Schedule:

Lec. No.	Topic	Book No.	Topic No.	Page No.	Weightages (%)
UNIT-I					
1-4	Remote Sensing : Definition, stages in Remote Sensing, Remote Sensing systems Remote Sensing Sensors and Resolutions Remote Sensing Platforms Electro Magnetic Radiation Concept of Signature & Multispectral Concept Spectral Reflectance of Vegetation, Soil and Water	 2 1	 1.1 1.3 5.1, 5.3, 5.4, 5.5, 5.6 1.3.2 2.0 1.2, 1.2.1 1.4	 1-2 6 129-143 8-9 25-27 3-6 17-21	30
5-6.	Introduction to Visual Image Interpretation : Fundamental of Visual Image Interpretation and Elements of Image Interpretation	1	4.1, 4.2	190-194	
7-8	Digital Image Processing: Introduction, Image Rectification and Restoration, Image Enhancement, Contrast Manipulation, Image Classification: Supervised Classification and Unsupervised Classification.	1	7.1, 7.2, 7.3, 7.4, 7.7, 7.8, 7.11	470-559	
UNIT-II					
9	Introduction of GIS : GIS definitions, components of GIS, GIS software's and their products.	3 4		1-25 4-5	30
10-12	GIS data types and structures Data input and editing, Attribute data management, Co-ordinate system, data and map projections.	4 3 3 3 3		5-11 60-69 102-122 82-89 35-45	
13	GIS data analysis : vector based and raster based.	4		234-277	
14	GPS: Introduction and applications	2		32-35	
15-16	Applications of Remote Sensing for Land cover and land use mapping and water resources	2	11.3, 11.4	358-363	
UNIT-III					
17-	Modeling :		Notes to be		40

19	Simulation and Modeling use in water Recourse management: What is Model, Simulation, Application in water Recourse management: Types of models: Physical models, Mathematical models, Conceptual model, Hybrid Models Introduction to some models		circulate		
20-24	Study of SWAT Model : Introduction Overview Land phase of Hydrological cycle (component list only) Routing Phase of the Hydrological cycle (component list only) Model input Overview (list of input) Model output Overview (list of output)	5 6	 Chapter31 Chapter31	1-2 6-9 9-21 303-312 313-335	
25-28	Study of CROPWAT Model: Description of CropWat model Input /output of Model Calculation method used by model	7		 1 2 2-3	
29-32	Study of Aqua Crop Model: Introduction to AquaCrop The AquaCrop model Practical applications The calculation scheme of AquaCrop Input requirement Limitations	8		 1 1 2 2-3 4 4	

Practical Exercises

Ex. No	Title
1-2	Introduction to Remote Sensing software's
3-4	Introduction to GIS software's
5-6	Study of GPS and DGPS systems
7	LULC mapping using RS and GIS
8	Estimation and mapping of WR of different crops using RS and GIS.
9-10	Estimation of evapotranspiration: conventional methods and RS based methods.
11	Water feature mapping using RS
12-13	Application of SWAT Model for Irrigation Management
14	Estimation of crop-water requirement and Irrigation requirement using CROPWAT model.
15-16	Application of Aqua-Crop Model for Planning and management in Agriculture.

Suggested Readings :

1. Lillesand T.M. and Kiefer R.W.-2009, Remote Sensing and Image Interpretation, John Wiley and Sons, New Delhi (www.wileyindia.com)
2. George Joseph. Fundamentals of Remote Sensing, 2009. Universities Press Pvt. Ltd., Hyderabad (www.universitiespress.com)
3. Lan Heywood, Sarah Comelius, Steve Carver and Srinivasa Raju., 2006. An Introduction of Geographical Information Systems. Person Education in South Asia, Published by : Dorling Kindersley (India) Pvt. Ltd.
4. Kang-Tsung Chang, Introduction to Geographical Information System, 2008, McGraw Hill. (www.tatamcgrawhill.com)
5. SWAT Theoretical Documentation version 2009 (Document Download link **http://swat.tamu.edu/documentation/**)
6. SWAT User manual version 2000 (Document Download link **http://swat.tamu.edu/documentation/**)
7. Cropwat Documentation , (Document Download link **http://agromet-cost.bo.ibimet.cnr.it/fileadmin/cost718/repository/cropwat.pdf**) Software download link**http://www.fao.org/land-water/databases-and-software/cropwat/en/**
8. 4.AquaCrop training handbooks:FAO Document Download link: http://www.fao.org/3/a-i6051e.pdf
9. P.A.Burrough and R.A. McDonnell, Principles of Geographical Information System, 2000, Oxford, University
10. Jhon R. Jensesn Introductory Digital Image Processing: A Remote Sensing Prospecting, Prentice-Hall, Englewood Cliffs, New Jersey.

Course No: - ELE-IDE 483	Course Title: - Lift Irrigation System Design and Management
Semester: - VIII	Credit:- 3=2+1

Syllabus:

Theory

Site selection for lift irrigation and reconnaissance survey, survey and mapping of field, cropping pattern and computing water requirement, selection of site for intake and jackwell, computing total head and power requirement, design of intake chambers, inlet pipe and pump house, selection of pump, pump layout and connection. Design and layout of rising main, distribution system and delivery chamber, working out water rates.

Practicals:

Selection of site for lift irrigation scheme and reconnaissance survey, Survey and mapping of field, including 'L' section, Estimation of water availability and computing water, requirement, Design of intake well, Design of intake pipe, Design of sump well, Design of jack well, Computation of total head and power requirement, Selection of pump, Economic of lift irrigation project, Field visit to lift irrigation project

Teaching Schedule:

Lecture No.	Topics	Article No./ Page No.	Book	Weightage, (%)
Unit I				
1	Introduction to lift irrigation, necessity and role of lift irrigation schemes in irrigation development	249-250	1,2	10
2	Assessment of feasibility of lift irrigation project	250-251	1	
3, 4	Selection of site and reconnaissance survey for lift irrigation scheme	257-260	1, 2	
Unit II				
5, 6	Survey and leveling procedure i) Chain and Compass survey ii) Plain Table Survey iii) Dumpy/Automatic level	159-161 293-298 371-379	3	30
7	Water availability	251, 255-256	1	
8	Computation of water requirement and capacity of project	25-35	4	
Unit III				
9	Components of lift irrigation scheme i) Intake well-function, type, constructional details	260-262	1	20
10	Sump well	268-269	1	
11	Jack well	270-271	1	
12, 13	Intake pipe and rising main	278-280 263-264	1 2	
Unit IV				
14	Pumps	487	5	30
15	Pump house	271-275	1	
16	Delivery/distribution chamber	282-283	1	
17	Electrical equipments and accessories	275-276	1	
18	Valves and water Hammer Control Devices	633-635 281-282	1 1	
19	Design of intake well	262-263	1	
20	Design of intake pipe	264-667	1	
21	Design of sump well	269-270	1	
22	Specification of jack well	274-275	1	
23	Pump house structure	272-273	1	
24	Layout of rising main	280-281	1	
25	Design of rising main	420-421	6	
26, 27	Computation of power requirement	209-213 238-241	1	

Unit V				
28, 29	Operation of lift irrigation scheme (Pump)	277-278	1	10
30, 31	Economics of lift irrigation project	697-704	1	
32	Norms for fixing economic water rate	283-285	1	

Practicals:

1. Selection of site for lift irrigation scheme and reconnaissance survey,
2-3. Survey and mapping of field, including 'L' section
4-5. Estimation of water availability and computing water requirement
6. Design of intake well
7. Design of intake pipe
8. Design of sump well
9. Design of jack well
10. Computation of total head and power requirement
11. Selection of pump
12-13. Economic of lift irrigation project
14-16. Field visit to lift irrigation project

Suggested readings

Text books

Sr. No.	Title	Author	Publication
1	Irrigation Theory and Practices (II^{nd} edition 2008)	A.M.Michael	Vikas Publishing House Pvt. Ltd.
2	Technical aspects of agricultural project. Volume – I		NABARD Publication, November 1989
3	Surveying and leveling	T.P. Kanetkar, S.V.Kulkarni	Punde Vidyapeeth, Griha Prakashan, Pune
4	Irrigation Engineering and Hydraulic Structures	S.K.Garg	Khanna Publishers, Delhi
5	Water, Well and Pumps	A.M.Michael and S.D.Khepkar	Tata McGraw Hill Publication Co. Ltd. New Delhi
6	A Text Book of Fluid mechanics and Hydraulic machines (Eighth edition)	R.K.Bansal	Laxmi Publications (p) Ltd. New Delhi

Course No: ELE-IDE 484 **Course Title: ENVIRONMENTAL ENGINEERING**
Semester:- VIII **Credit: 3 (1 + 2)**

Syllabus:

Theory:

Importance of safe water supply system. Domestic water requirements for urban and rural areas. Sources of Water supply. Intakes and transportation of water. Drinking water quality. Indian Standards of drinking water. Introduction to water treatment. Importance of sanitation. Domestic waste water: quantity, characteristics, disposal in urban and rural areas. Sewer: types, design discharge and hydraulic design. Introduction to domestic wastewater treatment. Design of septic tank. Solid waste: quantity, characteristics and disposal for urban and rural areas. Introduction to air pollution. Types of pollutants properties and their effects on living beings. ISI standards for pollutants in air and their abetments.

Practical:

Determination of turbidity; pH solution; Suspended solids; Dissolved solids; Total solids; Determination of temporary hardness; Determination of permanent hardness; Determination of fluorides and chlorides, Determination of dissolved oxygen, Determination of BOD, Determination of COD, Collection of air samples and their analysis; Estimation of water demand; Design of water distribution system; Design of sewer system; Visit to treatment plant.

Teaching Schedule with weightages

Lecture No.	Topics	Article No.	Page No.	Book	Weightages (%)
Unit I					
1	Importance or safe water supply		9-10	1	10
2	Quantity water, rate of demand and factor affecting rate of demand		12-13	1	
3-4	Estimating population		28-38	1	
Unit II					
5	Sources of water supply-types		45-72	1	20
6	Intakes: types		258-262	1	
7,8,9	Conveyance of water: pipes various materials		262-270	1	
10, 11	Water quality analysis		109-134	1	
12	Standards of drinking water		19-25	3	
Unit III					
13-18	Water treatments: sedimentations coagulations of water filtration disinfection water softening		142-143 158-160 179-181 203-221 224-225	1	30
Unit IV					
19	Sanitation: introduction, purpose		233-235	2	20
20, 21	Sewage disposal		197-201	2	
22	Sewers: definition and types		344-345	1	
23, 24	Design of sewers		411-418	1	
25, 26	Septic tank		202-206	2	
27, 28	Types and methods of Sludge disposal		193-197	2	
Unit V					

29	Air pollution		253-258	2	20
30	Types of pollutants and their effects		Notes		
31, 32	ISI standards for pollutants		Notes		

Practicals:

1-2. Determination of turbidity; pH solution; Suspended solids; Dissolved solids; Total solids;
3. Determination of temporary hardness;
4. Determination of permanent hardness;
5. Determination of fluorides and chlorides,
6. Determination of dissolved oxygen
7. Determination of BOD
8. Determination of COD
9. Collection of air samples and their analysis;
10. Estimation of water demand;
11. Design of water distribution system;

12-13. Design of sewer system;

14-16. Visit to treatment plant.

Suggested readings

Text books

Sr. No.	Title	Author	Publication
1	Fundamentals of water supply and sanitary engineering	S.C.Rangwala	Charotar publishing house Anand, India
2	Environmental engineering Water supply, sanitary engineering and pollution	A. Kamala, D.L. Kanth rao	Rata McGraw- Hill New Delhi
3	Manual for rural supply by, 1st edition, 1989	SKAT	Divyajoyti Prakashan Jodhpur

Course No:- ELE-IDE-485	Course Title:- Landscape Irrigation Design And Management
Semester :- VIII	Credit:- 3=2+1

Syllabus:

Theory

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, shrub adopter, drip irrigation and bubblers; Merits and demerits of conventional and modern irrigation systems, 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; Automation system for landscape irrigation- main components, types of controllers and their application, Design of modern landscape irrigation systems, operation and maintenance of landscape irrigation systems.

Practical:

Study of irrigation equipment's 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.

Teaching Schedule:

Lecture No.	Topics	Article No.	Page No.	Book	Weightages (%)
Unit I					
1	Conventional method :Hose irrigation, Quick release coupling system	3.5	34-37	2	10
2	Modern irrigation systems-importance, status, merits and demerits	3.3	22-23	2	
3	Pop up sprinklers-Spray pop up,shrub pop up, Bubbler	-	600-601	1	
4&5	Drip irrigation types, emitter selection criteria	2.2-2.6	12-26	2	
Unit II					
6 &7	Computation of water requirement for various landscapes by FAO Penman- Montieth and Pan evaporimeter method	-	480-482 501-515	1	30
8&9	Main components of landscape irrigation system	3.5	23-37 581-587	2 1	
10	Types of landscapes- scope, objective, inventory for landscape gardening	17-56 589-592		3 1	
11	Plan of landscape work and general principles				
12	Styles/ types of landscape gardens				
Unit III					
13	Design criteria and procedure for sprinkler nozzle	4.1 - 4.16	49-58	2	30
14	Types of pipes- pressure rating, sizing and selection	-	352-355	1	
15&16	Design of sprinkler irrigation pipe network on flat and sloping land. Determination of number of subunits/valves	4.10	589-595 77-78	1 2	
17	Distribution of moisture under pop up sprinkler irrigation and overlapping of pop up sprinklers	4.3 & 6.1	64-65 114-116	2	
18	Computation of system capacity	4.7	71-72	2	
19	Design of pump unit –Power requirement and pump selection	4.9	75-77	2	
20	Evaluation of pop up sprinkler irrigation system, uniformity, pressure-discharge etc	-	587-589	1	

21	Selection of landscape irrigation system	Notes to be prepared			
Unit IV					
22	Automation of micro-irrigation system - Time based - Volume based - Sensor based	-	96-99	4	30
23 &24	Automation valves and their applications	Notes to be prepared			
25	Types of automation controllers and their applications	Notes to be prepared			
26	Sensors used for automation	Notes to be prepared			
27	Maintains of landscape irrigation system		597-599	1	
28 &29	Maintenance irrigation system-acidification and Chlorination requirement	7.4	84-92	5	
30	Fertigation system for landscape irrigation	-	603-606	1	
31	Optimization of pipe network in pop up sprinkler irrigation system	Notes to be prepared			
32	Cost estimation of landscape irrigation system	-	595-596	1	

Practicals:

1. Study of the components of landscape irrigation system.
2. Preparation of layout for landscape irrigation system by using AUTOCAD.
3. Hydraulic design of main and sub-main
4. Design of pop up sprinkler irrigation system
5. Estimation of water requirement of different landscapes.
6. Selection of power requirement and capacity for pump.
7. Calculation of the pressures in various components under landscape irrigation system
8. Irrigation scheduling for existing landscape gardening.
9. Installation of pop up sprinkler irrigation system.
10. Studies of different filtration system.
11. Studies of different fertigation system.
12. Study of components of automation controllers and valves.
13. Field evaluation of the landscape irrigation system
14. Field visit to the landscape irrigation garden.

15-16. Field visit to automatic irrigation system.

BOOKS:

Text books

S. N.	Title	Author	Publication
1	Irrigation Theory and Practice Second Edition, 2008	A.M.Michael	Vikas Pub. House Pvt. Ltd. New Delhi.
2	Principles of sprinkler irrigation	M.S.Mane, B.L.Ayare	Jain Brothers, New Delhi
3.	Landscape gardening and design with plants	S. K. Bhattacharjee	Avishkar Publishers, Distributors, Jaipur (Raj.)
4	Trickle irrigation design	Jack Keller, David Karmelli	RainbirdSprinkler manufacturing, California,
5	Principles of drip irrigation	M.S.Mane, B.L.Ayare, S.S.Magar	Jain Brothers, New Delhi

Reference books:-

Sr. No.	Title	Author	Publication
1	Trickle irrigation for crop production-design, operation and management	F.S.Nakayama, D.A. Bucks	Elsevier Publication
2	Irrigation systems: design and operation	D. karmelli, G. Peri. M.Todes	Oxford University Press, Capetown 1985

GAE- IDE-477-1: **Planning, design and installation of pressurized irrigation systems.**

Week	Topics to be covered
1	Topographical survey of the designated farms for the preparation of boundary and contour maps.
2	Preparation of boundary and contour maps (preferably by GPS and use of software).
3	Design of sprinkler and drip irrigation systems for the designated farms, including cost economics.
4	Marking and layout of the sprinkler and drip irrigation systems on designated farms.
5	Installation and fitting of sprinkler irrigation system.
6	Installation and fitting of drip irrigation system.
7	Testing and performance evaluation of sprinkler irrigation system.
8	Testing and performance evaluation of drip irrigation system.
9-10	Survey design, layout and cost estimate and /or installation of sprinkler and drip irrigation systems on farmers'/Institutions' farms.

GAE - IDE- 477-2: Maintenance and Management of Pressurized Irrigation Systems.

Week	Topics to be covered
1.	Verification of the existing design and layouts of drip and sprinkler irrigation system on designated farms
2.	Performance evaluation of existing sprinkler and drip irrigation systems on designated farms
3.	Computation of water requirement and irrigation schedules by different approaches - preferably using existing softwares and mobile apps, implementation the irrigation schedules
4.	Filtration : Operation and maintenance of primary filters (screen and disc), sand and media filters, Periodical flushing of lateral and sub mains.
5.	Acid and chlorine treatments: Soil and water quality tests, problem identification determination of quantity (doses) and flow rates for application of the acid and chlorine.
6.	Types of water soluble fertilizers/ sources of fertilizers, selection and compatibility of different fertilizers, principle of mixing of fertilizers and preparation of fertigation schedules.
7.	Fertigation devices : ventury, pressure tank and fertigation pump, application of fertilizers through different devices, their comparison, suitability, ease of operation etc.
8.	Automation : concept, types and operation of different automation devices.
9.	Quality standards of different components of sprinkler and drip irrigation systems, visit to drip and sprinkler irrigation industries including IS standard labs, dealers.
10.	Market survey, preparation of project proposal for finance, different Govt. scheme and process for approval of proposals.

GAE- IDE-477- 3: **Cropping pattern and irrigation management in canal command for major/minor/medium irrigation projects**

Week	Topics to be covered
1	Visit to the representative minor/medium/major irrigation projects. Selection of minor/medium irrigation projects/minor or water course of major irrigation project.
2	Reconnaissance, demographical and socio-economic survey of selected of irrigation projects
3	Collection of data on existing cropping pattern, reservoir, canal network, wells, land and water (surface and ground) availability, rotation schedules, meteorological data required for irrigation water management.
4	Topographical survey of command area of the selected irrigation project, preferably using GPS and software
5	Determination of physical-chemical and irrigation properties of soils in command area, soil mapping
6	Optimization of cropping pattern based on water and land availability and by introducing recent technological advances. Optimum conjunctive utilization of water in canal command area.
7	Determination of rotation schedule for proposed optimum cropping pattern, and their implementation strategies.
8	Comparison of existing and optimized cropping pattern, Study of gaps in adoption of advanced irrigation systems in command area.
9	Performance evaluation of existing and optimized water distribution schedule (equity, adequacy and reliability)
10	Deliberations with the irrigation officials for adoption of optimized cropping pattern and water distribution schedules.

GAE-IDE-477 - 4: Irrigation and Nutrient Management in Greenhouse

Week	Topics to be covered
1	Fundamentals of Greenhouse Technology, site selection, classification, components, frame and covering materials.
2	Greenhouse standards, Determination of different components/materials for the greenhouse of different sites/shapes, Economics of crop production in greenhouse.
3	Different types of media, media preparation and its fumigation, bed preparation, studies of different systems in greenhouse.
4	Instruments/equipments used in greenhouses for environmental control and monitoring.
5	Types of micro-irrigation systems for greenhouse and their components and working principles, design and layouts. Installation, operation and maintenance of micro-irrigation systems. Installation/operation and maintenance of greenhouses.
6	Estimation of irrigation water requirement of crops. Estimation of daily crop co-efficient. Use of standard methods/software, mobile apps for estimation of water requirement
7	Operation of irrigation schedules in greenhouse, water quality, determination of fertigation doses, Performance evaluation of micro irrigation system in greenhouse.
8	Nutrition application equipments and management.
9	Package of practices of different crops.
10	Visit to various industries dealing with manufacturing of micro-irrigation system and greenhouse.

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

Syllabus:

Theory:

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; 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; Laminar flow: Stress strain relationships, flow between infinite parallel plates both plates fixed, one plate moving, discharge, average velocity; Laminar and turbulent flow in pipes, general equation for head loss Darcy, Equation, Moody's diagram, Minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic gradient and energy gradient; 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, 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, dimensionless numbers. Introduction to fluid machinery.

Practical:

Study of manometers, Study of pressure gauges, Verification of Bernoulli's theorem, Determination of coefficient of discharge of venturimeter, Determination of coefficient of discharge of orifice meter, Determination of coefficient of friction in pipeline, Determination of coefficient of discharge for rectangular notch, Determination of coefficient of discharge for triangular notch, Determination of coefficient of discharge for trapezoidal 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 metacentric height, Determination of efficiency of hydraulic ram, Study of current meter, Velocity distribution in open channels and determination of Manning's, coefficient of rugosity.

