SCHEME OF TEACHING AND EXAMINATION

**M.TECH.- ENVIRONMENTAL ENGINEERING**

**I SEMESTER**

| Subject Code | Name of the Subject | No. of Hrs. / week | | Duration of Exam in Hours | Marks for | | Total Marks |
|---|---|---|---|---|---|---|---|
| | | Lecture | Practical/ Field Work/ Assignment | | I A | Exam | |
| 10 CEE 11 | Applied Environmental Chemistry and Microbiology | 4 | 2 | 3 | 50 | 100 | 150 |
| 10 CEE 12 | Water Treatment Technology | 4 | 2 | 3 | 50 | 100 | 150 |
| 10 CEE 13 | Water Resources Engineering & Applied Hydraulics | 4 | 2 | 3 | 50 | 100 | 150 |
| 10 CEE 14 | Solid Waste Engineering & Management | 4 | 2 | 3 | 50 | 100 | 150 |
| 10 CEE 15x | Elective- I | 4 | 2 | 3 | 50 | 100 | 150 |
| 10 CEE 16 | Seminar- I (Lab + Seminar) | - | 3 | - | 50 | - | 50 |
| **Total** | | **20** | **13** | **15** | **300** | **500** | **800** |

Note: Lab – Water Quality Parameters Analysis Lab
Out of 50 marks, 25 each for Seminar and Lab

**ELECTIVE- I**

| Subject Code | Name of the Subject |
|---|---|
| 10 CEE 151 | Advanced Computational Methods and Optimization |
| 10 CEE 152 | Occupational Safety and Health |
| 10 CEE 153 | Remote Sensing & GIS in Environmental Engineering |

I SEMESTER

## APPLIED ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY

Subject Code **: 10 CEE-11** IA Marks : 50
No. of Lecture Hrs/ Week - 04 Exam Hrs : 03
Total no. of Lecture Hrs. - 52 Exam Marks : 100

Importance of Environmental Chemistry, types of reactions, redox reactions, reaction kinetics. Electrochemistry and its applications.

**Physical and equilibrium chemistry** – fundamentals and applications. Trace Contaminants and their analyses.

**pH –** Principle, Measurement, Numerical Examples, Buffers and Buffer index.

**Colloidal Chemistry** – Properties of colloids, colloidal dispersions, stability of colloids and applications.
Applications of Organic Chemistry in Environmental Engineering.

**Colourimetry** – Principles and applications.
Applications of Analytical Chemistry – emission and absorption techniques.

**Microbiology -** Microorganisms of importance in air, water and soil environment Principles and applications of microscopy, microscopic flora and fauna of importance.
Metabolism and metabolic pathways, Bioconcentration, Biomagnification and Bioaccumulation.

**Bacteria –** Morphology, typical growth curve and generation time, Measurement Techniques – APC, MPN (Probability and Thomas methods), MFT. Monod's equation and its applications. **Algae** - orphology, classification and their importance. **Fungi** - Protozoa - morphology, classification and their importance. Enzymes - classification, kinetics - Michaelis-Menten equation, factors influencing enzyme reaction.

**Virology** - Types, characteristics and enumeration methodology.

**REFERENCES:**


1. McKinney R.E.(1962) "**Microbiology for Sanitary Engineers**", Newyork McGraw Hill.
2. Sawyer C.N. and McCarty, P.L ., (2003), **"Chemistry for Environmental Engineering and Science**",
   5th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
3. Pelczar M.J ,Chan ECS, Krieg, NR(1998) **"Textbook of Microbiology"** 5th edition Tata McGraw Hill
   Publishing Co. Ltd., New Delhi

4. Gaudy and Gaudy (1980), "**Microbiology for Environmental Scientists and Engineers**", McGraw Hill.
5. APHA, (2002), "**Standard Methods for Examination of Water and Wastewater**"; 21st Edition.
6. Stumn and Morgan(1970), "**Aquatic Chemistry",** John Willey & Sons Newyork

**7. Relevant Journals**


## WATER TREATMENT TECHNOLOGY

| | |
|---|---|
| Subject Code **: 10 CEE-12** | IA Marks : 50 |
| No. of Lecture Hrs/ Week : 04 | Exam Hrs : 03 |
| Total no. of Lecture Hrs. : 52 | Exam Marks : 100 |

**Introduction –** Sources of water, necessity of treatment, Critical Water quality parameters, water quality guidelines and standards for various water uses.

**Unit operations** – principles and design of aeration systems – two film theory, water in air system, air in water system. **Intake structures** – Different types, design criteria.

**Principles of sedimentation** – types of settling and settling equations, design criteria and design of settling tanks. **Principle of Coagulation and Flocculation** – types of coagulants, coagulant aids, coagulation theory, optimum dose of coagulant, design criteria and numerical examples.

**Filtration** – theory, types, hydraulics of filter bed, design criteria and design of filters, filter backwash, operational problems and trouble shooting.