Teaching Schedule theory with weightages(%)

Lecture No.	Topics	Article No.	Page No.	Book	Weightage, (%)
Unit I					
1	**Properties of fluids:** Introduction, properties of fluid like mass density, specific weight, specific volume, specific gravity, viscosity, types of fluids,	1.1, 1.2.1, 1.2.2., 1.2.3, 1.2.4, 1.3, 1.3.1, 1.3.2, 1.3.3, 1.3.4, 1.3.5	1-8	1	15
2	Compressibility, surface tension, and capillarity	1.5, 1.6,	22-25	1	
3	**Pressure and its measurement:** Fluid pressure at point, pascal's law, absolute, gauge, atmospheric and vacuum pressure	2.1, 2.2, 2.4,	32-33 38-39	1	
4,5,6,7	**Measurement of Pressure:** **Simple manometers:** piezometer, U-tube manometer, single column manometer, **Differential manometers:** U-tube differential	2.5, 2.6, 2.7,	39-48	1	
	Manometers, Inverted U-tube differential manometer, Mechanical gauges	2.6	70-72	2	
Unit II					
8,9,10	**Pressure forces on plane and curved surfaces:** Introduction, total pressure and center of				15
	pressure, vertical plane surface submerged in liquid, horizontal plane surface submerged in liquid, inclined plane surface submerged in liquid, curved surface sub-merged in liquid.	3.1, 3.2, 3.3, 3.4, 3.5, 3.6	65-67 81-83 90-92	1	
11,12	**Buoyancy and Floatation:** Introduction, buoyancy, center of buoyancy, meta-centre, metacentric height, analytical method for metacentric height	4.1, 4.2, 4.3, 4.4, 4.5, 4.6	110-111 114-117	1	
13	Conditions of floatation and stability of submerged and floating bodies	4.7	121-122	1	

Unit III					
14	**Kinematics of fluid flow:** Introduction, methods of describing fluid motion, types of fluid flow, continuity equation, continuity equation in three-dimensions,	5.1, 5.2, 5.3, 5.4, 5.5, 5.6,	139-141 145-146	1	20
15	**Description of the flow pattern:** Path lines, streak lines and stream lines, stream tube **(only definitions)**	6.4	245-248	2	
	Rotational and irrotational flow and circulations and vorticity **(only definitions)**	6.8 6.9	266-267 269-270	2	
	Velocity potential function and stream function	**5.8**	**152-155**	**1**	
	Velocity potential function, Stream function, Equipotential lines, line of constant stream function, flow net, relation between stream function and velocity potential function **(only theory)**	**5.8.1, 5.8.2, 5.8.3, 5.8.4, 5.8.5, 5.8.6**			
16	**Dynamics of flow:** Introduction, equations of motion, Euler's equation of motion. Assumptions, Bernoulli's equation for real fluid,	6.1, 6.2, 6.3, 6.5, 6.6, 6.7	233-235 239	1	
17	Venturimeter, practical applications of Bernoulli's equations Orifice meter Nozzle (Pitot-tube) Siphon	6.7.1 6.7.2 6.7.3 11.6	241-243, 253-255, 257-258, 402	1 1	
Unit IV					
18,19,20	**Flow through notches, weirs:** Introduction, classification of notches and weirs,	8.1, 8.2	319-320	1	10
	Discharge over a rectangular notch or weir	8.3	320	1	
	Discharge over a triangular notch or weir	8.4	321	1	
	Discharge over a trapezoidal notch or weir	8.6	325-326	1	
	Discharge over a stepped notch	8.7	326	1	
	Advantages of triangular notch or weir over rectangular notch or weir	8.5	324-325	1	

21	**Flow through orifices and Mouth pieces:** Introduction, classifications of orifices, Classifications of mouthpiece	7.1, 7.2, 7.12	285 & 306	1	
	Flow through an orifice	7.3	285-286	1	
	Hydraulic coefficients	7.4	286-287	1	
	Flow through an external cylindrical mouthpieces	7.13	306-307	1	
Unit V					
22, 23	**Flow in open channels:** Introduction, classification of flow in channels	16.1, 16.2	664-665	1	30
	Discharge through open channel by Chezy's formula and Manning's formula, Bazin formula, Ganguillet-Kutter's formula,	16.3, 16.4 16.4.3	666-667 672	1	
	Most economical section of channel	16.5, 16.5.1 16.5.2, 16.5.3	675-676 678-680 688-689	1	
	Hydraulic jump	10.1, 10.2	521-522	3	
24,25	**Laminar flow:** Introduction to laminar flow	13.1	605	2	
	Turbulent flow: Introduction, Reynolds experiment Frictional loss in pipe flow	10.1, 10.2, 10.3	391-394	1	
	Shear stress in turbulent flow	10.4	395-396	1	
	Velocity distribution in turbulent flow in pipes	10.5	396-397	1	

26,27	**General equation of head loss:** Introduction, loss of energy in pipes	11.1 11.2	420	1	
	Darcy-Weisbach equation, Chezy's equation	11.3	420-421	1	
	Minor head losses	11.4	425-428 434-436	1	
	Hydraulic gradient and energy line	11.5	443-444	1	
28, 29	**Flow through network of pipes:**				
	Flow through pipes in series	11.7	454-455	1	
	Flow through pipes in parallel pipes	11.9	459	1	
	Flow through branched pipes	11.10	474-475	1	
	Power transmission through pipe, siphon	11.11 11.15	480-481	1	
Unit VI					
30, 31	**Dimensional analysis and similitude.** Introduction, secondary or derived quantities, dimensional homogeneity	12.1, 12.2, 12.3	502-504	1	10
	Methods of dimensional analysis: Rayleigh's method Buckingham's π - theorem	12.4 12.4.1 12.4.2	504-509	1	
	Types of similarities (similitude)	12.6	522-523	1	
	Types of forces acting in moving fluid	12.7	523-524	1	
	Dimensionless numbers	12.8	524-525	1	
32	**Introduction of fluid machinery:** Definition. Only names of fluid machinery. Hydraulic ram in details.	25.1, 25.5	889, 901-902	1	

Practicals:

1. Study of manometers.
2. Study of pressure gauges.
3. Verification of Bernoulli's theorem.
4. Determination of coefficient of discharge of venturimeter
5. Determination of coefficient of discharge of orifice meter.

6. Determination of coefficient of friction in pipeline.
7. Determination of coefficient of discharge for rectangular notch
8. Determination of coefficient of discharge for triangular notch
9. Determination of coefficient of discharge for trapezoidal notch
10. Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice.
11. Determination of coefficient of discharge for mouth piece.
12. Determination of metacentric height.
13. Determination of efficiency of hydraulic ram
14. Study of current meter
15 -16. Velocity distribution in open channels and determination of Manning's coefficient of rugosity.

Suggested reading

Text books

Sr. No.	Title	Author	publication
1	A text book of fluid mechanics and hydraulic mechanics (Eighth edition)	Dr. R.K. Bansal	Laxmi Publications (P) Ltd. New Delhi
2	Hydraulics and fluid mechanics (including hydraulic machines) (Thirteenth edition)	Dr- P.N. Modi & Dr. S.M. Seth	Standard Book House, Delhi-6
3	Irrigation Engineering and Hydraulic Structures	S.K.Garg	Khanna Publisher, New Delhi

Reference books

Sr. No.	Title	Author	Publication
4	Fluid mechanics	Dr. Jagdish Lal	Metropolitan books CI. Pvt. Ltd. New Delhi

Course No.	**:**	**IDE- 242**	**Course Title**	**:**	**Irrigation Engineering**
Semester	**:**	**IV**	**Credits**	**:**	**3 (2+1)**

Syllabus:

Theory:

Major and medium irrigation schemes of India, purpose of irrigation, environmental impact of irrigation projects, source of irrigation water, present status of development and utilization of different water resources of the country; measurement of irrigation water: weir, flumes and orifices and other methods; 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; 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, water and 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 gravimetric method, Measurement of soil moisture by tensiometer, gypsum block, Determination of bulk density, Measurement of irrigation water using weir, notch, orifices, Measurement of irrigation water using flumes and siphon tubes, Measurement of infiltration using double ring infiltrometer, Determination of field capacity, wilting point using pressure plate apparatus, Determination of field capacity, wilting point using pressure field method, Estimation of evapotranspiration based on climatological data by Penman-Monteith, Hargreaves-Samani and pan evaporation, Design of irrigation open channel, Design of underground pipeline system, Estimation of irrigation efficiencies, Study of advance, recession and computation of opportunity time, Evaluation of border Irrigation method, Evaluation of furrow irrigation method, Evaluation of check basin irrigation method.

Teaching Schedule:

Lecture No.	Topics		Page No.	Book	Weightage, (%)
Unit I					
1	Sources of irrigation water Surface water sources Ground water resources		21-44 15-16	1 2	25
2	Present status of development and utilization of different water resources of the country			Recent notes to be circulated	
3	Major and medium irrigation schemes of India			(Recent notes to be circulated)	
4, 5	Purpose of irrigation, environmental impact of irrigation projects		FAO publication	(Recent notes to be circulated)	
6,7,8	Measurement of irrigation water: flumes and orifices and other methods	Chapter 5	290-310	1	
9,10	Open channel Water conveyance system, Design and lining of irrigation field channels, On farm structures for water conveyance, control & distribution	Chapter 5	311-347	1	
11,12	Underground pipe conveyance system: components and design	Chapter 7	351-355, 361-370	1	
13,14,15	Land grading: Criteria for land leveling Land leveling design methods (plane method) Estimation of earthwork quantities	Chapter 8	 382-384 387-389 398-401	1	
Unit II					
16,17,18	Soil plant water relationship: Soil properties influencing irrigation such as soil texture, soil Structure, bulk density, capillary and non capillary pores, soil consistency, Volume and mass relationships of soil constituents, kinds of soil water	Chapter 9	421-429 444-445	1	35
19,20	Infiltration: Soil water potential, soil moisture characteristics Movement of water into soils: Infiltration, factors affecting	Chapter 9	445-450	1	

	infiltration rate, measurement of infiltration, Infiltration equation y=at + b				
21,22	Soil moisture constants: Saturation capacity, field capacity, moisture equivalent, permanent wilting percentage, available water. Soil moisture stress and plant response	Chapter 9	454-459 469-470	1	
23	Water requirements of crops: Concept of evapotranspiration (ET) Water and irrigation requirements of crops	Chapter 9	478-485	1	
24	Measurement of evapotranspiration Lysimeter experiment, field experimental plots, soil moisture depletion studies, Water balance method.	Chapter 10	488-490	1	
Unit III					
25	Estimation of evapotranspiration from climatological data: Balaney-Criddle method Thornthwaite formula Selection of crop coefficient for Estimating ET (crop)	Chapter 10	490-494	1	20
	Penman-Monteith (FAO 56) Jeansen-Haise, Hargreaves-Samani			Notes to be circulated	
26	Depth of irrigation: Net irrigation requirement Gross irrigation requirement	Chapter 10	518-520	1	
27	Irrigation frequency Irrigation period	Chapter 10	518-520	1	
28	Irrigation efficiencies	Chapter 10	523-527	1	
Unit IV					
29	Surface irrigation methods: Introduction and classification	Chapter 11	554-555	1	20
30	Border Irrigation: Introduction, types, adaptability, specification Hydraulic of border irrigation, Design of Border irrigation	Chapter 11	555-564	1	

31	Check basin irrigation: Introduction, types, specifications, Hydraulic of check basin irrigation Design of check basin irrigation	Chapter 11	564-567	1	
32	Furrow irrigation: Introduction, types, specifications, Hydraulic of furrow irrigation, Design of Furrow irrigation, contour irrigation	Chapter 11	668-673	1	

Practicals:

1) Measurement of soil moisture by gravimetric method.
2) Measurement of soil moisture by tensiometer, gypsum block.
3) Determination of bulk density.
4) Measurement of irrigation water using weir, notch, orifices.
5) Measurement of irrigation water using flumes and siphon tubes.
6) Measurement of infiltration using double ring infiltrometer.
7) Determination of field capacity, wilting point using pressure plate apparatus.
8) Determination of field capacity, wilting point using pressure field method.
9) Estimation of evapotranspiration based on climatological data by Penman- Monteith, Hargreaves-Samani and pan evaporation.
10) Design of irrigation open channel.
11) Design of underground pipeline system.
12) Estimation of irrigation efficiencies.
13) Study of advance, recession and computation of opportunity time.
14) Evaluation of border Irrigation method.
15) Evaluation of furrow irrigation method.
16) Evaluation of check basin irrigation method.

Suggested readings

Text books

Sr. No.	Title	Author	Publication
1	Irrigation theory and practice	A.M. Michael	Vikas publishing house Pvt. Ltd. New Delhi 2 nd Edition
2	Irrigation Water Management Principles and Practice	Dilip Kumar Majumdar	PLrentice-Hall of India Pvt. Limited. New Delhi

Reference books

Sr. No.	Title	Author	Publication
3	Land and Water Management Engineering	V.V.N. Murthy	Kalyani publishers, New Delhi
4	Irrigation Principles and Practice	Israelsen and Hunson	
5	Crop evapotraspiration (Guidelines for computing crop water requirements) FAO-56	Pereira, D. Raes, M. Smith	FAO, Rome
6	Design and Operation of Irrigation System	Ed. M.E. Jenson	ASCE

Course No.	**:**	**IDE- 353**	**Credits**	**:**	**3=2+1**
Course Title	**:**	**Groundwater, Wells and Pumps**	**Semester**	**:**	III

Syllabus:

Theory:

Occurrence and movement of ground water; aquifer and its types; classification of wells, fully penetrating tubewells and open wells, familiarization of various types of bore wells; design of open wells; groundwater exploration techniques; methods of drilling of wells: percussion, rotary, reverse rotary; design of tubewell and gravel pack, installation of well screen, completion and development of well; groundwater hydraulics-determination of aquifer parameters by different method such as Theis, Jacob and Chow's, Theis recovery method; well interference, multiple well systems, estimation of ground water potential, quality of ground water; artificial groundwater recharge techniques; 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; 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, Design of gravel pack and well screen, Estimation of specific yield and specific retention, Estimation of aquifer parameters by Theis method, Estimation of aquifer parameters by Coopers-Jacob method, Estimation of aquifer parameters by Chow method, Theis Recovery method, Design of well under confined and unconfined conditions, Well losses and well efficiency, 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, Study of centrifugal pump, Installation and testing of centrifugal pump, Study and Installation of submersible pump.

Teaching Schedule:

Lecture No.	Topics	Article No.	Page No.	Book	Weightage, (%)
Unit I					
(A)	**Ground water and wells**				20
1	**Occurrence and movement of ground water:** Origin and age of groundwater, rock properties affecting groundwater, Important definitions, hydraulic Conductivity, transmissibility, coefficient of storage, specific yield, hydraulic resistance, leakage factor	-- 2.2	23-28, 6-8 59-63	2, 3 1	
2	**Aquifer and its types**	1.2	7-9	1	
3	**Classification of wells** Fully penetrating tubewells and open wells, Familiarization of various types of bore wells	1.10	25-28	1	
4	**Steady and transient flow into partially, fully and non penetrating and open wells:** Steady state flow to wells in unconfined aquifers Steady state flow to wells in confined aquifers Unsteady state flow to wells in unconfined aquifers Unsteady state flow to wells in confined aquifers	2.3 2.4	63-71 74-76	1 1	
Unit II					
5	**Ground water exploration techniques** Surface investigations of groundwater, sub surface investigations of groundwater	1.11	33-39	1	25
6	Design of open well	3.2	99-114	1	
7	**Methods of drilling of wells:** Drilling equipment and methods, Percussion drilling Rotary drilling Reverse rotary drilling	5.2 5.3 5.4 5.6 5.10	222-229 241-242 258-	1	

		5.11	260		
8	**Design of tubewell and gravel pack:** Design of tube well, analysis of particle-size distribution of the aquifer, design of housing pipe and well casing, bore size and well depth, selection of strata to be screened	4.9 4.10 4.11 4.12	192-197	1	
9	**Installation of well screen:** Design of well screen, slot opening, percent open area, diameter of the screen	4.13	198-202	1	
10	**Design of gravel pack:** design criteria for gravel pack, Gravel pack material, screening of gravel	4.14	202-210	1	
11	**Completion and development of well**	6.1, 6.2, 6.3	310-329	1	
Unit III					
12	**Groundwater hydraulics aquifer parameters determination:** Theis method Cooper-Jacob method Chow method Recovery method (Theis)	2.4	75-84	1	15
13	**Well interference**	2.6	88-91	1	
14	**Multiple well systems**	4.5	179-180	1	
15	**Ground water quality**		291-301	2	
16	**Artificial ground water recharge techniques** Concept of artificial recharge, Recharge methods	1.12	39-42	1	
17	**Estimation of ground water potential**	Notes to be circulated			

Unit IV					
(B)	**Pumps**				20
18	**Pumping systems and machinery:** Principles of lifting and moving of water, water lifting devices: scoop, swing basket, Archimedean screw, counterpoise bucket lift, Persian wheel	10.1 10.2 10.3 10.4	486-513	1	
19	**Classification of pumps**		487	1	
20	**Centrifugal pump:** Classification of variable displacement pumps, principles of operation of centrifugal pumps, classification of centrifugal pump	12.1 12.2 12.3	619-630	1	
21	**Power requirements in pumping**	12.8	640-644	1	
22	**Pump characteristic curves**	12.9	645-648	1	
23	**Pump performance:** Effect of change of speed on head, capacity, power and efficiency Effect of change of impeller diameter on head, capacity, power and efficiency System head curve	--	650-652	1	
Unit V					
24	**Selection of centrifugal pump**	12.11	652-657	1	20
25	**Design of centrifugal pumps**	13.1	676-683	1	
26	**Centrifugal pump installation and trouble shooting:** Location, pump foundation, installation of centrifugal pump in shallow/deep open well and in tube well	14.1 14.2 14.3 14.4 14.5	708-711 716-727	1	
27	Trouble-shooting in centrifugal pumps		737-744		

28	**Propeller pumps:** Introduction, principles of operation, construction, operating characteristics, installation	16.1 16.2 16.3 16.4	797-806	1	
29	**Mixed flow pumps:** Principles of operation, operating characteristics and installation, selection of mixed flow pump	16.8 16.9 16.10	812-815	1	
30	**Priming and self Priming**	3.6	225-226	4	
31	**Rotodynamic pumps:** **Deep well turbine pump:** Introduction, principle of operation, construction, characteristics of pump, selection of pump	15.1 15.2 15.3 15.4	747-755	1	
32	**Submersible pumps:** Introduction, construction, installation, operation of pump, common troubles in operation and remedies	15.11 15.12 15.14 15.16	780-795	1	

Practicals:

1. Verification of Darcy's Law
2. Study of different drilling equipments
3. Design of gravel pack and well screen
4. Estimation of specific yield and specific retention
5. Estimation of aquifer parameters by Theis method.
6. Estimation of aquifer parameters by Coopers-Jacob method.
7. Estimation of aquifer parameters by Chow method.
8. Theis Recovery method
9. Design of well under confined and unconfined conditions
10. Well losses and well efficiency
11. Estimating ground water balance
12. Study of artificial ground water recharge structures
13. Study of radial flow and mixed flow centrifugal pumps, multistage centrifugal pumps, turbine, propeller and other pumps
14. Study of centrifugal pump.
15. Installation and testing of centrifugal pump.
16. Study and Installation of submersible pump.

Suggested Readings

Text books

Sr. No.	Title	Author	Publication
1	Water well and pump engineering (9^{th} Edition, 2005)	A.M.Michael and S.D.Khepar	Tata McGraw-Hill publishing Company Ltd. New Delhi
2	Groundwater hydrology (2^{nd} Edition)	David Keith Todd	John Wiley and sons, New York (International Book Disturbing Co. Lucknow)
3	Irrigation: Theory and Practices	A.M. Michael	Vikas publishing house Pvt. Ltd. New Delhi

Reference books

4	Groundwater Assessment and Management (11^{th} Edition, 2007)	K.R.Karanth	Tata McGraw-hill publishing Company Ltd. New Delhi.
5	Irrigation Engineering and Hydraulic Structures (14^{th} Edition, 1999)	S.K.Garg	Khanna Publisher 2-13 Nath Market Naisaraf Delhi-06
6	Groundwater hydrology (International student Edition)	Herman Bouwer	McGraw-hill publishing Company Ltd. New York.

Course No.	**:**	**IDE-354**	**Credits**	**:**	**3 =2+1**
Course Title	**:**	**Drainage Engineering**	**Semester**	**:**	**V**

Syllabus:

Theory:

Drainage, objectives of drainage, familiarization with the drainage problems of the state. Surface drainage, drainage coefficient, types of surface drainage, design of open channel, subsurface drainage purpose and benefits, investigations of design parameters, hydraulic conductivity, drainable porosity, water table etc., drainage criteria, types and use of subsurface drainage system. Design of surface drains, interceptor and relief drains. Derivation of ellipse (Hooghoudt's) and Ernst's drain spacing equations. Steady and unsteady state groundwater condition, dynamic equilibrium concept. Design of subsurface drainage system. Drainage materials, drainage pipes, drain envelope. Layout, construction and installation of drains. Drainage structures. Vertical drainage. Bio-drainage. Tile drains. Drainage of irrigated and humid areas. Salt balance, reclamation of saline and alkali soils. Leaching requirements, conjunctive use of fresh and saline waters. Economic aspects of drainage.

Practical:

In-situ measurement of hydraulic conductivity by single auger hole method, *In-situ* measurement of hydraulic conductivity by inverse auger hole method, Determination of drainage coefficients, Installation of piezometer and observation well, Preparation of iso- bath and isobar maps, Determination of drainable porosity by sand tank model, Determination of drainable porosity using field method, Design of surface drainage systems, Design of subsurface drainage systems, Determination of chemical properties of soil and water (EC, pH, ESP or SAR), Cost analysis of surface and sub-surface drainage system, Visit to subsurface drainage project and drainage material manufacturing industry.

Teaching Schedule:

Lecture No.	Topics	Article No.	Page No.	Book	Weightage, (%)
Unit I					
1	Drainage: Introduction, definition, Drainage problem of the state and country, Causes and effect of waterlogging, prevention and control of waterlogging.	1.1, 1.2, 1.3, 1.4, 1.5,	1-17	1	10
2	Need of drainage, purpose of drainage, effect of Drainage requirement of various crops	1.6 1.7	18-23	1	
3	Interrelationship of irrigation and drainage	2.1, 2.2, 2.3, 2.3.1, 2.3.2	27-40	1	
Unit II					
4, 5	Surface drainage: Introduction, surface drainage system and components, factors affecting drainage, types of land requiring drainage Drainage coefficient	20.1 20.2	799-807	2	30
6	Types of surface drainage: Surface drainage for flat areas, Surface drainage for sloping areas, Interceptor drains	20.4- 20.6	814-817, 821-825	2	
7, 8 , 9	Design of surface drainage system: Design consideration, design of surface drainage system, hydraulic design of open channel (drain)	6.4 6.9	230-234 255-261	1	
10, 11	Subsurface drainage, Drainage properties-Structure and texture, Drainable porosity, Hydraulic conductivity	- - -	480-481 80-82 87-97	3 4 4	
12	Subsurface drainage system: Introduction, general considerations, Components of subsurface drainage system and different layouts of subsurface drainage system	8.1 21.1 21.3.7	352-353 827 846-849	1 2 2	

Unit III					
13, 14,	Derivation of ellipse (Hooghoudt's),	--	149-156	4	35
15	Ernst's drain spacing equations,	8.4.3	366-369	1	
	Unsteady state equation (Glover-Dumn) without	8.3.1	284-287	1	
	derivation				
16, 17	Dynamic equilibrium concept	2.4.4	47-48	1	
18	Drainage criteria for steady and unsteady state				Notes to be circulated
19	Design of subsurface drainage system- problems	-	-	-	Notes to be circulated
20, 21	Drainage materials: Drainage pipes, envelop	21.3.2 21.3.4		2	
	materials and drainage structures,				
	Design of gravel envelope	21.3.3	830-844	2	
22, 23	Installation of subsurface drainage system	8.12.3 to	418-426	1	
		8.12.8			
24	Subsurface drainage system design:	8.3	355-358	1	
	Procedure, hydraulic design of subsurface drains	8.8	391-400		
25	Mole drainage,	21.7	313-314	2	
	Bio-drainage,	8.16.3	460-466	1	
	Vertical/well drainage	-	579-580	3	
		14.1-14.5	225-228	4	
Unit IV					
26	Types of salt affected soil	7.3			25
	Chemical properties of soil,	7.10	313-315	1	
	Classification of soil	15.2.4	540-542	2	
27, 28	Reclamation of saline and alkali soils,	7.12.2	320-323	1	
	Leaching requirement and methods,	7.12.4 to	323-333		
		7.12.6			
	Gypsum requirement	7.13	337-346		
29	Salt balance	15.3	544-548	2	
30	Economic aspect of drainage- problem	8.10	438-446	1	
31	Drainage for humid area, irrigated area				Notes to be circulated
32	Conjunctive use of fresh and saline water				

Practicals:

1. *In-situ* measurement of hydraulic conductivity by single auger hole method
2. *In-situ* measurement of hydraulic conductivity by inverse auger hole method
3. Determination of drainage coefficients

4-5. Installation of piezometer and observation well

6. Preparation of iso- bath and isobar maps
7. Determination of drainable porosity by sand tank model

8. Determination of drainable porosity using field method

9-10. Design of surface drainage systems

11-12. Design of subsurface drainage systems

13. Determination of chemical properties of soil and water (EC, pH, ESP or SAR)

14. Cost analysis of surface and sub-surface drainage system

15-16. Visit to subsurface drainage project and drainage material manufacturing industry

Suggested Readingsd

Text books

Sr. No.	Title	Author	Publisher
1.	Agricultural Drainage: Principles & Practices (1st Edition)	U.S.Kadam, R.T.Thokal, Sunil Gorantiwar, A.G,Powar	Westville Publishing House, New Delhi
2.	Drainage Principles and Applications	H. P. Ritzema	ILRI Publication 16, Netherlands.
3	Principles of Agricultural Engineering Vol. II (1st edition)	A.M.Michael and T.P. Ojha	Jain Brothers Jodhpur
4	Drainage Engineering	J.N.Luthin	Wiley Eastern Pvt. Ltd. New Delhi

Reference books

Sr. No.	Title	Author	Publisher
1.	Land Drainage Principles, Methods and Applications	A.K.Bhattacharya A.M.Michael	Vikas Publishing House Pvt Ltd., New Delhi

Course No:- IDE-365 **Title :- CANAL IRRIGATION MANAGEMENT**

Credit- 2=1+1 **Semester:-VI**

Syllabus:

Theory:

Description of components of irrigation canal system, their functions, planning and layout of canal irrigation system, preliminary design procedure for irrigation project, crop water requirement, duty and delta, specific discharge of canal, design of canal by Kennedy and Lacey's theory and tractive force approach, Canal seepage and lining of canal, design of lined canal and economics.

Diversion head works and canal head regulators, theories of seepage, cross drainage works, canal falls, irrigation structures on distributory and minor, regulator and modules, maintenance of canal.

Practical:

Irrigation water requirement of crops based on duty, delta concept, Design of canal by Kennedy's and Lacey's theory, Design of lined irrigation canal, Planning and layout of water conveyance system, Study of canal outlets, Study of straight Glacis fall, Study of aqueduct, Conjunctive water use planning, Study of irrigation distribution schedule (Warabandi and Shejpali), Visit to canal irrigation projects.

Teaching Schedule:

Lecture No.	Topic	Article no.	Page no.	Book	Weightage, (%)
Unit I					
1	Introduction to irrigation development and status		xx-xxi	1	20
	Components of irrigation canal system:				
	Planning and layout of canal irrigation system	3.1 3.2 3.3	63-66	1	
	Distribution system for canal irrigation	3.4	66-68	1	
2-3	**Preliminary design procedure for irrigation project**	12.2 -12.6	251 -255	2	
	Diversion head works: Weir and barrage, gravity and non gravity weirs, layout of a diversion head works and components, certain important definitions Fish ladder Canal head regulators Silt control devices	 9.1 9.2 9.3.1 9.3.2 9.3.3 9.3.6 9.3.7 9.3.8	 600-608 612-615 615-621 622-623	 1	
Unit II					
4	Crop water requirement: Introduction, crop period and base period, duty and delta of a crop, certain important definitions	2.1 2.2 2.3 2.5	25-31 32-35	1	40
5	Specific discharge of canal: Certain important definitions, Determination of required channel capacity	 3.6 3.7	 69-70 70-84	1	
6,7	Design of canal: i. Tractive force approach ii. Kennedy's theory iii. Lacey's theory Comparison of Kennedy's and Lacey's theory	 4.1 – 4.4 4.7.3 4.7.4 4.7.5	 90 -94 108 -116 116 – 122 122- 123	 1 1 1 1	
8	Canal seepage: Causes of failure, Blight's creep theory, Lane's weighted creep theory	 11.1 11.2 11.3	 643-647	 1	

9	Lining of canal: Advantages of lining, financial justification & economics of canal lining	5.1 5.2 5.3	184- 194	1	
10,11	Design of lined irrigation channel	5.5 5.6	195 – 200	1	
Unit III					
12	**Cross drainage works:** Types of cross drainage works, selection of drainage work, Types of cross drainage works	14.1 14.2 14.3	841-848	1	30
13	**Canal falls:** Definition, location, types of falls	12.1 12.2	734-744	1	
14	Canal regulator: Canal regulator works, alignment of the off-taking channel, Distributary head regulator and cross regulator	13.1 13.2 13.3 13.4	797-800	1	
15	Canal outlet or modules: Requirements of good modules, types of modules. Criteria for judging the performance of modules, certain important definitions	13.8 13.9 13.10 13.11 13.12 13.13 13.14	817 - 836	1	
Unit IV					
16	**Maintenance of irrigation canal**	4.13	175-179	1	10

Practicals:

1-2. Irrigation water requirement of crops based on duty, delta concept
3-4. Design of canal by Kennedy's and Lacey's theory
5-6. Design of lined irrigation canal
7-8. Planning and layout of water conveyance system
9. Study of canal outlets
10-11. Study of straight Glacis fall
12. Study of aqueduct
13. Conjunctive water use planning
14. Study of irrigation distribution schedule (Warabandi and Shejpali)
15-16. Visit to canal irrigation projects

Suggested readings

Text books

Sl. No.	Title	Author	Publisher
1	Irrigation Engineering and Hydraulic Structures (12 th Revised edn)	Santosh Kumar Garg	Khanna Publishers, New Delhi
2	Irrigation Engineering and Hydraulic structures	S.R. Sahastrabudhe	--

Reference books

Sl. No.	Title	Author	Publisher
3	Irrigation Theory and Practice	A.M. Michael	Vikas Publishing house Pvt. Ltd, New Delhi
4.	Operation and management of irrigation system in Maharashtra State, Second Edition, Pub No. 20	-	WALMI Publications, Aurangabad
5	Water distribution practices in Maharashtra State, Pub No. 22	-	WALMI Publications, Aurangabad

Course No. : IDE 366 **Title: Sprinkler and Micro irrigation Systems**
Sem:-VI **Credits: 2(1+1)**

Syllabus:

Theory:

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 unit for sprinkler irrigation system; performance evaluation of sprinkler irrigation system: uniformity coefficient and pattern efficiency;

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

Teaching Schedule:

Lecture No.	Topics	Article no.	Page no.	Book	Weightage, (%)
Unit I					
1	**Sprinkler Irrigation:** Introduction, problems and prospects, adaptability, limitations, types of systems ,	3.6	578-581 37-45	2 3	20
	Components of the sprinkler system		581-585	2	
2	**Uniformity and efficiency:** Moisture distribution patterns and uniformity of coverage, uniformity coefficient		587-589	2	
Unit II					
3	**Design of Sprinkler irrigation system:** Inventory of resources, layout of sprinkler system, sprinkler selection and spacing, capacity of the sprinkler system	3.7	589-593 45-48	2 3	25
4	**Hydraulic design of sprinkler systems:** Discharge of sprinkler nozzle, pressure discharge relationship, sprinkler head selection	4.1 to 4.3	49-65	3	
5	Design of sprinkler laterals, submains, main line	4.4, 4.5	65-71	3	
6	Pressure requirement and power units for sprinkler system	4.6-4.7 4.9-4.10	71-72 73-90	3 3	
7	Operation and maintenance of sprinkler, cost economics	7	123-126 595-596	3 2	
Unit III					
8	Micro irrigation: Introduction, merits/demerits, types, components of drip system	 1.3 2.4-2.5	1-9 12-18 611-616 5-6 15-21	1 1 2 4 4	30
9	Design criteria for emitters	3.2	25-34	4	
10	Preliminary design factor for drip design		27-35	1	
	Estimation of water requirement and hydraulics of drip irrigation system	4.1 – 4.3	35-48	4	
11	Emitter design and selection, Design of lateral, submain, main and pump	 4.4	18-22 48-67	1 4	
Unit IV					
12	Clogging and filtration	6 11	76-79 130-139	4 4	25
13	Maintenance and chemigation	7	80-92	4	
14	Fertigation	9	107-124	4	

15	Cost economics of drip system Evaluation of drip irrigation system	4.6.1	67-68	4	
		(Notes to be circulated)			
		8.1-8.2	93-103	4	
16	Automation in drip system	(Notes to be circulated)			

Practicals:

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

Suggested readings

Text book

Sr. No.	Title	Author	Publication
1	Trickle Irrigation Design	Jack Keller and David Karmeli	Rain Bird Sprinkler Manufacturing Co., Clendora, California, USA.
2	Irrigation: Theory and Practice, Second Edition	Michael A.M.	Vikas Publishing Vikas Pub. House New Delhi
3	Principles of Sprinkler Irrigation systems, Second Edition	Mane M.S. and Ayare B.L	Jain Brothers, New Delhi
4	Principles of Drip Irrigation Systems, Third Edition	Mane M.S and Ayare B.L. and Magar S.S.	Jain Brothers, New Delhi

Reference books

5	Design and Evaluation of Irrigation Methods, (IARI Monograph No.1)	Michael AM, Shrimohan and KR Swaminathan	Water Technology Centre, IARI New Delhi
6	Micro Irrigation for Cash Crops, 2006	Choudhary M.L and Kadam U.S	Westville Publishing House
7.	Drip Fertigation for Higher Crop Productivity	Pawar D. D., Dingre S. K., Shinde M. G. and Kaore S. V.	MPKV/Res. Pub. No. 99/2013

Course No. :- ELE - IDE 481 Course Title: - MINOR IRRIGATION AND COMMAND AREA DEVELOPMENT

Semester:- VIII **Ctredit:- 3=2+1**

Syllabus:

Theory:

Major, medium, and minor irrigation projects; factors affecting performance of irrigation projects; development and utilization of water resources. Basic concepts of command area - definition, component, need and scope: historical perspective, organization structure and command area development authorities;

Types of minor irrigation systems in India; 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; On-farm development works, reclamation works, use of remote sensing techniques for CAD works.

Farmers' participation in command area development and water users' association, Water productivity: concepts and measures for enhancing water productivity, benchmarking of irrigation project, performance evaluation of irrigation management in canal command area (productivity, equity, adequacy and reliability), irrigation acts and laws; regulations

Design of gravity pipe distribution network in command area, adoption of micro irrigation systems on canal command and intermediate storages.

Conjunctive utilization of surface and ground water, enhancing the surface and ground water availability, ground water recharge, water balance and budgeting in canal command area and formulation of crop plans. Different measures undertaken for enhancing water availability under *"Jalyukt Shivar"* and water Conservation including farm storage tanks/ponds for protective/supplemental irrigation

Practical

Preparation of command area development layout plan; Irrigation water requirement of crops and preparation of irrigation schedules; Planning and layout of water conveyance system (open canal and closed conduits); determination of storage capacity of tanks and design of tanks; Case study for design of lift irrigation project, performance indicators of irrigation management, water balance and water budgeting in canal command area, determination of crop plan based on water availability and demand, groundwater recharge, design of farm storage tanks/ponds for protective/supplemental irrigation, visits to irrigation project and *"Jalyukt Shivar"*

Teaching Schedule:

Lecture No.	Topic	Weightage, (%)
Unit I		
1-2	Major, medium, and minor irrigation projects; factors affecting performance of irrigation projects;	10
3	Water resources its development, utilization and present status in India.	
4-5	Command area its definition, component, need and scope, command area development authorities, administrative structure interaction/collaboration with water use Societies/Association	
Unit II		
6-7	Minor irrigation systems in India; tank Irrigation: grouping of tanks, storage capacity, supply works and sluices;	20
8-9-10	Lift irrigation systems; its design and components	
11-12	On farm development works, reclamation works, use of remote sensing techniques for CAD works;	
Unit III		
13	Farmers' participation in command area development and water users' association,	25
14-15	Water productivity: concepts and measures for enhancing water productivity,	
16-17	Benchmarking of irrigation project, performance evaluation of irrigation management in canal command area (productivity, equity, adequacy and reliability),	
18	Irrigation acts and laws; regulations	
Unit IV		
19-20-21	Material used for distribution of water under gravity through close conduit, Design of gravity pipe distribution network in command area and its installation	25
22-23	Adoption of micro irrigation systems on canal command and design of intermediate storages, identification of storage site, its capacity, community storage.	
24-25-26	Conjunctive use for enhancing surface and ground water, Ground water availability estimation techniques. Enhancing ground water through recharge techniques.	

Unit V		
27-28	Water balance and budgeting in canal command area and formulation of crop plans.	20
29-30	Government plans for enhancing water availability under "Jalyukt Shivar" and its evaluation.	
31-32	Design and layout of Water storage units including farm storage tanks/ponds for protective/supplemental irrigation and its economics.	

Practical:

1. Preparation of command area development layout plan
2. Irrigation water requirement of crops based on duty, delta concept
3. Design of irrigation tanks.
4. Planning and layout of water conveyance system

5-6. Design of lift irrigation systems.

7. Study of water conservation structure in command area.

8-9. Evaluation of minor irrigation projects.

10. Design of gravity pipe distribution network in command area.
11. Economic evaluation of internal water storage structure in command area.

12-13. Case study of micro irrigation system in canal command area.

14-16. Field visit for evaluation of '*Jalyukt Shivar'* project

Suggested Reading

Garg S. K. 2014. Irrigation Engineering and Hydraulic Structures, Khanna Publishers New Delhi.

Arora, K.R. 2001. Irrigation, Water Power and Water Resources Engineering. Standard Publishers Distributors, Delhi.

Technical Aspect for Agriculture Project Vol. 1, NABARD, Pub. Nov. 1989

Operation and Management of Irrigation system in Maharashtra State, Second Edition, Pub. No. 20, WALMI Publication Aurangabad

Water distribution practices in Maharashtra State, Pub. No. 22, WALMI Publication Aurangabad

Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Publ.House New Delhi.

Sahasrabudhe SR. 2011. Irrigation Engineering and Hydraulic structures. SK Kataria & Sons Reprint 2015.

PROCESS FOOD ENGINEERING

Course No :	**ELE - PFE 481**	**Course Title :**	**Food Quality and Control**
Semester :	**: VIII**	**Credits :**	**: 3 (2+1)**

Syllabus

Theory

Concept, Objectives and need of food quality. Food quality management –TQM. Food adulteration and food safety. Food Safety management system –GAP ,GHP, GMP, Hazards and HACCP Sanitation in food industry (SSOP) .Food Laws and Regulations in India .FSSAI.CAC(Codex Alimentarius Commission). Food grades and standards BIS, AGMARK ,PFA , FPO ,ISO 9000 ,22000 Series Measurement of colour ,flavour ,consistency,viscosity ,texture and their relationship with food quality and composition .Methods of food Analysis. Subjective and objective tests. Sensory evaluation methods. Instrumental method.

Practical

Determination of moisture content of food product. Determination of protein content of food product. Determination of carbohydrates of food product. Determination of fats of food products. Study on microbial count of food products. Development of HACCP for milk processing .Visit to food testing laboratory .Visit to milk quality testing laboratory

Lesson Plan –Theory

Lect. No.	Title	Book No.	Chapter / Art No.	Page No	Weightage, %
1	Concept, Objectives and need of food quality .	1	Ch 17	269-277	20
2	Food quality management –TQM	1	Ch19	309, 356-358	
3-4	Food adulteration and food safety.	1	Ch 20	311-321 324-336	
5	Food Safety management system –GAP		-	Notes	20
6	Food Safety management system -GHP				
7	Food Safety management system –GMP				
8	Food Hazards	1	Ch 16	257-268	
9 - 10	HACCP	1	Ch 23	359-378	10
11	Sanitation in food industry (SSOP)	1		Notes	
12	Food Laws and Regulations in India	1	Ch 22	337-338	25
13-14	FSSAI .CAC (Codex Alimentarius Commission)	1	Ch22	348	
15-16	Food grades and standards BIS , AGMARK	1	Ch 22	343	
17-19	PFA , FPO , ISO 9000 , 22000 Series		Ch-22	338-356	
20 -21	Measurement of colour, flavour, texture and relationship with food quality and composition .	1	Ch 18	280-285	10
22-23	Measurement of viscosity, consistency and relationship with food quality and composition			Notes	
24-25	Sensory evaluation methods		Ch 18	279-289	15
26-29	Subjective and objective tests .		Ch 18	289-292	
30-32	Instrumental method of food Analysis			Notes	

List of Practical

No.	Title
1	Determination of moisture content of fruits and vegetables
2	Determination of protein content of fruits products
3	Determination of ash content of process products.
4	Determination of carbohydrates of food product
5	Determination of fats of food products
6	Determination of ascorbic acid of fruit products

No.	Title
7	Determination of sugars in fruits products
8	Determination of titatable acidity of food products
9	Determination of carotene content of food products
10	Estimation of microbial load of food products
11	HACCP for processing plants
12	Study on good hygienic practices
13	Determination of food adulterant in milk
14	Sensory evaluation of different products
15	Visit to food testing laboratory
16	Visit to milk quality testing laboratory

Suggested readings

Text Books

No.	Author	Title & Year	Publisher
1.	Dr P Suresh Kumar, Dr V R Sagar, Dr Manish Kanwat	Post harvest physiology and quality management of fruits and vegetables	Agrotech publishing academy 11-A, Vinayak Complex-B,Durga Nursery Road, Udaipur-313001 INDIA

Reference Books

1	Ranganna S.	Hand book of Analysis and Quality Control for Fruits and Vegetables Products.	

Course No : **ELE- PFE 482** **Course Title :** **Process Equipment Design**

Semester : **: VIII** **Credits :** **: 3 (2+1)**

Syllabus

Theory

Introduction on process equipment design. Design parameters and general design procedure, Material specification, Types of material for process equipment, Design codes,Application of design engineering for food processing equipment.

Design ofprocess equipments -Pressure vessel, Tubular heat exchanger, Shell and tube heat exchanger and Plate heat exchanger.

Design of process :Air screen cleaner, Cyclone separator, LSU and spray dryer, Belt conveyer, Screw conveyer and Bucket elevator.

Design of milling equipment.

Optimization of design with respect to process efficiency, energy and cost.

Computer Aided Design for food processing machineries.

Practical

Numerical :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.

Lesson Plan –Theory

Lect. No.	Title	Book No.	Chapter / Art No.	Page No	weightage %
1	Introduction on process equipment design	1	Art 1.1	1	
2	Application of design engineering for processing equipments	1		1	
3	Design parameters and general design procedure	1	Art 1.2	1-3	20
4 - 5	Material specification	1	Art 2.1, 2.2	5-9	
6	Types of material for process equipments	1	Art 2.3	9-12	
7	Design codes	1	Art 1.3	3-4	
8 -9	Pressure vessel design	1	Ch. 3	13-35	10
10- 11	Design of cleaners	3	Ch2	81-87	15
12	Design of cyclone separator	3	Ch2	96-99	
13	Design of tubular heat exchanger	1	Art 5.1, 5.2, 5.3, 5.5	52-58, 58-66	
14 - 15	Design of shell and tube heat exchanger	1	Art 5.6	66-92	20
16 - 17	Design of plate heat exchanger	1	Art 5.7	93-98	
18 - 19	Design of belt conveyer	1	Ch11	181-199	
20 - 21	Design of screw conveyer	1	Ch13	216-227	15
22 - 23	Design of bucket elevator	1	Ch12	201-215	
24 - 25	Design of LSU dryers	2	-	94-99, 106-114	
26 - 27	Design of Spray dryers			Notes	10
28 - 29	Design of milling equipments	1	Ch10	174-180	
30-31	Optimization of design with respect to process efficiency, energy and cost	1	Ch15	233-243	10
32	Computer Aided Design			Notes	

Practical Exercises

Ex. No.	Title
1	Numerical on design of pressure vessels
2	Numerical on design of air screen cleaner
3	Numerical on design of bucket elevator
4	Numerical on design of belt conveyor
5	Study of cyclone separator
6	Numerical on design of screw conveyor
7	Numerical on design of shell and tube heat exchanger.
8	Numerical on design plate heat exchanger.
9	Numerical on tubular heat exchanger.
10	Study on parallel flow and counter flow heat exchanger
11	Numerical on LSU dryer
12	Numerical on spray dryer
13	Numerical on design of milling equipment and hopper
14	Computer assisted design of dryer
15	Computer assisted design of storage vessel
16	Visit to processing machine manufacturing industry

Suggested readings
Text Books

No.	Author	Title & Year	Publisher
1	Phirke P.S.	Processing and conveying equipment design, 2004	Jain Brothers, New Delhi
2	A. Chakraverty	Post Harvest Technology of Cereals, Pulses and Oilseeds, 3rd Edition, 2000	Oxford & IBH Publishing Co. Pvt. Ltd., 66, Janpath, NEW DELHI – 110 001
3	Sahay K. M. and K.K. Singh	Unit operations of agricultural processing. 2nd Edition, 2002,	Vikas Publishing House Pvt. Ltd. 576, Masjid Road, Jangpura, New Delhi – 110 014
Reference Book			
1	M. V. Joshi and V. V. Mahajani	Process Equipment Design	McMillan India, Ltd. New Delhi

Course No :	**ELE PFE 483**	**Course Title :**	**Food Packaging**
Semester :	**: VIII**	**Credits :**	**: 3 (2+1)**

Course Content

Theory

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, 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, 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, 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, Experiment on bottling of fruit products, Aseptic packaging, Modified atmospheric packaging and Visit to packaging industries.

Lesson Plan –Theory

Lect. No.	Title	Book No.	Chapter /ArticleNo.	Page No.	Weightage (%)
1.	Introduction,	7	1	5-6	
	Definition and Functions of packaging	3	1.5	8-9	
2 - 4	Factors affecting shelf life of food material during storage,	7	4	15-16	
	Interactions of spoilage agents with environmental factors as water, oxygen, light, pH, etc. and general principles of control of the spoilage agents;	1	24.1	466 - 474	10
5 - 6	Packaging of foods, requirement, importance and scope,	3	1.3 & 1.4	4-8	
	frame work of packaging strategy,	3	1.6	9	
	Environmental considerations,	1	24.5	502-503	
7 - 8	Packaging systems, types: flexible and rigid; retail and bulk;	3	7.1	174-178	10
	Levels of packaging;	7	3	10	
9 - 10	Different types of packaging materials,	1	24.2	474	
	their key properties and applications,	3	1.7.1.3	16-17	
11.	Metal cans, manufacture of two piece and three piece cans,	1	24.2.2	474 - 477	
12 - 13	Plastic packaging, different types of polymers used in food packaging and their barrier properties.	1	24.2.4	481-483	

Lect. No.	Title	Book No.	Chapter /ArticleNo.	Page No.	Weightage (%)
	Manufacture of plastic packaging materials, profile extrusion, blown film/ sheet extrusion, blow molding, extrusion blow molding, injection blow molding, stretch blow molding, injection molding.	1	24.2.5	487-490	
14 - 15	Glass containers, types of glass used in food packaging, manufacture of glass and glass containers, closures for glass containers.	1	24.2.3	478-481	
16 - 17	Paper and paper board packaging, paper and paper board manufacture process, modification of barrier properties and characteristics of paper/ boards.	1	24.2.6	490-494	40
	Lamination,	1		484-485	
18.	Effect of these materials on packed commodities.	1	24.4	501	
19 - 20.	Printing and labelling, Nutritional labelling on packages,	1	24.3	498-499	
21 - 22	MAP,	7	7	22-24	
23.	Shrink packaging,	2		615-620	
24.	Vacuum packaging;	2		593-594	
25.	Active packaging and Smart packaging,	1	24.2.8	497-498	15
		3	9.1	282-284	
26.	Packaging requirement for raw and processed foods, and their selection of packaging materials,	1		463-465	
27.	Factors affecting the choice of packaging materials,	3	7.10	222-224	10
28.	Disposal and recycle of packaging waste,	3	1.7.1.6	26-28	
29.	Package testing: Testing methods for flexible materials, rigid materials and semi rigid materials;	7	31	105	
30.	Tests for paper (thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply bond test, surface oil absorption test, etc.),	4	8.2.2	-	
31.	Tests for Plastic film and laminates (thickness, tensile strength, gloss, haze, burning test to identify polymer, etc.),	4	8.2.2	-	15

Lect. No.	Title	Book No.	Chapter /ArticleNo.	Page No.	Weight age (%)
	Tests for aluminium foil (thickness, pin holes, etc.),				
32.	Tests for Glass containers (visual defects, colour, dimensions, impact strength, etc.), Tests for metal containers (pressure test, product compatibility, etc.)	7	32	106-107	

Practical Exercises

No.	Title
1	Identification of different types of packaging materials
2	Determination of tensile/ compressive strength of given material/package
3	To perform different destructive and non-destructive tests for glass containers
4	Vacuum packaging of agricultural produces
5	Determination of tearing strength of paper board
6	Measurement of thickness of packaging materials
7	To perform grease-resistance test in plastic pouches
8	Determination of bursting strength of packaging material
9	Determination of water-vapour transmission rate
10	Shrink wrapping of various horticultural produce
11	Testing of chemical resistance of packaging materials
12	Determination of drop test of food package
13	Experiment on bottling of fruit products
14	Aseptic packaging
15	Modified atmospheric packaging
16	Visit to packaging industries

Suggested readings

Text Books

Book No.	Title	Author	Publisher	Year
1.	Food Processing Technology-Principle and Practices. Second Edition	P. Fellow	Wood head Publishing Ltd. Cambridge	2000
2.	Modern Food Packaging	Compiled by Mrs. M. C. Dordi	Indian Institute of Packaging, E-2, MIDC, Indl. Area, Andheri (E), Mumbai400 0093	1998
3.	Food Packaging Technology,	Edited by Coles R., D. McDowell and M.J. Kirwan,	Blackwell Publishing Ltd, CRC Press USA	2003
4.	Handbook of Food Engineering Practice,	Edited by E. Rotstein, R. P. Singh, & K. J. Valentas	CRC Press Boca Raton New York	2003
5	Handbook of food packaging	Frank Albert Paire.		
6	Packaging of food products	A. P. Vaidya	Indian Institute of Packaging, E-2, MIDC, Indl. Area, Andheri (E), Mumbai 400 093	
7.	Food Packaging – Study Material (e - Lecture Notes)	KaleemullahS.	Department of Food Engineering, College of Food Science & Technology, (ANGRAU) Pulivendula	

Department of Agricultural Process Engineering

(Lesson plan for 10 weeks experiential learning on campus)

Semester	VII
Credits	10(0+10)
Course no.	GAE 475-1
Title	Processing of cereals, pulses and oil seeds
Nodal Department	Department of Agricultural Process Engineering

Objectives:

1. To acquaint the students in the field of cereal, pulses and oil seed processing.
2. To acquaint the students for different unit operations, processing of cereal, pulses and oil seed its marketing.
3. To estimate the cost economics of different products,

Layout of work

Duration (weeks)	**Work**
0-1	Orientation to processing of cereals, pulses and oil seeds, present status and future prospectus of processing and value addition Introduction of machineries used in cereals, pulses and oil seed processing
2	Procurement of raw material Primary processing of cereals, receiving, cleaning, grading and drying
3	Processing of cereals-preparations of products wheat flour, Sevai, noodles
4-5	Processing of pulses: Pigeon pea Packaging and marketing
6-7	Processing of pulses: Green gram & Black gram Packaging and marketing
8-9	Processing of pulses: Bengal gram Packaging and marketing
10	Processing of Soybean: soy-dal, fortified Atta, soy milk, soy paneer, packaging and marketing

Department of Agricultural Process Engineering

(Lesson plan for 10 weeks experiential learning on campus)

Semester	VII
Credits	10(0+10)
Course no.	GAE 475- 3
Title	Cashew Nut Processing
Nodal Department	Department of Agricultural Process Engineering

Objectives:

1. To acquaint the students in the field of Cashew Processing.
2. To acquaint the students for different unit operations, processing of Cashew and its marketing.
3. To estimate the cost economics of different cashew Processing machineries.

Layout of work

Duration (weeks)	**Work**
0-1	Registration and Orientation to Cashew Processing Unit. Introduction of machineries used in Cashew Processing unit.
2	Repair and Maintenance of Cashew processing machineries, its working and energy estimation.
3 – 4	Processing and Preparation of different value added products of cashew nut. Survey of Cashew Processing Units in Ratnagiri.
5 – 7	Packaging labeling and marketing of different Cashew products.
8 -9	Cost economics of different Cashew nut processing products its by products. Preparation of Cashew Processing project reports.
10	Compilation of Report of Experiential Learning Unit of Cashew nut processing. Report writing and Oral presentation.

Department of Agricultural Process Engineering

(Lesson plan for 10 weeks experiential learning on campus)

Semester	VII
Credits	10(0+10)
Course no.	GAE 475- 2
Title	Bakery Products.
Nodal Department	Department of Agricultural Process Engineering

Objectives:

1. To acquaint the students in the field of Bakery Processing.
2. To acquaint the students for different unit operations, processing of grains for bakery and its marketing.
3. To estimate the cost economics of different bakery products,

Layout of work

Duration (weeks)	**Work**
0-1	Registration and Orientation to Bakery Processing Unit. Introduction of machineries used in bakery unit.
2	Repair and Maintenance of Bakery machineries, its working and energy estimation.
3 – 4	Processing and Preparation of different bakery products.
5 – 7	Packaging labeling and marketing of different bakery products.
8 -9	Cost economics of different bakery products. Preparation of bakery project reports.
10	Compilation of Report of Experiential Learning Unit of Bakery Unit. Report writing and Oral presentation.

DEPARTMENT OF PROCESSING AND FOOD ENGINEERING

Lesson plan for 10 weeks Experiential Learning on campus

Semester	:	VII
Credits	:	10(0+10)
Course No	:	GAE-PFE-475-4
Title	:	Fruits and Vegetables Processing
Nodal Department		Agricultural Process Engineering

Objectives:

1) To acquaint the students in the field of Food and Process Engineering
2) To acquaint the students for different processing operations, their value addition and marketing
3) To estimate the cost analysis of the products

Duration (Week)	**Work**
0-1	Registration and orientation of fruits and vegetables processing, present status and future prospects of food processing and value addition, Introduction of machineries used in food processing
2	Maturity indices, grading, sorting, cleaning, washing, pre-cooling, waxing, packaging, storage etc of fruits and vegetables, cold chain management, minimal processing
3-4	Processing and value addition of different fruits i.e. candy, pulp, supari, murrabba, chunda, pickles, chavanprash etc. and their marketing
5-7	Preparation of RTS from different fruits and their marketing
8-9	Preparation of jam, jelly, syrup, squash from fruits and dehydration of fruits and their marketing
10	Compilation of the Report of experiential learning programme Report writing Oral presentation

Layout of Work

RAHURI

Date: 17.07.2017

……..	……..
S. R. Garud Dept. of APE, CAET, Parbhani	V. P. Kad Dept. of APE, Dr. ASCAET, Rahuri.
……..	……..
A. A. Sawant Dept. of APE, CAET, Dapoli.	B. N. Patil Dept. of APE, CAET, Akola
……..	……..
V. L. Kanawade Dept. of APE, Dr. ASCAET, Rahuri.	R. N. Kenghe Dept. of APE, Dr.ASCAET, Rahuri.
……..	……..
S. U. Khodhke Professor & Head, Dept. of APE, CAET, Parbhani.	S. P. Sonawane Professor & Head, Dept. of APE, CAET, Dapoli.
……..	……..
A.P. Patil Professor & Head, Dept. of APE, Dr. ASCAET, Rahuri.	P. A. Borkar Course Coordinator, Professor and Head of APE, CAET, Akola.

Course No.:	**PFE 111**	**Course Title:**	**Thermodynamics**
Credits:	**2(1+1)**	**Semester:**	**I**

Syllabus

Theory

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. Otto, diesel and dual cycles.

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,

Steam, Generation of steam, Types of steam, Properties of steam, Phase change, Dryness fraction, critical point of water.

Practical

Tutorials on thermodynamic air cycles, Study and application of P V and T S chart, Study of psychrometic charts with numericals, Study of vertical boiler, Cochran boiler, Lancashire boiler, Locomotive, Babcock-wilcox boiler., study of various mountings of Boilers, Study of various accessories of boilers, Performance of steam boiler, study of steam tables and numericals.

Lesson Plan -Theory

Lect. No.	Title	Book No.	Chapter / Art No.	Page No	Weightage (%)
1.	Introduction, Definitions, units and systems	1	1.1-1.14	1-5	
2	Thermodynamic systems, properties, classification,	1	1.19-1.38	7-14	
3	Heat, energy and work, Laws of thermodynamics	1	1.39-1.52	15-23	20
4	Properties of gases, gas laws, enthalpies,	1	2.1-2.10	30-36	
5.	Specific heat, relation of specific heats	1	2.11-2.18	37-45	
6	Flow and non-flow processes	1	3.1-3.3	50-51	
7-8	Application of first law in heating and expansion of non-flow processes	1	3.4-3.13	51-83	25
9	First law applied to steady flow processes	1	3.17- 3.18	86-89	
10-12	Entropy, physical concept of entropy, change of entropy in thermodynamic processes	1	4.1-4.5 4.8-4.15	103-106 108-117, 120-121, 124-125, 126-128, 135-136	25
13	Carnot cycle and Carnot theorem	1	6.1-6.12	153- 159	
14	Otto cycle , Diesel cycle and Dual cycle (P-V&T-S diagram)	1	6.16, 6.17 and 6.18	171-172, 178, 187	
15	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,	1	37.1- 37.7	798-804, 806-807, 809-811	10
16	Steam, Generation of steam, Types of steam, Properties of steam, Phase change, Dryness fraction, critical point of water.	1	7.1-7.9	199-203, 206-208	20

Practical Exercises

No.	Title
1	Tutorials on thermodynamic air cycles
2	Study and application of P V and T S chart
3	Study of psychrometic charts with numericals
4	Study of Simple Vertical boiler
5	Study of Cochran boiler
6	Study of Lancashire boiler
7	Study of Babcock and Wilcox boiler
8	Study of Locomotive boiler
9	Study of various mountings of boilers
10	Study of various accessories of boilers
11	Study of steam generation
12	Performance of steam boiler
13	Study of steam tables with numerical
14	Study of Kelvin Plank and Clausius statement
15	Study of wet bulb temperature or adiabatic saturation temperature
16	Study of carnot cycle with numericals

Suggested readings
Text Book

No.	Author	Title & Year	Publisher
1	Khurmi R.S. and J.K. Gupta	A Text Book of Thermal Engineering (SI Units) 2007	S. Chand and Company Ltd., 7361 Ram Nagar, New Delhi

Reference Book

No.	Author	Title & Year	Publisher
1	Ballaney P.L.	Thermal Engineering (SI Units) 1994	Khanna Publisher, New Delhi.

Course No	**: PFE122**	**Course Title**	**: Heat and Mass Transfer**
Semester	**: II**	**Credits**	**: 2 (1+1)**

Syllabus

Theory

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, cylinder and spheres. Electrical analogy. Insulation materials. Fins, Free and forced convection. Newton's law of cooling, heat transfer coefficient in convection. Dimensional analysis of free and forced convection. Combined free and forced convection. 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.

Radiation exchange between black surfaces. Heat transfer analysis involving conduction, convection.

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. Fundamental transport processes.

Practical

Study of thermal conductivity apparatus, Determination of thermal conductivity of solid metal rod, Determination of thermal conductivity of solid composite wall, Numerical on thermal conductivity of cylinder and sphere, Study of tubular type heat exchanger, Study of plate type heat exchanger, Study of overall heat transfer coefficient in parallel flow heat exchanger and counter flow heat exchanger and numerical, Determination of heat transfer through insulated pipe, Determination of Stefan-Boltzman constant, Determination of emissivity of a given material, Study of mass transfer coefficient of solid and liquid, Visit to nearby dairy and food processing industry.

Lesson Plan -Theory

Lect. No.	Title	Book No.	Chapter / Art No.	Page No	Weightage (%)
1-2	Concept, modes of heat transfer, thermal conductivity of materials, measurement. General differential equation of conduction Fundamentals of Transport processes	2	1.1,1.2,1.3,1.4,1.6,1.9,2.2	1-5,6-8, 10-11, 26-30	10
3-4	One dimensional steady state conduction through plane and composite walls, cylinder and spheres	3	7.3,7.5, 7.7,7.9	250-264	30
5	Heat transfer analysis involving conduction, convection. Electrical analogy. Insulation materials, Fins.	2 1	1.11,1.12, 2.9, 2.11 Table 2.1	12-17, 48-50, 61-62 29	
6-7	Newton's law of cooling, heat transfer coefficient in convection	3	7.6,7.12,7.13,7.14	272-276	20
8	Dimensional analysis of free and forced convection.	4	4.4.4	285-290	
9	Combined Free and Forced convection	1	7.12	372-376	
10	Absorptivity, reflectivity and transmissivity of radiation, Black body and monochromatic radiation, Planck's law.	3	7.15,7.16,7.17,7.18,7.19	404-411 422-423	20
11	Stefan-Boltzman law, emissive power, Kirchoff's law grey bodies	3	7.20,7.21,7.22	278-279	

Lect. No.	Title	Book No.	Chapter / Art No.	Page No	Weightage (%)
12	Radiation exchange between black surfaces.	2	6.18	453-457	
13-15	Fouling factor, types of heat exchangers, log mean temperature difference, Heat exchanger analysis restricted to parallel and counter flow, transfer units, heat exchanger performance,	1	10.3,10.4,10.5,10.6	559-575	20
16	Steady state molecular diffusion in fluids at rest and in laminar flow, Fick's law, Mass transfer coefficient	4	10.1, 10.1.1	595-600	

Practical Exercises

No.	**Title**
1	Study of thermal conductivity apparatus
2	Determination of thermal Conductivity of solid metal rod
3	Determination of thermal conductivity of solid composite wall
4	Numerical on thermal conductivity of cylinder and sphere
5	Study of tubular type heat exchanger
6	Study of plate type heat exchanger
7	Study of molecular diffusion in fluid at laminar flow
8	Study of overall heat transfer coefficient in parallel flow heat exchanger and counter flowheat exchanger and numerical
9	Determination of heat transfer through insulated pipe
10	Determination of Stefan-Boltzman constant
11	Determination of emissivity of a given material
12	Study of mass transfer coefficient of solid and liquid
13	Study of dimensional analysis of free and force convection
14	Study of fouling factor
15	Study of absorptivity, reflectivity and transmissivity of radiation
16	Visit to nearby dairy and food processing industry

Suggested readings

Text Books

No.	Author	Title & Year	Publisher
1	J. P.Holman	Heat Transfer	Tata McGraw-Hill Education Pvt. Ltd. (Ninth Edition)
2	Gupta C .P. and Prakash R.	Engineering Heat Transfer	Nem Chand and Bros., Roorkee
3	P.L. Ballaney	Thermal Engineering	Khanna Publications, (Twenty fourth Edition)
4	R Paul Singh &Dennis R Heldman	Introduction to Food Engineering	Academic press (Fourth Edition)

Reference Books

1	Christie Geankoplis	Transport Processes and Unit Operation, Prentice-Hall of India (Third Edition)	Prentice-Hall of India (Third Edition)
2	Incropera F. P. and De Witt D. P.	Fundamentals of Heat and Mass Transfer	John Wiley and Sons, New York.

Course No	: PFE 233	**Course Title**	: Engineering Properties of Agricultural Produce
Semester	: III	**Credits**	: 2 (1+1)

Syllabus

Theory

Importance of engineering properties of Agricultural Produce and Classification. Physical properties- 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.

Aero dynamics properties of agricultural products, drag coefficients, terminal velocity. Rheological properties; force, deformation, stress, strain, elastic, plastic and viscous behaviour, Newtonian and Non-Newtonian liquid, Visco-elasticity, Newtonian and Non-Newtonian fluid, Pseudo-plastic, Dilatant, Thixotropic, Rheopectic and Bingham Plastic Foods. Electrical properties.

Practical

Study of moisture content measuring methods and determination, Determination of the shape and size of grains, fruits and vegetables, Determination of sphericity and roundness of fruits and vegetables, Determination of surface area of food materials, Determination of bulk density and true density of grains, Determination of density of fruits and vegetables, Determination of angle of repose of grains and friction co-efficient of grains, Determination of terminal velocity of grains, Study of thermal conductivity of food materials, Study of specific heat of food materials, Determination of hardness of food material and determination of viscosity of liquid foods, Visit to seed processing plant.

Lesson Plan -Theory

Lect. No.	Title	Book No.	Chapter / Art No.	Page No	Weightage (%)
1	Importance of engineering properties of Agricultural Produce and Classification.	1	1.1, 1.2, 1.3	1 to 10	10
2 -5	Physical properties- shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area of grains, fruits and vegetables.	1	3.1 to 3.5	51 to 87	30
6-7	Thermal properties, Heat capacity, Specific heat, Thermal conductivity, Thermal diffusivity, Heat of respiration; Co-efficient of thermal expansion.	2	7.2 7.4, 7.4.1 7.4.1.2 (i)(ii) 7.5 7.9	192 to 196 198 to 199 203, 204, 205 211 to215	20
8-9	Friction in agricultural materials; Static friction, Kinetic friction, rolling resistance, angle of internal friction, angle of repose.	1	10.1 10.2 10.3 10.4	556 to 558 566 to 569 577 to 578 583 to 584 586 to 587	10
10	Aero dynamics properties of agricultural products, drag coefficients, terminal velocity.	1	9.1 9.2	495 to 497 499 to 501	10
11-13	Rheological properties; force, deformation, stress, strain, elastic, plastic and viscous behaviour.	1	4.2 4.3	90 to 94 94 to 100	15
14-15	Newtonian and Non-Newtonian liquid, Visco-elasticity, Newtonian and Non-Newtonian fluid, Pseudo-plastic, Dilatant, Thixotropic, Rheopectic and Bingham Plastic Foods	1	5.1 5.2 5.3	174,175,180 180 to 183 205 to 208	
16	Electrical properties.	1 2	1.4 9.1 9.2.1, 9.2.2 9.3 9.4	10 to 12 273 to 274 279 to 280 280 to 283 283 to 285	5

Practical Exercises

No.	**Title**
1	Study of moisture content measuring methods and determination
2	Determination of the shape and size of grains, fruits and vegetables
3	Determination of sphericity and roundness of fruits and vegetables
4	Determination of surface area of food materials
5	Determination of 1000 grain weight
6	Determination of bulk/ true volume, specific gravity of food materials
7	Determination of bulk density and true density of grains
8	Determination of density of fruits and vegetables
9	Determination of angle of repose of grains
10	Determination of co-efficient of external/ internal friction of grains
11	Determination of terminal velocity of grains
12	Study of thermal conductivity of food materials
13	Study of specific heat of food materials
14	Determination of hardness of food material Foods
15	Determination of viscosity of liquid
16	Visit to seed processing plant

Suggested readings
Text Books

No.	**Author**	**Title & Year**	**Publisher**
1	Mohsenin, N.N.	Physical Properties of Plants & Animals, 1980	Gordon & Breach Science Publishers , New York
2	Singhal OP & Samuel DVK	Engineering Properties of Biological Materials, 2011	Saroj Prakashan, 644-647, Katra, ALLHABAD – 211 002.

Reference Books

1	Rao, M.A. and Rizvi, S.H.	Engineering Properties of Foods, 1995	Marcel Dekker Inc. New York

Course No : PFE 244 Course Title : Post Harvest Engineering of Cereals, Pulses and Oil seeds

Credits: 3 (2+1) Semester : : IV

Syllabus

Theory

Introduction, Unit operations of grain processing. Cleaning and grading, aspiration, scalping. Screens and sieves-Types, classification, Ari screen cleaner- and capacity, effectiveness of screens. Various types of separators- specific gravity, magnetic, disc, spiral, pneumatic, inclined draper, velvet roll, colour sorters, cyclone.

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. Sieve analysis and particle size.

Drying: moisture content; 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. Methods of drying, types of grain dryers.

Milling of paddy, Type of rice milling machinery. Modern rice milling – unit operations and machines. Parboiling of paddy – importance and methods. milling of maize- methods and processed products, milling of wheat operations and machineries. Processing of sorghum and millets. Milling of pulses-Unit operation, methods and machines.

Processing of oilseeds- Unit operations. Mechanical expression and solvent extraction methods.

Mixing: Theory of mixing of solids and pastes, Mixing index, types of mixers for solids, liquid foods and pastes.

Material handling equipment. Types of conveyors: Belt, roller, chain and screw. Pneumatic conveying. Bucket Elevator. Cranes & hoists. Trucks (refrigerated/ unrefrigerated),

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 pulse mills and their performance evaluation, Visit to grain processing industries.

Lesson Plan -Theory

Lect. No.	Title	Book No.	Chapter / Art No.	Page No	Weightage (%)
1	Introduction and unit of operation of grain processing	1	Ch1	1-3	
2	Cleaning and grading, screening aspiration, scalping;	1	Ch 2	66-69	
3	Screen opening capacity and effectiveness of screens. Air screen cleaner.	1	Ch 2	71-81	20
4 -5	Various types of separators: specific gravity, magnetic, disc, spiral, pneumatic, inclined draper, velvet roll, colour sorters, cyclone.	1	Ch 2	87-100	
6	Principles of size reduction, crushing efficiency, energy requirements, Rittingers and Kick,s Laws, Bonds law.	1	Ch 5	227-233	
7	Size reduction procedure, machinery: Jaw crusher, Hammer mill, Plate mill, Ball mill.	1	Ch 5	235-241	20
8	Sieve analysis and particle size fineness modulus,	1	Ch 2	221-225	
9-10	Drying: moisture content, Free, bound and equilibrium moisture content, isotherm, hysteresis effect, EMC determination	2	Ch 3	25-33	
11-12	Psychrometric chart and its use in drying.	2	Ch 2	11-22	
13	Drying principles and theory, Thin layer and deep bed drying analysis, Falling rate and constant rate drying periods, maximum and decreasing drying rate period.	2	Ch 3	25, 34-36	
14	Drying equations, Mass and energy balance.	2	Ch 3	36-40,48-53	20
15-16	Methods of drying, Different types of grain dryers: bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray.	2	Ch 4 Ch 5	66-68 80-91	
17	Milling of paddy, Type of rice milling machinery. Modern rice milling – unit operations and machines.	1	Ch 5	249-251; 257-269 256	
18	Parboiling of paddy – importance and methods.	1		251-254	
19	Milling of corn and its products. Dry and wet milling.	2	Ch 15	226-234	15

Lect. No.	Title	Book No.	Chapter / Art No.	Page No	Weightage (%)
20	Milling of wheat, unit operations and equipment	2	Ch 13	235-238	
21	Processing of sorghum			Notes HOD, Parbhani	
22	Processing of millets			Notes HOD, Akola	
23-25	Modern Milling Methods, pre-conditioning, dry milling and wet milling methods for pulses: CFTRI and Pantnagar methods. Problems and factors affecting milling. Numerical on pulse milling efficiency	1	Ch 5	274-285	10
26-27	Processing of oilseeds: mechanical expression, screw press, hydraulic press, solvent extraction methods,	1	Ch 5	244-249	
28-29	Mixing: Theory of mixing of solids and pastes, Mixing index, types of mixers for solids, liquid foods and pastes.	3	Ch12	166-173	5
30	Material handling devices. Types of conveyor. Belt conveyor – components, capacity.	1	Ch 6	289-297	10
31	Bucket elevator – components, capacity	1	Ch 6	297-305	
32	Screw conveyor – components, capacity	1	Ch 6	305-308	
	Pneumatic conveyor	1	Ch 6	308-309	

List of Practical

No.	**Title**
1	Determination of grain moisture content and numerical
2	Study of drying curves
3	Determination of relative humidity and use of physcrometric chart and numerical
4	Study of EMC curves and numerical
5	Study of Air screen cleaner
6	Study of Specific gravity separator
7	Study of spiral separator
8	Study of indented separator
9	Study of various types of grain dryers

No.	**Title**
1	Determination of grain moisture content and numerical
2	Study of drying curves
3	Determination of relative humidity and use of physcrometric chart and numerical
4	Study of EMC curves and numerical
5	Study of Air screen cleaner
6	Study of Specific gravity separator
7	Study of spiral separator
10	Study of hammer mill and attrition mill
11	Study of rice mill and dal mill
12	Determination of fineness modulus and uniformity index
13	Study of mixing equipment
14	Study of bucket elevator
15	Study of screw conveyor and belt conveyor
16	Visit to rice mill, roller mill, dhal mill and oil mill

Suggested readings

Recommended Text Books

No.	**Author**	**Title & Year**	**Publisher**
1	Sahay K. M. and K.K. Singh	Unit Operations of Agricultural Processing. 2002	Vikas Publishing House Pvt. Ltd. 576, Masjid Road, Jangpura, New Delhi – 110 014
2	A. Chakraverty	Post Harvest Technology of Cereals, Pulses and Oilseeds.	Oxford & IBH Publishing Co. Pvt. Ltd., 66, Janpath, New Delhi – 110 001
3	Earle, R. L.	Unit operations in Food processing.	Pergamon Press, New York. USA

Reference Book

1	Henderson, S.M., and Perry, R. L.	Agricultural Process Engineering,	Chapman and hall, London
2	Pande P.H.	Principles and Practices of Post Harvest Technology, 2007	Kalyani Publishers, Ludhiana
3	Geankoplis C. J.	Transport processes and unit operations,	Prentice Hall of India Pvt Ltd, New Delhi

Course No : PFE 355 **Course Title: : Dairy and Food Engineering**

Semester: **Credits: : V3 (2+1)**

Syllabus

Theory

Food deterioration and spoilage. Physical, chemical and biological methods of food preservation. Nanotechnology. Composition and proximate analysis of food products.

Dairy development in India. Properties of milk and milk products. Unit operation of various dairy and food processing systems. Material and energy balances. Process flow charts for Butter, Ghee (butter oil), Yoghurt, Paneer, Milk powder, Ice-cream, and Cheese. Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization, centrifugation and cream separation. Dairy plant design and layout.

Principles of operation and equipment for food processing, Canning, Aseptic processing, Evaporation of food products: principle, types of evaporators, steam economy, multiple effect evaporation. Freezing.

Drying and dehydration of liquid and perishable foods: Phase diagram and triple point of water. Cabinet drying, Drum drying, Freeze drying, and Spray drying.

Filtration: principle, types of filters. Membrane separation, RO, Nano-filtration, Ultra filtration and Macro-filtration.

Non-thermal food processing techniques. Filling and packaging. Plant utilities and sanitation requirement.

Practical

Proximate analysis of food. Numerical on material and energy balance. Study of pasteurizers, Study of homogenizers. Study of cream separators. Study of butter churner. Study of evaporators and numerical. Numerical on freezing. Study freeze dryer. Study of spray dryers. Study of food processing plant design and layout, Utilities and estimation of steam requirement for dairy food processing plant. Visit to dairy and food industries.

Lesson Plan –Theory

Lecture No.	Topics to be covered	Text Book No.	Chapter No.	Page No./ Remarks	Weightage (%)
1.	Introduction to the subject; Dairy Development in India	3	-	-	15
2-3	Food deterioration and spoilage. Methods of food preservation.	5	-		
4	Nanotechnology & its application in Dairy Engineering	-	-	Note is to be given	
5	Properties of milk and milk products	1	1	-	
6	Basic principles of food process engineering, Unit operations in food processing systems..	3	1	1 to 3	20
7-8	Mass and energy balance, Basic principle, Material balance, Heat balance	3	2	9 to 21	
9-10	Process flow charts for Butter, Ghee (butter oil), Yoghurt, Paneer, Milk powder, Ice cream and cheese	6			25
11	Pasteurization; effect of time and temperature on pictorial reduction,	3		72-73	
12-13	Types of Pasteurization Vat pasteurization, Long hold high temp. short temp (HTST) pasteurizer, ultra high temp(UHT) pasteurizer.	1	-	359 to 375	
14	Homogenization, general effect of homogenization, Theory of homogenization	1	12	334-345	
15-16	Food plant design; site selection and requirement of services.	4	16	342-344	
17-19	Drying and dehydration; basic drying theory, phase diagram & triple point of water, Heat requirement, Heat efficiency Types of drying equipments such as Cabinet drying, Drum drying, Freeze drying and Spray drying	3	7	85-89	10
20-21	Evaporation single effect, Multiple effect evaporator & vacuum evaporator	3	8	105-111	10
22	Freezing & estimation of freezing time	3	6	79-82	10
23	Sterilization, Thermal processing	3	6	68-72	
24	Filtration, Constant rate and Constant pressure filtration.	3	10	151-152	
25	Distillation, Steam distillation batch	3	9	138-141	05

26	Membrane separation (without problem)	3	9	135-138	
27-28	Non Thermal processing techniques			Note is to be given	
29	Filling & Packaging of Food Products	2	22	-	
30-31	Plant Utilities, Steam and its applications, calculating steam requirement, Utilization of steam, stream piping	1	7	129 to 139 & 159 to 161	05
32	Food plant sanitation and waste disposal, In-place cleaning	4	-	345-382	

Practical Exercise

No.	Title
1.	Proximate analysis of food
2.	Numerical on material and energy balance
3.	Study of cream separator
4.	Study of butter churner
5.	Study of HTST & UHT pasteurizer
6.	Study of homogenizers
7.	Study of evaporators and numerical
8.	Estimation of freezing time &Numerical on freezing time
9.	Study of drying/ dehydration equipments
10.	Study freeze dryer
11.	Study of spray dryers
12.	Study of food processing plant design and layout
13.	Utilities and estimation of steam requirement for dairy food processing plant
14.	Study of flow process chart
15.	Visit to Commercial Dairy Processing Plant
16.	Visit to Food Processing Industries

Suggested Readings
Text Books

No.	Author	Title & Year	Publisher
1	Farall A.W.	Engineering for dairy and food products	Robert E.Krieger publishing company
2	Farall A.W	Food engineering system Vol.I	AVI publishing Co. INC Connecticut
3	Earle, R. L.	Unit operations in Food processing.	Pergamon Press, New York. USA
4	J.G.Brennan	Food engineering operation	Applied science publisher Ltd, London
5	Girdharilal & Siddappa	Preservation of fruits and vegetables	ICAR, New Delhi
6.	Sukumar De	Outline of Dairy Technology	Oxford University Press

Reference Book

1	R.M. Toledo	Fundamentals of Food Process Engineering : 1991 (2nd edition)	Van Nostrand Reinhold, New York
2	Kessler V.A	Food Engineering and Dairy Technology	Freizing, Germany
3	W McCabe, J.G. Smith and P. Hamiot	Unit operations in Chemical Engineering (5th edition) 1993	McGraw hill Book Co. Inc., Singapore
4	Tufal Ahmed	Dairy Plant System Engineering	KitabMahal 15, Thorn Hill Road, Allahabad
5	Charm S.E.	The Fundamentals of Food Engineering	AVI Publishers
6	Heldman, D.R.	Food Process Engineering	AVI Publisher
7	Harper	Elements of Food Engineering	AVI Publisher

Course No :	**PFE 366**	**Course Title :**	**Post Harvest Engineering of Horticultural Crops**
Semester:	**VI**	**Credits:**	**: 2 (1+1)**

Syllabus

Theory

Importance of processing of fruits and vegetables, spices, condiments and flowers. Composition and nutritional value of horticultural crops. Maturation standards and indices, preparation of fruits and vegetables for fresh market. Post harvest handling operations. Cooling of horticultural produce, need changes, methods. Low temperatures and physiological disorders. Quality-components, factors influencing quality. Quality standards for fresh fruits and vegetables. Storage atmosphere-CO2, ethylene, micro-biological growth. Modified atmosphere during transport and storage. Cold Storages and control atmosphere storages. Storage deterioration - biological and environmental factors. Codex standards and ISO.

Practical

Study of maturity of selected fruits, study of physiological maturity of given fruits, study of wax coating, study of a ripening chambers, studyb of use of chemicals for ripening and enhancing shelf life of fruits and vegetables, study of respiration quotient, study of pre-cooling methods, study of commercial cold storage units, study of chilling injury of selected fruits, study of physiological disorders in fruits and vegetables, study of blanching of vegetables, visit to commercial fruits and vegetable processing plant and pack house.

Lesson Plan Theory :

Lecture.	Topic	Book	Page No	Weightage (%)
1	Importance of processing of fruits and vegetables, spices, condiments	4	11-17	
2	Composition and Nutritional value of horticultural crops	2 4	17-26 337-354	**15**
3	Maturity, Standards and Indices	1	39-44	
4	Ripening changes and regulation	1	31-38	
5-6	Post harvest handling operations for the preparation of fruits and vegetables for market (washing, cleaning , sorting, grading, sizing, curing, blanching, waxing, packaging)	4	115-122	
7	Pre-Cooling of horticultural produce—Need and Methods (Room cooling, forced air cooling and hydro cooling, icing, vacuum cooling, ice bank cooler and evaporative cooling)	2	153-156	**25**
8	Chilling requirements of different fruits and vegetables, Equipment for chilling, Effect on food during chilling	3	359-369	
9	Peeling: Different peeling methods and devices (manual peeling, mechanical peeling, chemical peeling, and thermal peeling)	3	85-87	**25**
10	Blanching: Importance and objectives; blanching methods, effects on food (nutrition, colour, pigment, texture)	3	201-208	
11	Cold storage – Modified, Controlled. Factors affecting storage deterioration Cold chain system	3 1	369-372 63-64	
12	Packaging of horticultural commodities, Packaging requirements (in terms of light transmittance, heat, moisture and gas proof, micro organisms, mechanical strength).	3	421-423	
13	Different types of packaging materials commonly used for raw and processed fruits and vegetables products bulk and retail packages	5	529-551	**15**
14	Transportation of fruits and vegetables (Truck, Rail, water and air transport)	2	132-136	
15	Pack house technology	2	119-131	**20**
16	Quality- components, factors affecting quality, quality standards of Fruit and vegetable.	1 2 2	25-30 341-344 349-378	

Practical Exercises

Ex. No.	Titles
1	Study of maturity indices of selected fruits
2	Study of maturity indices of selected vegetables
3	Study of peelers
4	Study of slicers
5	Study of fruits washer
6	Study of wax coating of fruits
7	Study of use of chemicals for ripening and enhancing shelf life of fruits and vegetables.
8	Study of pre-cooling methods
9	Study of commercial cold storage unit
10	Study of chilling injury of selected fruits
11	Study of blanching of vegetables
12	Preparation of value added products from fruits and vegetables
13	Flowcharts for preparation of different finished products
14	Study of CAP storage
15	Study of MAP storage
16	Visit to commercial fruit and vegetable processing plant and pack house

Suggested readings
Recommended Text Books

No.	Author	Title & Year	Publisher
1	I.S. Singh	Post Harvest Handling and Processing of fruits & vegetables	Westville Publishing House New Delhi
2	P. Suresh Kumar, V. R. Sagar, and M. Kanwat	Post Harvest Physiology and Quality Management of fruits and vegetables,	Agrotech Publishing Academy. Udaipur, 313001
3	by P. Fellows	Food Processing Technology, Principles & Practice	Woodhead Publishing Ltd., Cambridge, England (UK)
4	L. R. Verma and V.K. Joshi	Postharvest Technology of Fruits and Vegetables (Vol I)	Indus Publishing Co. New Delhi
5	L. R. Verma and V.K. Joshi	Postharvest Technology of Fruits and Vegetables(Vol II)	Indus Publishing Co. New Delhi
6.	R.P. Shrivastav	Post harvest management and value Addition of fruits and vegetables	

Reference Book

1	GirdhariLal, G.S.Siddappa and G.L. Tanden	Preservation of fruits and vegetables	ICAR Pub. New Delhi
2	Arthey, D. and Ashurst, P. R.	Fruit Processing (1966)	Chapman and Hall, New York.
3	Pantastico, E.C.B.	Postharvest physiology, handling and utilization of tropical and subtropical fruits and vegetables (1975)	AVI Pub. Co., New Delhi.
4	Pandey, R.H.	Postharvest Technology of fruits and vegetables (Principles and practices) (1997)	Saroj Prakashan, Allahabad.
5	Sudheer, K P. and Indira, V.	Post Harvest Engineering of horticultural crops (2007)	New india Publishing House

Course No : **PFE 367** **Course Title:** **: Refrigeration and Air conditioning**

Semester: **VI** **Credits :** **: 2 (1+1)**

Syllabus

Theory

Terminology & laws of thermodynamics applied to refrigeration, Principles of refrigeration, Units of refrigeration, Types of refrigeration systems. Mechanical vapour compression, Components of mechanical refrigeration system, Reverse Carnot cycle and Bell Coleman cycle.P-V, P-S, P-H diagrams, Vapor compression cycles- dry and wet compression, superheating and sub cooling. Vapour absorption refrigeration system. Common refrigerants and their properties.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.

Air conditioning, principles, type and functions of air conditioning, physiological principles in air conditioning.Humidifiers and dehumidifiers, cooling load and calculations, types of air conditioners, applications.

Practical

Study of vapour compression systems; Study of domestic household refrigerator,Study of domestic water cooler,Study of absorption type refrigeration system, Study of window air conditioner,Tutorials on thermodynamic air cycles, Solving problems of refrigeration on vapour compression and absorption system; Numerical on vapour compression cycle refrigeration system, Study cold storage for fruit and vegetables, Freezing load and time calculations for food materials, Determination of refrigeration parameters (COP) using refrigeration tutor , Determination of refrigeration parameters (COP) using Air conditioning tutor, Numerical on design of air conditioning systems, Estimation of refrigeration requirements in dairy & food plant; Visit to chilling or ice making and cold storage plants.

Lesson Plan –Theory

Lect. No.	Title	Book No.	Chapter / Art No.	Page No	Weightages (%)
1.	Terminology & laws of thermodynamics applied to refrigeration, Principles of refrigeration,	1	1.1-1.37	1-19	15
2	Units of refrigeration, Coefficient of Performance, Heat Engine, Refrigerator and Heat pump including Numericals	1	2.1-2.4	38-40, 44-45	
3	Types of refrigeration systems.	2	2.1-2.8	2.1-2.8	
4	Mechanical vapour compression, Components of mechanical refrigeration system, p-h chart,	1	4.1-4.4	125-128	20
5-6	Reverse Carnot cycle and Bell Coleman cycle. Vapor compression cycles-dry and wet compression, superheating and sub cooling. (Including Numericals 4.1 - 4.4)	1	2.7 4.5- 4.10	41-43 128-134, 137-138, 146-148	
7	Vapour absorption refrigeration system.	1	7.2-7.4	274-277	15
8	Common refrigerants and their properties.	1	8.1-8.14	294-313	
9-10	Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, (Including numericals)	1	16.1-16.6	467-484	10
11-12	Psychometric chart and its use, elementary psychometric process. (including numericals Humidification and dehumidification processes (excluding numericals)	1	16.7-16.12 16.13-16.22	484-497	20
13	Cooling load and calculations,	2	19.3-19.8	19.4-19.12	20
	Cold storage plants.	1	22.13	740	
14-15	Air conditioning, principles, type and functions of air conditioning, types of air conditioners, applications. (excluding numerical)	1	18.1-18.12	549-561	
16	Physiological principles in air conditioning.	1	17.1-17.14	534-544	

Practical Exercises

Ex. No.	Title
1	Study of vapour compression systems;
2	Study of different types of compressors of vapour compression system
3	Study of different types of condensers of vapour compression system
4	Study of different types of evaporators of vapour compression system.
5	Study of different types of expansion devices of vapour compression system
6	Study of domestic household refrigerator and domestic water cooler,
7	Study of domestic domestic water cooler,
8	Numericals on vapour compression refrigeration cycle,
9	Determination of COP using refrigeration tutor.
10	Study of window air conditioner.
11	Determination of COP using Air conditioning tutor
12	Numerical on design of air conditioning systems.
13	Study of cold storage for fruit and vegetables.
14	Study of Freezing load and time calculations for food materials,
15	Estimation of refrigeration requirements in dairy & food plant;
16	Visit to precooling and cold storage plants or ice making plant

Suggested readings

Text Books

No.	Author	Title & Year	Publisher
1.	Khurmi R.S. and J.K. Gupta	A Text Book of Refrigeration and Air conditioning (SI Units) 2011	S. Chand and Company Ltd., 7361 Ram Nagar, New Delhi
2.	S.C. Arora and S. Domkumwar	A course in Refrigeration and Air conditioning	Dhanpat Rai and Co. Pvt. Ltd., Nai Sarate, Delhi -6

Reference Books

1	Dossat Roy	J. Principles of Refrigeration	Prentice Hall, Upper Saddle River, New Jersy,

REE

Course No : ELE-REE-481	**Course Title : Photovoltaic Technology and Systems**
Semester : VIII	**Credit : 3(2+1)**

Syllabus:

Theory:

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

Teaching Schedule:

Lec. No	Topic	Text Book No	Chapter No	Article No	Page No
1-2	Solar PV Technology: Advantages, Limitations	01 03	05 02	5.6 2.3	192-193 31-33
3	Current Status of PV technology	02	08	8.13	171-174
4	SWOT analysis of PV technology.	02	08	8.2	148
5-6-7	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.	03	01	1.5	16-20
8-9	Solar Photo Voltaic Module: Solar cell, solar module, solar array,	03	12	12.1	
10-11	Series & parallel connections of cell, Mismatch in cell, fill factor,	03	12	12.2	324-346
12-13	Effect of solar radiation and temperature on power output of module.	03	12	12.3	
14-15	I-V and power curve of module.	03	12	12.4, 12.5	
16-17	Balance of Solar PV system: Introduction to batteries, battery classification, lead acid battery, Nicked Cadmium battery.	03	13	13.1 13.2	347-363
18-19	Comparison of batteries, battery parameters.	03	13	13.3	
20-21	Charge controller: types of charge controller, function of charge controller.	03	13	13.4 13.5	363-381
22-23	PWM type, MPPT type charge controller.	03	13	13.6	

24-25	Converters: DC to DC converter and DC to AC type converter.	03	13	13.7	
26-28	Application of Solar PV system. Solar home lighting system, solar lantern, solar fencing,	03	14	14.1 to 14.9	391-
29-30	Solar street light, Solar water pumping	03	14		
31-32	Roof top solar photovoltaic power plant and smart grid.	03	14		

Practical Exercises:

Sr. No.	Title of Practicals
1.	Study of V-1 characteristics of solar PV system
2.	Study of smart grid technology and application
3.	Study of manufacturing technique of solar array
4.	Study of different DC to DC and DC to AC converter
5.	Study of domestic solar lighting system
6.	Design and estimation of domestic solar home lighting system.
7.	Study of solar PV water pumping system
8.	Design of roof top solar system for domestic/industrial application
9.	Study of SPV system estimation softwares/ Calculators
10.	Visit to SPV power plant.

Suggested readings

Text Books / Reference Books:

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.

Course No.	**:**	**ELE-REE-482**	**Course Title**	**:**	**Waste and By-Products Utilization**
Semester	**:**	**VIII**	**Credits**	**:**	**3(2+1)**

Syllabus:

Theory

Types and formation of by-products and waste; Magnitude of waste generation in different food processing industries; Uses of different agricultural by-products from rice mill, sugarcane industry, oil mill etc., Concept, scope and maintenance of waste management and effluent treatment, Temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues. Briquetting of biomass as fuel, production of charcoal briquette, concept of vermin-composting, Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation, Secondary treatments: Biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons, Tertiary treatments: Advanced waste water treatment process-sand, coal and activated carbon filters , Environmental performance of food industry to comply with ISO-14001 standards

Practical:

Determination of temperature, pH, turbidity solids content, BOD and COD of waste water, Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash, Study about briquetting of agricultural residues, Estimation of excess air for better combustion of briquettes, Study of extraction of oil from rice bran, Study on bioconversion of agricultural wastes, Recovery of germ and germ oil from by-products of cereals, Visit to various industries using waste and food by-products.

Suggested Reading:

Markel, I.A. 1981. Managing Livestock Waste, AVI Publishing Co.

Pantastico, ECB. 1975. Post Harvest Physiology, Handling and utilization of Tropical and Sub-tropical fruits and vegetables, AVI Pub. Co.

Shewfelt, R.L. and Prussi, S.E. 1992. Post-Harvest Handling – A Systems approach, Academic Press Inc.

USDA. 1992. Agricultural Waste Management Field Hand book. USDA, Washington DC.

Weichmann J. 1987. Post Harvest Physiology of vegetables, Marcel and Dekker Verlag.

V.K. Joshi & S.K. Sharma. Food Processing Waste Management: Treatment & Utilization. New India Publishing Agency.

Vasso Oreopoulou and Winfried Russ (Edited). 2007. Utilization of By-products and Treatment of waste in the Food Industry. Springer Science & Business media, LLC 233 New York.

Prashar, Anupama and Bansal, Pratibha. 2007-08. Industrial Safety and Environment. S.K. Kataria and sons, New Delhi

Garg, S K. 1998. Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering. Khanna Publishers, New Delhi

Bhatia, S.C.. 2001. Environmental Pollution and Control in Chemical Process Industries. Khanna Publishers, New Delhi.

Teaching Schedule:

Lecture No.	Topic	Chapter No.	Article No.	Page Nos.	Book No.
1-4	Types and Formation of By-products and Waste	1	1.3: 1.3.1, 1.3.4 & Table-4,5	5-7, 9-12	1
	Magnitude of Waste Generation in Different Food Processing Industries		Table-7,8	14-15	
5-9	Uses of different Agricultural By-products from (a) Rice mill	3	3.3	55-62	1
	(b) Sugarcane Industry	9	9.3.6-9.5.6	236-250	
	(c) Oil mill	10	10.6	268-273	
10-11	Concept, Scope and Maintenance of Waste Management	9	-----	9.1-9.4	2
12-13	Vermi composting	14	-----	839-841	6
14-15	Parameters of Effluent like Temperature, pH, Oxygen Demand (BOD,COD), Fat oil and Grease content, Metal content, Forms of phosphorus, Sulphur in Effluent	1	1.3	4-5	3
16-17	Effluent treatment : (a) Pre-treatment of Waste- Sedimentation, Coagulation, Flocculation, Floatation	11	-----	-----	7
18-21	(b) Secondary Treatments- Biological and Chemical Oxygen Demand for Different Food Plant Waste	12&13	-----	-----	7
22-23	(c) Tertiary Treatments- Advance water Treatment Process- Sand, Coal and Activated Carbon Filters	14	-----	-----	7
24-27	Briquetting of Biomass as Fuels	4	-----	69-89	4
28-29	Microbiology of Waste and Other Ingredients like Insecticides, Pesticides and Fungicides residues	15	-----	-----	7
30-32	Environmental Performance of Food Industry to Comply with ISO-14001 standards	5	-----	63,74,75	5

Practical

1. Determination of temperature, pH, turbidity solids content of waste water.
2. Determination of BOD and COD of waste water.
3. Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash.
4. Study of densification process of agricultural residues.
5. Estimation of excess air for better combustion of briquettes.
6. Study of extraction of oil from agricultural waste.
7. Study on bioconversion of agricultural wastes.
8. Study of biochar preparation process from agro residue.
9. Visit to effluent treatment plant.
10. Visit to various industries using waste and food by-products.

Suggested Reading:

1. V.K. Joshi and S.K. Sharma. Food Processing Waste Management; Treatment and Utilization, New India Publishing Agency, New Delhi.
2. USDA. 1992. Agricultural Waste Management Field Hand Book, USDA, Washington DC.
3. Jaidev Singh, 2012. Effluent Treatment Plant; Design, operation and Analysis of Waste Water.
4. N.S. Rathore, N.L. Panwar & A.K. Kurchaina. 2008, Renewable Energy Theory & Practice, Himanshu Publications, 464, sector 11, Hiran Magri, Udaipur.
5. Ioansis S. Arvantitoyannis. Waste management for the Food Industries, Elsevier Academic Press.
6. V.V.N Kishor. Renewable Energy Engineering Technology.
7. ICAR online notes for B.Tech.(Agril. Engg.).

Reference Books:

1. Markel, I.A. 1981. Managing Livestock Waste, AVI Publishing Co.
2. Pantastico, ECB. 1975. Post Harvest Physiology, Handling and utilization of Tropical and Sub-tropical fruits and vegetables, AVI Pub. Co.
3. Shewfelt, R.L. and Prussi, S.E. 1992. Post-Harvest Handling – A Systems approach, Academic Press Inc.
4. Weichmann J. 1987. Post Harvest Physiology of vegetables, Marcel and Dekker Verlag.
5. VassoOreopoulou and Winfried Russ (Edited). 2007. Utilization of By-products and Treatment of waste in the Food Industry. Springer Science & Business media, LLC 233 New York.
6. Prashar, Anupama and Bansal, Pratibha. 2007-08. Industrial Safety and Environment. S.K. Kataria and sons, New Delhi
7. Garg, S K. 1998. Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering. Khanna Publishers, New Delhi
8. Bhatia, S.C.. 2001. Environmental Pollution and Control in Chemical Process Industries. Khanna Publishers, New Delhi.

MAHARSHTRA COUNCIL OF AGRICULTURAL EDUCATION AND RESEARCH, PUNE
DEPARTMENT OF RENEWABLE ENERGY ENGINEERING

Lesson plan for B.TECH. (Agril. Engg.)

Layout of 10 Week Experiential Learning on Campus for B.Tech.(Agril. Engg.)

Course No	**:**	**GAE-REE-471-1**	**Semester**	**:**	**VII**
Course Title	**:**	**Drying of different Vegetables using solar dryers**	**Credits**	**:**	**10(0+10)**
Department	**:**	**Renewable Energy Engineering, (REE)**			

Objectives :

1. To acquaint the students in the field of solar energy utilization for vegetable drying.
2. To acquaint the students for different aspects of solar dryer and their operations.
3. To estimate the cost operations of different vegetables dried in solar dryer.
4. Economic analysis of different solar dryers for drying of vegetables.

Outline of the Course:

- The students will be trained to use solar drying technologies for vegetable drying.
- Different dryers based on solar energy for the drying and dehydration of different vegetables will be taught to the students.
- The commercial aspects of solar dryers for drying of locally available vegetables will be taught to the students
- Different type of solar dryers like force/ natural convection, Direct/Indirect, Walk in type etc will be techno economically evaluated for commercial drying of vegetables.

Credit hours and Syllabus

SN	Contact Units	Particulars of lecture /Practical's
A		**Basic of solar drying technology for vegetables**
1	**03**	Basic drying theory and its important
2	**03**	Drying technologies, their merits and demerits. Different type of dryers available in market
3	**03**	Basic theory of solar drying, its advantages and disadvantages
4	**03**	Different type of solar dryers. Comparison with other drying technologies in term of economical values
5	**03**	Study of different vegetables, potential, availability, utilization, losses during handling, storage period etc.
6	**05**	Study of drying and dehydration of different vegetables available in commercial market.
B		**Evaluation for different solar dryers for vegetable drying**
	05	Evaluation of natural convection cabinet type of solar dryer
	05	Evaluation of forced circulation cabinet type of solar dryer
	05	Evaluation of natural convection direct type of solar dryer
	05	Evaluation of forced circulation indirect type of solar dryer
	05	Evaluation of solar tunnel dryer
C		**Quality evaluation of dried vegetable samples**
	10	Quantification of dried products and their quality evaluation in term of colour, taste, texture etc.
	05	Economical evaluation of solar dried vegetables
D		**Production of different dried vegetables**
	35	Production of different dried vegetables using different solar dryers Viz; Direct type solar cabinet dryer Indirect type solar dryer Solar tunnel dryer etc
E		**Sales and Marketing of dried vegetables**
	02	Training and tips from experts
	02	Trial sales demonstrations
	02	Exhibition and sale
	10	Field sale and marketing
F		**Report preparation and Examinations**
	04	Report preparation
	01	Evaluation
	Total=120 units	

*01 contact unit = 3 hrs

MAHARSHTRA COUNCIL OF AGRICULTURAL EDUCATION AND RESEARCH, PUNE
DEPARTMENT OF RENEWABLE ENERGY ENGINEERING

Lesson plan for B.TECH. (Agril. Engg.)

Layout of 10 Week Experiential Learning on Campus for B.Tech.(Agril. Engg.)

Course No	**:**	**GAE-REE-471-1**	**Semester**	**:**	**VII**
Course Title	**:**	**Preparation of briquette for furnaces and cook stove**	**Credits**	**:**	**10(0+10)**
Department	**:**	**Renewable Energy Engineering, (REE)**			

Objectives :

1. To acquaint the students in the field of biomass energy utilization for heat generation.
2. To acquaint the students for different aspects of biomass briquetting and their utilization.
3. To estimate the cost operations of different briquetting machines for biomass briquetts.
4. Economic analysis of different biomass briquetts for heat generation.

Outline of the Course:

- The students will be trained to use biomass briquetting technologies for thermal heat generation.
- Different briquetting machines available for the briquetting of biomass will be taught to the students.
- The commercial aspects of briquetted fuels for heat generation using furnaces and cook stoves will be taught to the students
- Different type of briquetted fuel made from agricultural waste, forest waste, industrial waste and in different combination will be techno economically evaluated for commercial use.

Credit hours and Syllabus

SN	Contact Units	Particulars of lecture /Practical's
A		**Basic availability, potential, characterization and utilization of biomass**
1	**03**	Assessment of biomass in the selected area
2	**03**	Estimation of potential and categorization of biomass
3	**03**	Characterization of biomass in term of proximate and ultimate analysis
4	**03**	Biomass conversion technologies and selection of appropriate technology for biomass briquetting
5	**03**	Energy values, different technical aspects of briquetted fuel like energy ratio, density ratio, transport feasibility, calorific value etc.
6	**05**	Study of different combinations of raw material, missing, binding

		material etc for different biomass available locally.
B		**Evaluation for different briquetting machines for production of briquetted fuels**
	05	Techno economic evaluation of hand operated biomass briquetting machine
	05	Techno economic evaluation of pedal operated biomass briquetting machine
	05	Techno economic evaluation of screw extruded power operated biomass briquetting machine
	05	Techno economic evaluation of power operated biomass palletization machine
	05	Techno economic evaluation of power operated piston press biomass briquetting machine
C		**Quality evaluation of briquetted fuel for furnaces and cook stoves**
	10	Characterization of briquetted fuel made from different biomass using different briquetting machines in comparison with commercial briquetts.
	05	Thermal testing of briquetted fuel for furnaces and cook stoves
D		**Production of briquetted fuel for furnaces and cook stoves**
	35	Production of briquetted fuel using different material and using selected combination on large scale
E		**Sales and Marketing of briquetted fuel for furnaces and cook stoves**
	02	Training and tips from experts
	02	Trial sales demonstrations
	02	Exhibition and sale
	10	Field sale and marketing
F		**Report preparation and Examinations**
	04	Report preparation
	01	Evaluation
	Total=120 units	

*01 contact unit = 3 hrs

Course No. : REE 111 Course Title : Engineering Chemistry

Semester : I Credits : 2(1+1)

Syllabus:

Theory

Phase rule and its application to one and two component systems. Fuels: classification. calorific value. Colloids: classification. properties. Corrosion: causes. types and method of prevention. Water: temporary and permanent hardness. disadvantages of hard water, scale and sludge formation in boilers, boiler corrosion. Analytical methods like thermo-gravimetric. polarographic analysis. nuclear radiation. detectors and analytical applications of radioactive materials. Enzymes and their use in the manufacturing of ethanol and acetic acid by fermentation methods.Principles of food chemistry.Introduction to lipids, proteins, carbohydrates, vitamins, colouring and flavouring reagents of food. Lubricants: properties. mechanism. classification and tests. Polymers.types of polymerization. properties. uses and methods for the determination of molecular weight of polymers. Introduction to IR spectroscopy.

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.

Teaching Schedule:

Lect No	Topics to be covered	Book No	Chapter No	Article no	Page no
1	**Fuels: classification. Calorific value.**	1	2		
	Fuel –definition			2.1	73
	Classification of fuels			2.2	73
	Calorific value			2.3	74
	Characteristics of a good fuel			2.4	75
	Comparison between solid, liquid and gaseous fuels.			2.5	75-76
	Solid fuels: wood , coal			2.9 -2.10	81
2-3	Classification of coal by rank	1	2	2.11	
	Peat, Lignite , Bituminous, Anthracite				81-82
	Analysis of coal			2.13	84-86
	Solved ProblemNo.9				118-
	Unsolved problems No. 24 &25				119
	Gross and Net calorific Value			2.6	131
	Determination of CV by Bomb Calorimeter			2.6	78-80 76-79
	Theoretical calculations of CV of a fuel			2.8	80
	Solved problems No. 1-5				
	Un-solved Problems No.1,3,4,7,22,23				128 128- 130
4	Liquid fuels	1	2		
	Petroleum Classification of Petroleum			2.18	91
	Origin of Petroleum(modern theory only)			2.18	91 92
	Refining of crude oil				92
	Cracking-thermal cracking.				93-95
5-6	Gaseous fuel(Definition, composition and uses only)	1	2		
	Natural gas			2.28	106
	Coal gas				
	Oil gas			2.28	106
	Producer gas			2.29	106
	Water gas			2.30	107
	Bio gas			2.31	108
	Determination of CV of gas by Junkers gas Calorimeter			2.32 2.33	109 110
	Flue gas analysis by Orsat’s apparatus			2.36	113 113- 115

7-9	**Corrosion: causes, types and method of prevention.**	1	6		
	Introduction: Definition			6.1	351
	Gravity of corrosion problems				351-
	Dry or chemical corrosion			6.2	352
	(Definition only)			6.3	352
	Wet or electrochemical corrosion			6.5	353
	Galvanic corrosion			6.6	357
	Concentration cell corrosion			6.7	358
	Passivity				360
10-11	Underground or soil corrosion	1	6	6.8	360
	Pitting corrosion			6.9	361
	Inter granular corrosion			6.10	361
	Waterline corrosion			6.11	362
	Stress corrosion			6.12	363
	Microbiological corrosion			6.13	364
	Erosion corrosion			6.14	365
	Corrosion control(protection against corrosion) methods in short			6.17	369-374
12	**Water: temporary and permanent hardness. disadvantages of hard water, scale and sludge formation in boilers, boiler corrosion.**	1	1	1.5	4-5
	Hardness of water: temporary & permanent			1.6	5
	Disadvantages of hard water				
	Scale and sludge formation in boilers			1.7	6
				1.7	6
	Disadvantages of sludge formation			1.7	7
	Disadvantages of scale formation			1.9	10-11
	Boiler corrosion				
13-14	**Lubricants: properties. mechanism. classification and tests.**	1	18	18.2	721
	Lubricants				721
	Functions of lubricants			18.3	721-
	Mechanism of lubrication			18.4	723
	Classification of lubricants			18.5	723
	Lubricating oils				723
15-16	Greases or semi –solid lubricants	1	18	18.6	726
	Solid lubricants			18.7	727
	Properties of lubricating oils			18.10	729-
	Viscosity, Viscosity Index , Flash & Fire point, Oiliness			18.10	733
	Cloud and pour point, Emulsion,				733-

	Volatility, Carbon residue etc. Solved examples(1,2 &3) Unsolved examples(1,2&3)				737 741 742

Practical Exercise:

1) Determination of viscosity of oil:
2) Estimation of alkalinity of water sample:
3) Determination of carbonate and non- carbonate hardness by soda reagent:
4) Determination of coagulation of water and chloride ion content:
5) Determination of specific rotation of an optically active compound:
6) Determination of Xnax and verification of Beer Lambert Law:
7) Determination of calorific value of gaseous fuel:
8) Determination of various properties of water: Hardness/TDS,Na,Cl.$MgCO_3$,Ph
9) Ulltimate analysis of selected biomass
10) Proximate analysis of selected biomass
11) Determination of Fire point and Flash point of liquid fuel

Suggested Reading

1. Jain P L and Jain M. 1994. Engineering Chemistry. DanpatRai publishing company Pvt. Ltd., Delhi.
2. Bahl B S, ArunBahl and Tuli B D. 2007. Essentials of Physical Chemistry. S.Chand and Co. Ltd., Delhi.
3. M. Swaminathan, 1993. Hand Book of Food and Nutrition. Bangalore Printing and Publishing Co. Ltd., No. 88, P.B. No. 1807, Mysore Road, Bangalore-560018
4. Shubhangini A. Joshi. Nutrition and Dietetics. Tata McGraw-Hill Publishing Company Limited, New Delhi. (2^{nd} Edition)
5. S. N. Mahindru, 2009. Food Science & Technology. A P H Publishing Corporation 4435-36/7, Ansari Road, Darya Ganj, New Delhi-110002.

Course No : REE 122 **Course Title : Electrical Machines and Power Utilization**

Semester: II **Credits : 3(2+1)**

Syllabus:

Theory:

Electro motive force, reluctance, laws of magnetic circuits, determination of ampere-turns for series and parallel magnetic circuits, hysteresis and eddy current losses, Transformer: principle of working, construction of single phase transformer, EMF equation, phasor diagram on load, leakage reactance, voltage regulation, power and energy efficiency, open circuit and short circuit tests, principles, operation and performance of DC machine (generator and motor), EMF and torque equations, armature reaction, commutation, excitation of DC generator and their characteristics, DC motor characteristics, starting of shunt and series motor, starters, speed control methods-field and armature control, polyphase induction motor: construction, operation, phasor diagram, effect of rotor resistance, torque equation, starting and speed control methods, single phase induction motor: double field revolving theory, equivalent circuit, characteristics, phase split, shaded pole motors, various methods of three phase power measurement; power factor, reactive and apparent power, Concept and analysis of balanced poly-phase circuits; Series and parallel resonance.

Practical:

To obtain load characteristics of d.c. shunt/series /compound generator; To study characteristics of DC shunt/ series motors; To study d.c. motor starters; To Perform load-test on 3 ph. induction motor & to plot torque V/S speed characteristics; To perform no-load & blocked —rotor tests on 3 ph. Induction motor to obtain equivalent ckt. parameters & to draw circle diagram; To study the speed control of 3 ph. induction motor by cascading of two induction motors, i.e. by feeding the slip power of one motor into the other motor; To study star- delta starters physically and (a) to draw electrical connection diagram (b) to start the 3 ph. induction motor using it. (c) to reverse the direction of 3 ph. I.M.; To start a 3-phase slip —ring induction motor by inserting different levels of resistance in the rotor ckt. and to plot torque —speed characteristics; To perform no load & blocked —rotor test on I ph. induction motor & to determine the parameters of equivalent ckt. drawn on the basis of double revolving field theory; To perform load —test on I ph. induction motor & plot torque —speed characteristics; 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.

Teaching schedule theory

Lecture No.	Topics to be covered	Book No	Chapter No.	Article No.	Problem No
01	Electro motive force	1	6	6.21	
	reluctance, laws of magnetic circuits	1	6	6.22,6.23,6.24,6.25	
02	determination of ampere-turns for series and parallel magnetic circuits	1	6	6.26,6.27	
03	Transformer: principle of working	2	30	30.1	
04	EMF equation	2	30	30.6,30.7	30.1,30.2,30.3, 30.4
05-05	power and energy efficiency	2	30	30.28,30.29,30.30,30.	
07-08	open circuit and short circuit tests	2	30	30.19,30.20,30.22	
9-10	principle, operation and performance of DC Machine (generator)	2	24	24.1,24.2,24.3,24.31, 24.32	24.3,24.4,24.5
11-12	EMF equation of DC Generator	2	24	24.33	24.8,24.09
13-14	principles, operation and performance of DC machine (motor)	2	27	27.1,27.2,27.3,27.4, 27.5	27.1,27.2,27.3
15	DC motor characteristics,	2	27	27.12 27.13,27.14	
	Starters	2	28	28.19	
16	Speed control methods – field and armature control	2	28	28.1,28.2(i),(ii)	
17	Poly phase induction motor: construction,	2	32	32.2,32.3	
18-19	Operation	2	32	32.9,32.10,32.11	32.1,32.2,32.3,32.4,32.5

20-21	starting of 3-phase induction motor	2	33	33.9,33.10,33.11(a)	
22	speed control methods of 3-phase induction Motor	2	33	33.18(a) to 33.18 (d)	
23-24	single phase induction motor Characteristics, split-phase motor	2	34	34.1,34.2,34.4	
25-26	various methods of three phase power measurement	1	19	19.15,19.16,19.17,19.25	19.31 to 19.33
27	power factor Active, reactive and apparent power	1	13	13.2, 13.4	
28-32	Concept and analysis of balanced poly-phase circuits	1	19	19.1,19.5 , 19.6,19.7,19.8, 19.09	19.1 to 9.6, 19.10 to19.13

Practical Exercises:

Exercise No.	Title of Practicals
1	To obtain load characteristics of d.c. shunt / series / compound generator.
2	To study d.c. motor starters.
3	To perform load-test on 3-phase induction motor .
4	To perform no-load & blocked —rotor tests on 3 ph. induction motor .
5	To study power consumed in a three-phase circuit.
6	Two lights in series controlled by one switch.
7	Two lights in parallel controlled by one switch.
8	To perform open circuit test on single phase transformer.
9	To perform short circuit test on single phase transformer.
10	To find the efficiency and voltage regulation of single phase transformer by direct loading.
11	To study speed control of d,c motor
12	To measure power factor of the given circuit.
13	To study voltage control method for speed control of three phase induction motor

14	To study voltage and current relationship for star connection.
15	To study voltage and current relationship for delta connection.

Suggested Reading

Text Books

1. Thareja B L &Theraja AK. 2005. A text book of Electrical Technology. Vol. I, S. Chand & Company LTD., New Delhi.
2. Theraja B L &Theraja AK 2005. A text book of Electrical Technology. Vol. II, S.Chand &
   Company LTD., New Delhi.

Reference Books:

1. Vincent Del Toro. 2000. Electrical Engineering Fundamentals. Prentice-Hall of India Private LTD., New Delhi.
2. Anwani M L. 1997. Basic Electrical Engineering. Dhanpat Rai & Co.(P) LTD. New Delhi.S

Course No. : REE-243 **Course: Fundamentals of Renewable Energy**

Semesters: IV **Credits : 3(2+1)**

Syllabus:

Theory

Concept and limitation of Renewable Energy Sources (RES), Criteria for assessing the potential of RES, Classification of RES, Solar, Wind, Geothermal, Biomass, Ocean energy sources, Comparison of renewable energy sources with non renewable sources. Solar Energy: Energy available from Sun, Solar radiation data, solar energy conversion into heat through, Flat plate and Concentrating collectors, different solar thermal devices, Principle of natural and forced convection drying system, Solar Photo voltaics: p-n junctions. Solar cells, PV systems, Stand alone, Grid connected solar power station, Calculation of energy through photovoltaic power generation and cost economics. Wind Energy: Energy available from wind, General formula, Lift and drag. Basis of Wind energy conversion, Effect of density, Frequency variances, Angle of attack, Wind speed, Types of Windmill rotors, Determination of torque coefficient, Induction type generators, Working principle of wind power plant. Bio-energy: Pyrolysis of Biomass to produce solid, liquid and gaseous fuels. Biomass gasification, Types of gasifier, various types of biomass cook stoves for rural energy needs. Biogas: types of biogas plants, biogas generation, factors affecting biogas generation and usages, design consideration, advantages and disadvantages of biogas spent slurry.

Practical

Study of different types of solar cookers, solar water heating system, natural convection solar

Dryer, forced convection solar dryer, solar desalination unit, solar greenhouse for agriculture production, biogas plants, biomass gasifiers, biomass improved cook-stoves, solar photovoltaic system.

Teaching Schedule:

Lec. No.	Topics to be covered	Book no.	Chp. No.	Article No.	Page No.
1-2	Concept and limitation of Renewable Energy Sources (RES), Criteria for assessing the potential of RES,	1	1	1.5-1.6	35-43
		7	1	1.1-1.6	1-22
3-5	Classification of RES, Solar, Wind, Geothermal, Biomass, Ocean energy sources, Comparison of renewable energy sources with non renewable sources.	6	1	1.3-1.7	3-24
		1	1	1.4	4-8
					15-32
5-6	Solar Energy: Energy available from Sun, Solar radiation data	2	3	3.1-3.9	39-69
7-9	solar energy conversion into heat through, Flat plate and Concentrating collectors, different solar thermal devices,	1	3	3.1-3.3	73-86
				3.7-3.8	102-112
10-11	Solar cooker Solar water heater Solar Distillation Solar Dryer	1	6	6.4-6.7	112-125
12-14	Solar Photo voltaics: p-n junctions. Solar cells, PV systems, Stand alone, Grid connected solar power station	2	15	15.1-15.07	433-462
15-16	Calculation of energy through photovoltaic power generation and cost economics.	2	15	15.12 15.13	478-481 485-486
17-20	Wind Energy: Energy available from wind, General formula, Lift and drag. Basis of Wind energy conversion, Effect of density, Frequency variances, Angle of attack, Wind speed	1	6	6.1, 6.2 6.4 6.5 to 6.8 6.13	227-240 252 256-277 299-305
21-25	Types of Windmill rotors, Determination of torque coefficient, Induction type generators, Working principle of wind power plant.				
26-27	Bio-energy: Pyrolysis of Biomass to produce solid, liquid and gaseous fuels.	1	7	7.2	319-324
28-30	Biomass gasification, Types of gasifier	1	7	7.24	395-405
	Various types of biomass cook stoves for rural energy needs	8	7	7.1 to 7.7	115-132

31-32	Biogas: types of biogas plants, biogas generation, factors affecting biogas generation and usages, design consideration Advantages and disadvantages of biogas spent slurry.	1	7	7.4 to 7.9 7.14, 7.15	327-353 365-375
		3	8	8.1 to 8.6	51-58
		3	9	9.1 to 9.3	58-60

Practical Exercises:

Prac. No.	Title of practical
1.	Study of different types of solar cookers
2.	Study of solar water heating system
3.	Study of solar photovoltaic system
4.	Study of natural convection solar dryer
5.	Study of forced convection solar dryer
6.	Study of solar desalination unit
7.	Study of solar greenhouse for agriculture production
8.	Study of biogas plants
9.	Study of biomass gasifiers
10.	Study of biomass improved cook-stoves

List Text Books / Reference Books:

Sr.No.	Author	Title & year	Publisher
1.	Rai, G.D.	Non-Conventional Energy Sources	Khanna Publishers, Delhi.
			2013.
2.	Rai, G.D.	Solar Energy Utilization	Khanna Publishers, Delhi
3.	Khandelwal, K.C. &	Biogas Technology- A Practical	1990
	S. S. Mandi.	Handbook	
4.	Rathore N. S.,	Non Conventional Energy Sources	Himanshu Publications
	Kurchania A. K.,		2007
	Panwar N. L.		
5.	Tiwari, G.N. and	Renewable Energy Resources: Basic	Narosa Pub. House. Delhi
	Ghoshal, M.K.	Principles and Applications.	2005
6.	Rathore N. S.,	Renewable Energy, Theory and	Himanshu Publications
	Kurchania A. K.,	Practice	2007
	Panwar N. L.		
7.	John Twidell and	Renewable Energy Sources	Taylor & Francis Group,
	Tony Weir		London & N.York
8.	Rathore N. S.,	Biomass Production and Utilization	Himanshu Publication
	Panwar N. L.,	Technology	
	Surendra Kothari		

Course No : REE-354 Course Title : Renewable Power Sources
Semester: V Credits: 3(2+1)

Syllabus:

Theory:

Energy consumption pattern & energy resources in India. Renewable energy options, potential and utilization. Biogas technology and mechanisms, generation of power from biogas, Power generation from urban, municipal and industrial waste. Design & use of different commercial sized biogas plant. Solar thermal and photovoltaic Systems for power generation. Central receiver (Chimney) and distributed type solar power plant, OTEC, MHD, hydrogen and fuel cell technology. Wind farms. Aero-generators. Wind power generation system. Power generation from biomass (gasification & Dendro thermal), Mini and micro small hydel plants. Fuel cells and its associated parameters.

Practical:

Performance evaluation of solar water heater; Performance evaluation of solar cooker; Characteristics of solar photovoltaic panel; evaluation of solar air heater/dryer; Performance evaluation of biomass gasifier engine system (throatless & downdraft), Performance evaluation of a fixed dome type biogas plant; Performance evaluation of floating drum type biogas plant; Estimation of calorific value of biogas & producer gas; Testing of diesel engine operation using dual fuel and gas alone.

Teaching Schedule:

Lec. No	Topic	Text Book No.	Chap No	Article No	Page No
1-2	**Energy consumption pattern & energy resources in India.** Energy sources & availability Introduction, Energy global scenario Status of energy utilization, Non con. Energy sources, classification, Renewable energy sources	02	01	1.4.1, 1.4.2	1-11
3-5	**Biogas technology and generation of power from biogas.** Conditions for optimum production. Raw material for biogas Mechanical conversion of biogas	 06 06 06	 02 02 07	 2.3 2.4, 2.5 7.1 to 7.8	 13-24 25-31 104-112
6-8	**Power generation from urban, municipal and industrial** waste.	06	09	9.1 to9.4	124-141
9-11	**Design & use of different commercial biogasplant.**	06 02	03 07	3.5 7.15	48-51 366-375
12-14	**Solar thermal systems for generation.** Introduction of solar thermal systems Thermal electric conversion system Low, medium & High temp. system. Central receiver (Chimney) and distributed type solar power plant.	02	05	5.5	168-178
15-17	**Solar Photovoltaic Power generation** Introduction, conversion efficiency power output, power generation design of sp^{y} system for power generation, type of systems and components, design sp^{y} system for water pumping	03	08	8.9,8.10,8.11,8 8.14	165-170 177-182
18-19	**Ocean Thermal Energy Conversion**	03	15	15.2, 15.3, 15.4	310-316
20-21	**Hydrogen technology** Introduction Production method(Enlist) Storage	02	11		 609-612 613 637-641
22-23	**Wind farms. Aero-generators.** The power in wind, wind data & estimates. Basic components & design considerations, Performance of wind machines.	02	06	6.2.2, 6.3 6.8.3, 6.8.4, 6.10	230-292
24-25	**Wind power generation system.**	02	06	6.11	292-298

26-28	**Power generation from (Gasification & Dendro thermal)** Types of gasifier, reaction chemistry, impact of fuel, applications. Design of gasifier system, Performance of gasfier and testing parameters.	05 05	03 04	3.4 to 3.7 4.1 to 4.17	52-61 64-87
29-30	**Mini and micro small hydel plants** Introduction, nature and classification SHD, components, Turbine and generators, advantages and disadvantages	02	09	9.5.1, 9.5.4, 9.5.7,	541-556
31-32	**Fuel Cell and its associated parameters.** Fuel cell, Classification, efficiency	03	17	17.1 to 17.5	336-347

Practical Exercises:

Sr. No.	Title of Practicals
1	Performance evaluation of solar water heater (FPC/ETC)
2	Performance evaluation of solar cooker (BTSC/PSC)
3	VI-power Characteristics of solar photovoltaic panel
4	Evaluation of solar air heater/dryer (Direct type/Indirect type)
5	Performance evaluation of solar-wind hybrid system
6	Performance evaluation of biomass gasifier engine system (downdraft)
7	Performance evaluation of a fixed dome type biogas plant
8	Performance evaluation of floating drum type biogas plant
9	Estimation of calorific value of biogas
10	Estimation of calorific value of producer gas
11	Testing of diesel engine operation using dual fuel and gas alone

Suggested readings

Text Book:

1. Garg H.P. and J. Prakash 2000. Solar Energy Fundamentals and Applications. 1St Revised Edition. Tata Mcgraw-Hill , New Delhi
2. Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.
3. Rathore N. S., Kurchania A. K. & N.L. Panwar. 2007. Non Conventional Energy Sources, Himanshu Publications.
4. Khandelwal, K.C. & S.S. Mandi. 1990. Biogas Technology.
5. N.S.Rathore, N.L.Panwar and S. Kothari. Biomass Production and Utilization Technology, Himnashu Pub. Udaipur
6. Mathur, A.N. & N.S. Rathore. 1992. Biogas Production Management & Utilization. Himanshu Publications, Udaipur.

Reference Books:

1. Alan L: Farredbruch & R.H. Buse. 1983. Fundamentals of Solar Academic Press, London.

2. Bansal N.K., Kleemann M. & Meliss Michael. 1990. Renewable Energy Sources & Conversion Technology; Tata Mecgrow Publishing Company, New Delhi.

3. Mathur A.N. & N.S. Rathore. Renewable Energy Sources Bohra Ganesh Publications, Udaipur.

4. S.Rao and B.B.Parulekar.Energy Technology, Third Revised Edition.Khanna Publication, New Delhi

5. RK.Prasad and T.P. Ojha, Non Conventional Energy Sources, Jain Brothers

Course No. : REE-365	Course Title: Bio-Energy Systems: Design and Applicati ons
Semester: VI	Credits : 3(2+1)

Syllabus

Theory

Fermentation processes and its general requirements, an overview of aerobic and anaerobic fermentation processes and their industrial application. Heat transfer processes in anaerobic digestion systems, land fill gas technology and potential. Biomass Production: Wastelands, classification and their use through energy plantation, selection of species, methods of field preparation and transplanting. Harvesting of biomass and coppicing characteristics. Biomass preparation techniques for harnessing (size reduction, densification and drying).

Thermo-chemical degradation. History of small gas producer engine system. Chemistry of gasification. Gas producer — type, operating principle. Gasifier fuels, properties, preparation, conditioning of producer gas. Application, shaft power generation, thermal application and economics. Trans-esterification for biodiesel production. A range of bio-hydrogen production routes. Environmental aspect of bio-energy, assessment of greenhouse gas mitigation potential.

Practical:

Study of anaerobic fermentation system for industrial application, Study of gasification for industrial process heat, Study of biodiesel production unit, Study of biomass densification technique (briquetting, pelletization, and cubing), Integral bio energy system for industrial application, Study of bio energy efficiency in industry and commercial buildings, Study and demonstration of energy efficiency in building, Study of Brayton, Striling and Rankine cycles, Study of modern greenhouse technologies.

Teaching Schedule:

Lec. No.	Topic	Text Book No.	Chapter No.	Article No.	Page No.
1	Fermentation processes and its general requirements.	02	07	7.28	429-431
2-3-4-5	Aerobic and anaerobic fermentation processes and their industrial application.	03	02	2.1-2.7	10-32
6-7	Biogas generation from industrial waste.	03	9	9.4	134-143
8-9	Heat transfer processes in anaerobic digestion systems, land fill gas technology and potential.	02	10	10.1-10.6	235-248
10-11	Biomass Production: Wastelands, classification and their use through energy plantation, selection of species, methods of field preparation and transplanting.	04	01	1.1 to 1.6	1-19
12-13	Harvesting of biomass and coppicing characteristics.				
14-15	Biomass preparation techniques for harnessing (size reduction, densification and drying).				
16-17	Thermo-chemical degradation. History of small gas producer engine system.	02	07	7.24.1 to 7.24.4	395-411
18-19	Chemistry of gasification. Gas producer — type, operating principle.				
20-21	Gasifier fuels, properties, preparation, conditioning of producer gas.	04	03	3.1 to 3.9	49-63
22-23	Application, shaft power generation, thermal application and economics.				
24-25	Power generation by using gasifier.				

26-27	Bio-alcohol, Trans-esterification. for biodiesel production.	02	11	11.2	613-635
28-29	Bio-hydrogen production routes.				
30-31	Environmental aspect of bio-energy	06	01	-	06-16
32	Assessment of greenhouse gas mitigation potential.				

Practicals Exercises:

Ex. No.	Title of Practiclas
1	Study of anaerobic fermentation system for industrial application.
2	Study of gasification for industrial p[r]ocess heat.
3	Study of biodiesel production unit.
4	Study of biomass densification technique (briquetting, pelletization, and cubing).
5	Performance evaluation of biomass gasifier for power generation
6	Study of biomass based waste fired dryer
7	Study and demonstration of energy efficiency in building.
8	Performance evaluation of improved cookstove
9	Study of modern greenhouse technologies.
10	Study of various properties of briquettes
11	Visit to Biomass briquetting plant

Text Books:

1. Chakraverty A. Biotechnology and Other Alternative Technologies for utilization of Biomass/Agricultural Wastes. Oxford & IBH Publishing Co.PVT.LTD. New Delhi.
2. Rai, G.D.Non-Conventional Energy Sources. Khanna Publishers, Delhi.
3. Mathur, A.N. & N.S. Rathore. 1992. Biogas Production Management & Utilization. Himanshu Publications, Udaipur.
4. Rathor, S. R., Panwar N. L. and Kothari, S. Biomass production and Utilization Technics. Himanshu Publication.
5. V.V.N Kishor. Renewable Energy Engineering Technology.
6. Rathor, S. R., Mathur, A. N. and Kothari, S. Alternate Sources of Energy, ICAR Publication, New Delhi.

Reference Books:

1. British BioGen. 1997, Anaerobic digestion of farm and food processing practices- Good practice guidelines, London, available on www.britishbiogen.co.UK.
2. Butler, S. 2005. Renewable Energy Academy: Training wood energy professionals.
3. Centre for biomass energy. 1998. Straw for energy production; Technology- Environment-Ecology. Available: www.ens.dk.

SWCE

Course No : ELE-SWCE-481 **Course Title : Floods and Control Measures**
Credits : 3 (2+1) **Semester: VIII**

Syllabus
Theory

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, ModifiedPul's method. Flood control-history of flood control, structural and non-structural measures of flood control, storage and detention reservoirs, levees, channel improvement. 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 and rolled fill dams-homogeneous, zoned and diaphragm type, foundation requirements, grouting, seepage through dams, 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. Subsurface dams-site selection and constructional features. Check dasms-Small earthen embankment-types and design criteria.

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.

Teaching Schedule – Theory with weightages (%)

Lecture No	Topic	Book No	Article No.	Page No.	Weightage (%)
1	Definition & causes of floods, design flood, SPF, PMF and its importance	7 2	7.48, 7.49 7.1	445-446 245	25
2	Estimating design flood and flood flows	7 2	7.50, 7.50.1 7.2, 7.3	446-452 245-252	
3	Envelope curves	1 7	-- 7.50.2	676-678 452-453	
4	Methods of flood frequency, confidence bands	1	--	704-721	
5.	Flood frequency studies	2	7.6, 7.7	255-265	
6	Unit hydrograph method	7	7.50.4	477-478	
7.	Depth-Area-Duration analysis	1	--	734-736	
8	Flood forecasting: Need, problems, limitations	1	--	768-772	15
9	River forecasting procedure, flood forecasting methods	1 2	-- --	772-778 312-313	
10	Flood routing : channel routing, Muskingum method, crest segment routing	1 2	11.4 8.5	576-588 291-296	
11	Reservoir routing, Modified Pul's method	1 2	11.5 8.3	590-592, 601-602 281-284	
12	Flood control : history, structural and non-structural measures for flood control	2	8.10, 8.11	309-314	
13	Gully control structures : temporary check dams	3	15.8, 15.9	756-764	30
14	Permanent structures for gully control	4	26.8, 26.9	517-528	
15	Design of chute spillway, design of drop inlets	4	26.10, 26.11, 26.11	529-537	

16	Ravine reclamation	5 3	4.9 15.3-15.8	184-189 742-756	
17	Control & training of rivers, objectives, classification, methods of river training, marginal embankments	7	8.5, 8.5.1, 8.5.2, 8.5.3	500-503	
18	Guide banks	7	8.5.3(2)	503-509	
19	Earthen embankments: introduction, types, methods of construction	7 5	20.1,20.2, 20.3 16.1	1045-1047 553-555	30 (Lecture No.19 to 32)
20	Foundation design	6	128	211-212	
21	Grouting	6	129	212-218	
22	Seepage through embankments	4	27.5	545-547	
23	Flow net & its properties	5	16.6	565-567	
24	Seepage line in composite earth embankments	7	20.12.1-20.12.3	1060-1070	
25	Drainage filters, Piping & its causes	7	20.14, 20.7.2	1090-1092 1053-1054	
26	Design of earthen dams	3	16.7	819-821	
27, 28 & 29	Stability analysis of slopes, stability of foundation against shear	7	20.8, 20.9	1055-1057	
			20.13, 20.13.3, 20.13.4	1071-1072 1076-1077	
			20.13.5, 20.13.6 20.13.7	1077-1080 1080-1082	
30	Small earthen embankments	4	27.4	542-544	
31	Subsurface dams*: site selection & constructional features	-	-	-	
32	Planning of flood control projects and their economics*	-	-	-	

*****Topics may be covered from any other suitable book/source.

Practical Exercises

Exercise No.	Title
1.	Study of flood-stage-discharge and flood peak-area relationships of watershed.
2.	Determination of frequency distribution functions and confidence bands by Gumbel's method.
3.	Determination of frequency distribution functions by Log Pearson Type-III method.
4.	Determination of design flood, standard project flood and probable maximum flood.
5.	Determination of channel level by flood routing by Muskingum methods

6.	Determination of reservoir level by Modified Puls Method
7.	Determination of reservoir levels by Graphical method.
8.	Determination of reservoir inflow, outflow and storage by flood routing.
9.	Design of flood control levees and guide banks. (Ref. Book No.7, p. 501).
10.	Study of vegetative measures of gully control.
11.	Study of structural measures of gully control
12.	Design and cost estimation of permanent gully control structures.
13.	Design of earth dam and determination of phreatic (seepage) line.
14.	Analysis of stability of slopes and foundation shear safety of earth dam.
15.	Construction of flow net and computation of seepage of earth dam.
16.	Study of Designation for check dams

Suggested readings

Text Books:

1. Mutreja K. N. 1986, Applied Hydrology, Tata McGraw-Hill Publishing Co, Delhi.
2. Subramanya K., 2008, Engineering Hydrology, 3rd Edi., Tata McGraw-Hill Publishing Co, Delhi.
3. Michael, A. M. and T.P. Ojha2003, Principles of Agricultural Engineering Volume, 4th Edi., Jain Brothers, New Delhi.
4. Murthy, V.V.N. 2002, Land and Water Management Engineering, 4th Edi.,Kalyani Publishers, New Delhi.
5. Suresh R. 2014 Soil and Water Conservation Engineering, Standard Publisher Distributors, New Delhi.
6. Bureau of Reclamation, 1987, Design of Small Dams, US Department of Interior, Washington D.C.
7. Garg S.K., 2009, Irrigation Engineering and Hydraulic Structures, Khanna Publishers Pvt. Ltd, New Delhi.

Course No. : ELE-SWCE 482 Course Title: Remote Sensing and GIS Applications

Semester : VIII Credits : 3 (2+1)

Syllabus

Theory

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 carve for vegetation, soil and water; spectral signatures; different types of sensors and platforms; contrast ratio and possible causes of low contrast; aerial photography; types of aerial photographs, measurements on a stereo-pair-vertical measurements by the parallax method; ground control for aerial photography; satellite remote sensing, multispectral scanner-whiskbroom and push-broom scanner; different types of resolution; 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; microwave remote sensing. 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, 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; basis 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.

Teaching Schedule- Theory with weightages (%)

Lec. No.	Topic	Book No.	Topic No.	Page No.	Weightages (%)
1-2	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	1 2	3.1 – 3.2 1.0 – 1.1 1.4 – 1.7	65 – 69 1 – 3 11 – 21	30
3-4	Electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface	1 3	3.3 – 3.6 1.2 – 1.4	69 – 94 4 – 29	
5-6	Principal applications of different wavelength regions	4	1	2 – 6	
7-8	Major atmospheric windows; Different types of resolution, spectral signatures	2	1.1 – 1.3 5.1 – 5.6	2 – 11 129 – 144	
9-10	Different types of sensors and platforms; contrast ratio and possible causes of low contrast	1 4	5.1 – 5.14 1	115 – 176 6 – 13	
11-12	Aerial photography; types of aerial photographs, measurements on a stereo-pair-vertical measurements by the parallax method; ground control for aerial photography	1 3	2.1 – 2.10 3.1- 3.8	24 – 51 123 – 165	40
13-14	Satellite remote sensing, multispectral scanner-whiskbroom and push-broom scanner; Typical spectral reflectance curve for vegetation, soil and water;	4	1	13 – 23	
15-16	Analysis of digital data-image restoration; image enhancement; information extraction	1 3 4	7.1 – 7.5 7.1 – 7.3 8	211- 235 482 – 500 258 – 281	
17-18	Image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas	3	7.7 – 7.11	545 – 572	
19	Vegetation indices	2	4.1	74 - 76	
20	Microwave remote sensing	1	4.1 – 4.9	96 – 114	
21-22	GIS and basic components	1 2	9.1 – 9.8 12.0 – 12.1	302 – 317 390-396	30
23-24	Different sources of spatial data, basic spatial entities, major components of spatial data	1	10.1 – 10.6	323 - 355	
25-26	Basic classes of map projections and their properties	1	1.1 – 1.11	1 - 23	
27-28	Methods of data input into GIS, Data editing, spatial data models and structures	1	12.1- 12.5 10.1– 10.6	384 – 403 323 - 355	
29-30	Attribute data management, integrating data (map overlay) in GIS	1	11.1– 11.6 14.7– 14.8	356 – 381 434 – 448	
31-32	Applications of remote sensing and GIS for watershed management	1	18.1– 18.15	522 – 549	

Practical Exercises

Exercise No.	Title
1	Study of remote sensing and GIS hardware
2	Study of interpretation of satellites imageries
3-4	Study the basic GIS operation such as image display and geo-referencing
5	Study the various features of GIS software packages
6-7	Study the scanning and digitizing of contour maps
8	Downloading and analysis of DEM and Land use /land cover images
9	Supervised and unsupervised classification of images
10	Determination of Vegetative Indices
11-12	Estimation of Morphological characteristics of watershed
13-14	Case study in water resources management
15-16	Case study on application of RS and GIS techniques in watershed planning

Suggested readings

Text Books:

1. Reddy Anji, M. 2006. Textbook of Remote Sensing and Geographical Information Systems. 4th Edition, BS Publications, Hyderabad.
2. George Joseph. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad
3. Lillesand, T., R.W. Kiefer and J. Chipman. 2015 Remote Sensing and Image Interpretation. 6 th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.
4. Sabins, F. F. 2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA.

SWCE GAE - 477-1 Watershed Planning, Development and Evaluation
Credits: 10(0+10)

Sr. No.	Topics
1.	Classification of watershed and watershed characteristics.
2.	Resource mapping of watershed.
3.	PRA Technique for watershed development
4.	Geospatial technologies in planning of watershed development programme and prioritization of development of watershed.
5.	Institutions in watershed development at different levels.
6.	Water resources budgeting in watershed.
7.	DPR preparation.
8.	Planning & Layout of different works of watershed development program in field.
9.	Monitoring and indices of evaluation of watershed development programme.
10.	Environmental impact Assessment of watershed development programme.

SWCE GAE – 477-2 Design and Development of Rainwater Harvesting System

Credits: 10(0+10)

Sr. No.	Topics
1.	Importance, concept & need on Rainwater Harvesting
2.	Techniques of Rainwater Harvesting
3.	Measures of evaporation & seepage control.
4.	Site selection and cost estimation of Earthen Nala Bund
5.	Site selection and cost estimation or Cement Nala Bund
6.	Site selection, design & cost estimation of farm ponds .
7.	Design & cost estimation of Roof top water harvesting system.
8.	Site selection, design & cost estimation of contour trenching.
9.	Water balance study and measures of water harvesting structures.
10.	Monitoring, evaluation & impact of rain water harvesting methods.

Course No. : SWCE 121 Course Title: Surveying and Leveling

Semester : II Credits: 3 (1+2)

Syllabus

Theory:

Surveying: Introduction, classification and basic principles, linear measurements. Chain surveying,. Cross staff survey, Compass survey, Plannimeter, errors in measurements, their elimination and correction, Plane table surveying, Leveling difficulties and error in leveling, Contouring, Computation of area and volume. Theodolite traversing, Introduction to setting of curves, Total Station, Electronic Theodolite, Introduction to GPS survey.

Practical:

Chain survey of an area and preparation of map; Compass survey of an area and plotting of compass survey; Plane table surveying; Leveling L Section and X section and its plotting; Contour survey of an area and preparation of contour map; Introduction of software to drawing contour; Theodolite surveying; Ranging by Theodolite, Height of object by using Theodolite; Setting of curves by Theodolite; Minor instruments; Use of Total Station.

Teaching Schedule – Theory with weightages (%)

Lect. No.	Topic	Book No.	Page No.	Weight age (%)
1	Definitions, Object of Survey, Primary Divisions of Survey, Classification and use of survey	1	1 to 4	30
2	Principle of surveying, Measurement, Units of measurements, Methods of locating points, Works of surveyor, Precision in surveying	1	4 to 9 13 to 15,	
3	Principles of Chain Surveying, Triangulation survey, Survey station, Selection of stations, Survey lines, ranging and types of ranging	1	74 to 91 45 to 51	
4	Chaining, Type of chains, Recording the measurement, Offsets and their types, Number of offsets, Computation of areas.	1	34 to 46 77 to 83 309 to 317	
5	Errors in lengths due to incorrect chain, Correction for slopes, Error in chaining with tape and corrections, Numerical on chain and tape corrections	1	32 to 71	
6	Instruments for setting right angles, Cross staff, Prism square and optical square, Obstacles in chaining and ranging, Numerical	1	95 to 119	
7	Types and Methods of Traverse survey, Prismatic Compass, Surveyor Compass, Bearing of line, and computation of angles.	1	130 to 151	25
8	Local attraction and numerical, Magnetic declinations, Dip of needles, Plotting of traverse survey, Errors and limitation of compass survey.	1	151 to 173	
9	Plane Tabling, Instruments & Accessories. Advantages and Disadvantages, setting & orientating tables,	1	289 to 293	
10	Methods of Plane tabling, Radiation, Intersection, Traversing and Resection, Errors in Plane Tabling	1	293 to 303	
11	Leveling, Terms used in leveling, Types of levels, Leveling staffs, Focusing, Bench Marks, Adjustment of Level.	1	345 to 367	25
12	Principles of leveling, Reduction of levels, Booking of staff reading, Numerical	1	368 to 383	
13	Classification of leveling, Differential, Profile, Cross sectioning, effect of curvature and refraction, check leveling, Reciprocal and precise leveling.	1	384 to 409	
14	Contouring, Characteristics of contours, Use of contours, Locating the contours, Interpolation of contours.	1	430 to 438	20
15	Theodolites, Total Survey Stations, Traversing, Measurement of horizontal and vertical angle, Introduction to setting of curves, Introduction to GPS.	1 5	179 to 187 203 to 212, 276-278	

16	Computation of Earth Work Volumes, Formulae for straight level section, Two level section, Side Hill, Two level Section and Three level Section, Prizmoidal formula and Numerical	1	454 to 468	

Practical Exercises

Ex. No.	Exercise
1.	Study of distance measuring instruments
2.	Determination of error in length of chain using tape
3.	Ranging of survey line (Direct ranging)
4.	Ranging of survey line (indirect ranging)
5.	Dropping of perpendicular on chain line from point outside
6.	Erecting perpendicular on chain line
7.	Chain survey of an area by Triangulation and Cross staff
8.	Plotting of chain survey and computation of area
9.	Study of Prismatic Compass and surveyor compass, Taking bearing, and computation of angle
10.	Open traverses survey of Road or Stream and Plotting
11.	Closed Traverse survey of field / building and Plotting
12.	Plane Table survey by Radiation Methods
13.	Plane Table survey by Intersection Methods
14.	Plane Table survey by Traversing Methods
15.	Study of different levels , leveling staff, and their adjustment
16.	To study booking of staff reading to determine the reduced level
17.	To study the simple and differential leveling to determine reduced levels
18.	To study the profile leveling and determine reduced leveling
19.	To study the plotting of profile leveling and compute cutting & filling
20.	To study the Grid survey of field
21.	Plotting of contours and interpolation of contours
22.	Study the software for drawing of contours
23.	Cross sectioning of gully or nala and plotting
24.	L-section of a gully or nala and plotting
25.	To study the Theodolite, Measurement of vertical and horizontal angle by Theodolite
26.	Determine the height of object with Theodolite
27.	Setting of curves with Theodolite

28.	Study of Total Survey Station and Computation horizontal, Vertical and height of object with Total Survey Station
29.	Study of Minor Instruments (Abney level, hand level, Box sextant and Clinometers)
30.	Study of minor instruments (Box sextant Line ranger, optical square)
31.	Study of Plannimeter and Pentagraph
32.	Study of GPS and Measuring area with GPS

Suggested readings

Text Book:

1) Surveying and leveling, Part-I, T. P.Kanetkar, S. V. Kulkarni, 23rd edition, 1999
2) Remote Sensing and GIS, By AnjiReddey

Reference Books:

1) Surveying and levelling –Part-II, T. P.Kanetkr, S. V. Kulkarni,
2) Surveying, Vol I and II, Dr B. C.Punmia
3) Surveying, Vol I and II, S. K. Duggal
4) Surveying, Vol-I, Arora K R, 1990

Course No.: SWCE-232 **Course Title: Soil Mechanics**

Semester: III **Credits: 2(1+1)**

Syllabus

Theory:

Introduction of soil mechanics, field of soil mechanics, phase diagram, physical and index properties of soil, classification of soils, effective and neutral stress, elementary concept of Boussinesq and Wester guards analysis, new mark influence chart. Seepage Analysis; Quick condition-two dimensional flow-Laplace equation, Velocity potential and stream function, Flow net construction. Shear strength, Mohr stress circle, theoretical relationship between principle stress circle, theoretical relationship between principal stress, Mohr coulomb failure theory, effective stress principle. Determination of shear parameters by direct shear test, triangle test & vane shear test. Numerical exercise based on various types of tests. Compaction, composition of soils standard and modified protector test, abbot compaction and Jodhpur mini compaction test field compaction method and control. Consolidation of soil: Consolidation of soils, one dimensional consolidation spring analogy, Terzaghi's theory, Laboratory consolidation test, calculation of void ratio and coefficient of volume change, Taylor's and Casagrande's method, determination of coefficient of consolidation. Earth pressure: plastic equilibrium in soils, active and passive states, Rankine's theory of earth pressure, active and passive earth pressure for cohesive soils, simple numerical exercises. Stability of slopes: introduction to stability analysis of infinite slope and finite slopes friction circle method, Taylor's stability number.

Teaching Schedule- Theory with weightages (%)

Lecture No.	Topic	Book No.	Article No.	Weightages (%)
1	Introduction of soil mechanics, field of soil mechanics.	1	1.1, 1.3,	25
2, 3, 4	Soil as a three phase system, voids ratio, porosity and degree of saturation, functional relationship and numerical	1.	2.1, 2.4, 2.6	
5, 6	Index properties of soil: water content, specific gravity, particle size distribution, consistency limits, in-situ density and density index,	1.	3.1, 3.2, 3.3, 3.4, 3.10, 3.13	30
7	Classification of soils, particle size classification and textural classification	1.	4.1, 4.2, 4.3	
8,9	Compaction, Standard Proctor Test, Modified Proctor Test, Abbot compaction test, Jodhpur Mini-Compaction test, Field compaction methods and field compaction control.	1	17.1, 17.2, 17.3, 17.6, 17.7, 17.8, 17.10	20
10,11	Consolidation of soils, one dimensional consolidation spring analogy, Tergazi's theory of one dimensional consolidation, laboratory consolidation test, calculation of voids ratio and coefficient of volume change	1	15.1, 15.2, 15.5, 15.7, 15.8	
12,13	Effective stress principle, Determination of shear parameters by direct shear test and numericals.	1	18.4,18.5,18.6	25
14, 15	Earth pressure: plastic equilibrium in soils :active and passive states, Rankine's theory of earth pressure, active earth pressure for cohesive soils, passive earth pressure for cohesive soils	1	20.1, 20.2, 20.4, 20.5, 20.6	
16	Stability of slopes: stability analysis of infinite slopes	1	23.1, 23.2,	

Practical Exercises

Exercise No.	Title
1.	Determination of water content of soil by oven drying method.
2.	Determination of specific gravity of soil by pycnometer method.
3.	Determination Water content of soil by pycnometre method.
4.	Determination of field density of soil by core cutter method.
5.	Determination of field density of soil by sand replacement method.
6.	Mechanical analysis of soil by sieving.
7.	Determination of grain size distribution by hydrometer method.
8.	Determination of liquid limit by Casagrande's method;
9.	Determination of plastic limit of soil.
10.	Determination of shrinkage limit of soil.
11.	Determination of permeability by constant head method;
12.	Determination of permeability by variable head method;
13.	Determination of compaction properties of soil by standard proctor test.
14.	Determination of unconfined compression test parameters.
15.	Determination of triaxial shear strength of soil
16.	Determination of consolidation properties of soils.

Suggested readings

Text Book:

1. Punmia, B. C., Jain, A. K. and Jain A. K. 2005. Soil Mechanics and Foundations.Laxmi Publications(P) Ltd. New Delhi.

Reference Books:

1. RanjanGopal and Rao, A. S. R. 1993. Basic and Applied Soil Mechanics.Welley Easters Ltd., New Delhi.
2. Singh Alam. 1994. Soil Engineering Vol. I. CBS Publishers and Distributions, Delhi.

Course No.: SWCE-233 **Course Title: Watershed Hydrology**

Semester: III **Credits: 3(2+1)**

Syllabus

Theory

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. 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. Hydrograph - Components, base flow separation, unit hydrograph theory. Stream gauging - discharge rating curves, flood peak, design flood and computation of probable flood. 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 synthetichydrograph. Exercise on flood routing.

Teaching Schedule – Theory with weightages (%)

Lect. No.	Topic	Book No.	Article No.	Page No.	Weightages (%)
1	Introduction, Scope of Hydrology Hydrologic cycle	2 1	- 3.1	1-3,11-14 24-25	30
2	Precipitation-forms, Rainfall measurement, mass curve	2 4 1	 2.1 3.3,3.9	16-21/ 39-40 13-14 26-34	
3	Hyetograph, mean rainfall depth. Adequacy of raingauge, point precipitation, Mean Areal precipitation.	2 4	- 3.10,3.11,3.12	28-35, 39 46-54	
4	Intensity-Duration relationship, Intensity-Duration frequency relationship, Depth Area duration relationship, plotting positions. Frequency Analysis,	3 4	3.8 -	87-89 60-68	
5	Estimation of missing data, Test of consistency of rainfall records.	4	3.7, 3.8	36-45	
6-8	Hydrologic Losses (Interception, infiltration, Evaporation, Evapo-transpiration): Estimation & Measurement	4 2	4.1, 4.2, 4.3, 4.6, 4.9.2, 4.10, 4.12, -	82-88, 90-94, 101-109, 115-124, 135-138 62-68	
9	Geomorphology of watershed, stream number stream length, stream slope Horton law,	2		99-103	30
10-11	Runoff-factors affecting runoff Measurement: Stage & velocity, rating curve	2 4	- -	108,186-194, 253-259	
12-13	Estimation of peak runoff rate, rational method, Cook's method, SCS method; Numericals on above	2 1 4 5	- 3.11 5.2.1, 5.2.2 2.6	109-112 36-38 151-162 29-36	
14-15	Curve Number method (estimation of runoff volume) Numericals on above	4 1 5	5.2.3 - -	162-166 39-43 44-48	

16-17	Hydrograph, Components. Base flow separation.	2 4	- 6.1,6.4	121-129 182-184, 191-193	25
18	Unit Hydrograph theory, Unit hydrograph of different duration	4	6.6	193-208	
19-21	Examples/Numericals on above. Distribution hydrograph.	2	-	148-157	
22-23	Synthetic Unit Hydrograph(Snyder Method) Numericals on above	4	6.7	208-217	
24-25	Dimensionless Unit Hydrograph	4	6.8	217-220	
26-27	Head water flood control- methods	2 4	- 8.3	258-272 290-297	15
28-29	Flood routing, graphical method of Reservoir Flood Routing	4	9.1-9.3, 9.8	310-311, 328	
30	Hydrology of dryland areas-drought & its classification	4	11.1,11.2,11.4, 11.5	395-399 401-402	
31-32	Introduction to watershed management & planning	1	28.1-28.3,28.9	556-558 565-567	

Practical Exercises

Exercise No.	Title
1	Visit to meteorological observatory to study different instruments.
2	Study of different types of raingauges
3	Analysis of raingauge charts
4	Checking of consistency of rainfall data
5	Estimation of average rainfall depth by different methods
6	Probability analysis of rainfall data by Weibull's method
7	Estimation of peak runoff rate by rational method.
8	Estimation of peak runoff rate by Cook's method.
9	Computation of runoff volume by Curve Number method.
10	Study of stream gauging instruments (Stage level recorder and current meter).
11	Study of base flow separation methods
12	Development of DRH from stage hydrograph.
13	Development of unit hydrograph.
14	Development of Dimensionless Unit Hydrograph
15	Study of different flood routing methods for reservoir flood routing

16	Study of different geomorphologic characteristics of watershed

Suggested readings

Text Books:

1. Land and Water Management Engineering by V.V.N. Murthy, Kalyani Publishers, New Delhi, 1998 (2nd Ed.).
2. Hydrology by H.M. Raghunath, Wiley Eastern Limited, 1997.
3. Applied Hydrology by K.N. Mutreja, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1995 (4th Ed.).
4. Watershed Hydrology by R.Suresh, Standard Publishers Distributors, New Delhi-6, 1997 (1st Ed.).
5. Manual of Soil and Water Conservation Practices By G. Singh, C. Venkataramanan, G. Sastry, and B.P. Joshi.
6.

Reference Book:

1. Engineering Hydrology by K. Subramanya.

Course No.: SWCE-244 **Course Title: Soil and Water Conservation Engineering**

Semester: IV **Credits: 3(2+1)**

Syllabus
Theory

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. Soil loss estimation – Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity - estimation by KE>25 and EI_{30}methods.Soilerodibility - topography, crop management and conservation practice factors.Measurement of soil erosion - Runoff plots, soil samplers. 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, compartmental bunding. Terraces - level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stonewall and trenching(CCT, SCT, & deep CCT). Gully and ravine reclamation - principles of gully control - vegetative measures, temporary structures and diversion drains. Grassed waterways and design. 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.

Teaching Schedule – Theory with weightages (%)

Lecture No.	Topic	Book No.	Article No./ Page No.	Weightage (%)
1	Soil erosion, problems caused by erosion	4	1.1,1.2	25
2	Soil erosion types: geological and accelerated erosion, agents of erosion.	4	3.2, 3.2.1, 3.2.2	
3 , 4	Water erosion, Factors affecting water erosion, classification of water erosion, mechanics of water erosion	4	3.3, 3.4	
5	Gullies- classification of gullies, stages of gully development.	4	4.1, 4.2	
6 ,7, 8	Universal Soil Loss Equation (USLE), determination of USLE parameters, Modified USLE, numerical	3 4	7.3, 7.4 19.2(P.667-668)	
9	Measurement of soil erosion, runoff plots, soil samplers	6	16.8	30
10	Land capability classification	5	14.1	
11	Water erosion control measures-agronomic measures, contour farming, strip cropping, conservation tillage, mulching	1	5.10, 5.11, 5.12	
12, 13	Engineering measures-contour bund, design criteria, numerical, surplussing arrangement	5 6	P.712-716 18.12, 18.13	
14, 15	Engineering measures-graded bund, design criteria, numerical, compartmental bunding	5	14.11	
16	Terraces- level and graded broad base terraces	5	P. 685-688	20
17	Bench terraces-planning, design and layout procedure	5	14.12	
18,19	Contour stone wall and trenching(CCT, SCT, & deep CCT)	6	P.453-454 P. 440-442	
20, 21	Gully and ravine reclamation-Principles of gully control, vegetative measures	5	P. 738-750	25
22, 23	Temporary structures and diversion drain.	5 6	15.9 475-477	
24, 25	Grassed waterways and design, numerical	5	P723-726	
26, 27	Wind erosion- Factors affecting, mechanics, soil loss estimation	6	20.1,20.2, 20.3	
28, 29, 30	Wind erosion- control measures - vegetative, mechanical measures, wind breaks and shelter belts	6	20.4, 20.5,	

	and stabilization of sand dunes.	5	20.6, 20.7 13.8, 13.9	
31,32	Rate of sedimentation, silt monitoring and storage loss in tanks.	4	21.14, 22.5	

Practical Exercises

Exercise No.	Title
1.	Computation of rainfall erosivity index.
2	Computation of soil erodibility index
3	Determination of length of slope (LS) and cropping practice (CP) factors for soil loss estimation.
4-5	Study of soil loss estimation and measuring techniques.
6	Study of rainfall simulator for erosion assessment.
7	Study of Coshocton wheel sampler and multi-slot devisor.
8	Study of determination of sediment concentration through oven dry method.
9	Design of contour bunds.
10	Design of graded bunds.
11	Design of broad base terraces.
12	Design of bench terraces.
13	Design of vegetative waterways.
14	Study of shelterbelts and wind breaks for wind erosion control.
15-16	Visit to watershed project.

Suggested readings

Text Books:

1. 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.
2. Norman Hudson. 1985. Soil Conservation. Cornell University Press, Ithaka, New York, USA.
   Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water
3. Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Suresh, R. 2014. Soil and Water Conservation Engineering.Standard Publisher Distributors, New Delhi.
5. Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
6. Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.

Reference Books:

1. Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service, New Delhi.
2. Mal, B.C. 2014. Introduction to Soil and /Water Conservation Engineering. 2014. Kalyani Publishers.

Course No.: SWCE-355 **Course Title: Water Harvesting and Soil Conservation Structures**

Credits: 3(2+1) **Semester: V**

Syllabus

Theory

Water harvesting - principles, importance and issues. Water harvesting techniques – classification based on source, storage and use. Runoff harvesting – short-term and long - tem techniques. Short - term harvesting techniques – terracing and bunding, rock and ground catchments. Long-term harvesting techniques – purpose and design criteria. Structures – farm ponds – dug out and embankment reservoir types, tanks and subsurface dykes. 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. 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. Hydraulic jump and its application. 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. 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.

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. Runoff measurement using H-flume. 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's for design of soil and water conservation structures. Field visit to watershed project areas treated with soil and water conservation measures / structures.

Teaching Schedule- Theory with weightages (%)

S.N	Topic	Book No.	Article No.	Page No.	Weightage (%)
1 & 2	Water harvesting: Principles, importance and issues, Water harvesting techniques – classification based on source, storage and use.	5	14.1,14.2 14.3	523-525	
3 & 4	**Runoff harvesting**: short-term and long - term techniques. Short - term harvesting techniques – terracing and bunding, rock and ground catchments.	5	14.3.1 & 14.3.1.1	525-526	20
5 & 6	Long-term harvesting techniques – purpose and design criteria. Structures – farm ponds – dug out and embankment reservoir types, tanks and subsurface dykes. Flood water harvesting	5	14.3.1.2,14.4	527-531	
7 & 8	Farm pond : components, site selection, design criteria, capacity, Numericals	3	27.1, 27.2, 27.3	539-542	
9,10 &	Types of earthen Embankment, Rolled fill & Hydraulic fill dam , Design criteria & Design of earthen dam; Numericals Mechanical and emergency spillways, cost estimation and construction.	5 4	16.1-16.3 10.15,10.16	553-560 208-212	20
11&12	Percolation pond/tank: site selection, design and construction details.	6	3.7.1	115-125	
13 & 14	Nalabunding: Location, Execution, Practices Adopted	1	4.3	149-151	
15	Soil erosion control structures: introduction, classification and functional requirements.	4	9.1 & 9.2	172-173	
16, 17, & 18	Permanent structures for soil conservation and gully control : check dams, drop, chute and drop inlet spillways	1	5.3	226-232	25
19 & 20	Design procedures – hydrologic, hydraulic and structural design	5	5.1,5.2, & 5.3	190-193	
21	Stability analysis (Check against Overturning, Sliding, Tension,	5 1	5.4.1 5.6	209-212 282-284	

	Compression and Piping)				
22	Hydraulic jump and its application.	5	5.4	194-195	35
23, 24	Drop spillway : applicability, types – straight drop, box – type inlet spillways – description, functional use, advantages and disadvantages, Numericals	1	5.4	234-240	
25 & 26	Straight apron and stilling basin outlet, structural components and functions.	5	5.4	201-206	
27, 28	Chute spillway : material, functional uses, adaptability, advantages, limitations , components, Numericals	1	5.4	251-253	
29& 30	Design criteria of Saint Antony Falls (SAF) stilling basin , Numericals	5	5.6	221-223	
31& 32	Drop inlet spillway: description, functional use and design criteria, Numericals.	1	5.4	253-259	

Practical Exercises

Exercise No.	Title
1	Study of different types of farm ponds.
2	Computation of storage capacity of embankment type of farm ponds.
3-4	Design of dugout farm ponds
5	Design of percolation pond
6	Design of *nala* bunds
7	Runoff measurement using H-flume
8	Design and stability analysis of permanent structures
9	Stability analysis of drop spillway
10	Design of SAF stilling basin in chute spillway .
11	Design of drop inlet spillway
12	Design of small earthen embankment

13-14	Study of software's for design of soil and water conservation structures
15-16	Visit to watershed

Suggested readings
Text Books:

1. Singh Gurmel, C. Venkataraman, G. Sastry and B. P. Joshi. 2004, 6thed. 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. 4th Edition, Jain Brothers, New Delhi.
3. Murthy, V.V.N. 2002. Land and Water Management Engineering. 3rd 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 Waer 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.

Reference Books:

1) Theib Y. Oweis, DiterPrinz and Ahmed Y. Hachum. 2012. Rainwater Harvesting for Agriculture in the Dry Areas. CRC Press, Taylor and Francis Group, London.
2) Studer Rima Mekdaschi and HanspeterLiniger. 2013 Water Harvesting – Guidelines to Good Practice Centre for Development and Environment. University of Bern. Switzerland.

Course No. : SWCE-366 **Course Title: Watershed Planning and Management**

Semester - VI **Credits : 2 (1+1)**

Syllabus

Theory

Watershed - introduction and characteristics. Watershed development - problems and prospects, investigation, topographical survey, soil characteristics, vegetative cover, present 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. 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. Planning and formulation of project proposal for watershed management programme including cost-benefit analysis.

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. Techno-economic viability analysis of watershed projects. Visit to watershed development project areas.

Teaching Schedule- Theory with weightages (%)

Lect. No.	Topic	Book No.	Pages	Article No.	Weightages (%)
1	Watershed - introduction and characteristics.	1, 2, 6	267-271 785-793, 99 to 103	24.1- 24.2	30
2, 3	Watershed development-problems and prospects, investigation, topographical survey, soil characteristics, vegetative cover, Present land use practices and socio-economic factors.	3, 4	7-8 11-17 20 to 26	1.10 2.1-2.2 2.4-2.5	
4	Watershed management - concept, objectives, factors affecting, Integrated watershed management - concept, components	3, 2, 7	4 to 8, 714, 823- 824 1 to 5	1.4 to 1.10 24.8.1, 24.11	
5	Watershed planning based on land capability classes,	4	161 to 164		30
6	Hydrologic data for watershed planning, Water budgeting in a watershed.	5, 6	516 to 525, 89 to 91	15.1- 15.2	
7	Watershed codification, delineation and prioritization of watersheds – sediment yield index.	2	793 to 798	24.4 to 24.6	
8	Management measures - rainwater conservation technologies - *in-situ* and *ex-situ* storage,	7	11 to 19		
9	Water harvesting and recycling.	7	56 to 60		20
10	Dry farming techniques - inter-terrace and inter-bund land management.	8	192 to 197	8.2.1 - 8.2.3	
11	Arable lands - agriculture and horticulture, Non-arable lands - forestry, fishery and animal husbandry.	4	164 to 178		
12	Effect of cropping systems, land management and cultural practices on watershed hydrology.	8	233 to 240	9.1	
13	Watershed programme - execution, follow-up practices, maintenance, monitoring and evaluation.	5, 3	505-510 569, 572-576	14.10 24.1 24.2	20
14	Participatory watershed management - role of watershed associations, user groups and self-help groups.	3	531 to 535 538 to 544	21.1 to 21.4 21.6 to 21.7	
15, 16	Planning and formulation of project proposal for watershed management programme including cost-benefit analysis.	2, 9	815 to 823 146 to 148	24.9 to 24.10	

Practical Exercises

Exercise No.	Title
1-2	Surveying and preparation of watershed map.
3-4	Grid survey of watershed area.
5	Preparation of contour map and delineation of watershed.
6	Delineation of watersheds using top sheets.
7	Quantitative analysis of Geo-morphological characteristics of watershed.
8	Analysis of hydrologic data for planning of watershed development.
9	Water budgeting of watersheds.
10	Prioritization of watersheds based on sediment yield index.
11	Watershed planning and development.
12	Study of watershed management technologies.
13-14	Practice on software's for analysis of hydrologic parameters of watershed.
15-16	Visit to watershed development project

Suggested readings

Text Books

1. Soil Conservation and Land Management. S. K. Datta, International Book Distributors, Dehradun, 1985
2. Soil and Water Conservation Engg. R. Suresh, Standard Publishers Distributors, Delhi-6, Reprint Edition 2006
3. Watershed Planning and Management. Rajvir Singh. Yash Publishing House, Bikaner. 2000
4. Field Manual on Watershed Management. 2013. B. Venkateswarlu, Mohammed Osman, M.V. Padmanabhan, K. Kareemulla, P.K. Mishra, G.R. Korwar& K.V. Rao, CRIDA, Hyderabad
5. Hydrology and Soil Conservation Engineering : Including Watershed Management. Ghanshyam Das, 2008. Prentice-Hall of India Learning Pvt. Ltd., New Delhi.
6. Hydrology. H. N. Raghunath. New Age International Publishers, 2004 reprint.
7. Watershed Management. V.V. DhruvaNarayana G. Sastry& U.S. Patnaik. ICAR, New Delhi, 1997
8. Watershed Management: Guidelines for Indian Conditions. Tideman, E.M., Omega Scientific Publishers, New Delhi. 1996
9. Watershed Management: Design and Practice. P. K. Singh, 2000. E-media Publications, Udaipur.

Reference Books

1. 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.
2. Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service. New Delhi.
3. 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.
4. Singh, G.D. and T.C. Poonia. 2003. Fundamentals of Watershed Management Technology. Yash Publishing House, Bikaner.