**Adsorption Process** – types, factors affecting adsorption, kinetics and equilibrium – different isotherm equations and their applications.

**Unit processes** - disinfection – different types, disinfectants, factors affecting disinfection, methods of disinfection, chemistry of chlorination.

**Water Softening** – Ions causing hardness, Langelier index, various methods. **Fluoridation and defluoridation** – Principles and design.

**Trace organic contaminants** in water supplies and their removal.
Bench Scale and Pilot Plant studies in water treatment. Rural Water Supply Systems.

**REFERENCES:**


1. Fair, G.M., Geyer J.C and Okun, (1969) "**Water and Waste water Engineering**" Vol II, John Wiley Publications.
2. Weber W.J., (1975) "**Physico - Chemical Processes for Water Quality Control**".
3. AWWA, (1971), "**Water Quality and Treatment** "McGraw Hill.
4. CPHEEO Manual, (1991), "**Water Supply and Treatment",** GOI Publications.
5. Peavy, H.S., Rowe and Tchobonoglous,G., (1985), **"Environmental Engineering**", McGraw Hill
6. Raju, B.S.N., (1995), "Water Supply and Wastewater Engineering", Tata McGraw Hill Pvt. Co. Ltd., New Delhi.
7. World Health Organization, Geneva, (2004), Guidelines for Drinking Water Quality, Third Edition, Volumes 1-3.


## WATER RESOURCES ENGINEERING AND APPLIED HYDRAULICS

| | |
|---|---|
| Subject Code **: 10 CEE-13** | IA Marks : 50 |
| No. of Lecture Hrs/ Week : 04 | Exam Hrs : 03 |
| Total no. of Lecture Hrs. : 52 | Exam Marks : 100 |

Water resources of the world, India and Karnataka, National Water Policy.

**Hydrology -** Hydrologic cycle, estimation of missing precipitation and rain guage density.

**Hydrograph theory** - Unit hydrograph – derivation, flow routing, low flow analysis.

**Urban Hydrology** - Run-off estimation – Design of Stormwater Drains.

**Basics and applications of Remote Sensing** in water resources management.

**Unsteady Flow through Conduits** - Water hammer analysis, Water hammer protection methods - surge tanks.

**Flow Measurements –** Area –Velocity method, Weir method, flumes, end-depth method & chemical and radioactive tracers method

**Groundwater** - Basic equations of flow, confined and unconfined aquifers, sea water intrusion, artificial recharge, groundwater pollution, borewells - types & design principles, open wells – types, yield tests.

**REFERENCES:**


1. Raghunath H.M.(1988), "**Advanced Hydrology**", Wiley Eastern Ltd New Delhi
2. Subramanya K.S(1994)., "**Advanced Hydrology".Tata Mc Graw Hill, New Delhi**
3. David Keith Todd(1980), "**Ground Water Hydrology**".2nd Edition John Wiley & Sons New Delhi
4. Sabins F.F(1997)., "**Remote Sensing – Principles and Interpretations**", W.H. Freeman & Co.
5. Anji Reddy, (2001), "**Remote Sensing and GIS**", B.S. Publications, Hyderabad.
6. Ven T. Chow (1988), "**Hand Book of Applied Hydrology",** 1st Edition Mc Graw Hill Publications

**7.** Hammer M.J, and Mackichan K.A.(1981), "**Hydrology and Quality of Water Resources**", Newyork:Wiley.
8. John Permankian, **"Water Hammer Analysis**".
9. Linsley, Franzini, Freyberg, Tchobanoglous G.(1992), "**Water Resources Engineering**", TATA McGraw Hill Series.
**10.** Linsley, Kohler and Paulhes(1975), "**Hydrology for Engineers**", McGraw Hill.
11. Mays L.W. (2004), **"Water Resources Engineering**", John Wiley and Sons Publications.

## SOLID WASTE ENGINEERING AND MANAGEMENT

| | |
|---|---|
| Subject Code **: 10 CEE-14** | IA Marks : 50 |
| No. of Lecture Hrs/ Week : 04 | Exam Hrs : 03 |
| Total no. of Lecture Hrs. : 52 | Exam Marks : 100 |

**Land pollution and control** – Land Pollution sources and their impacts , general control measures

**Solid waste** – sources and engineering classification, characterization, generation and quantification.

**Transport** - collection systems, collection equipment, transfer stations, collection route optimization.

**Treatment methods** - various methods of refuse processing, recovery, recycle and reuse, composting – aerobic and anaerobic, incineration, pyrolysis and energy recovery,

**Disposal methods** – Impacts of open dumping, site selection, sanitary land filling – design criteria and design examples, leachate and gas collection systems, leachate treatment.

**Recent Developments in Solid Wastes Reuse and Disposal** – Power Generation, Blending with construction materials and Best Management Practices (BMP).

**Role of various organizations in Solid Waste Management** – Governmental, Non-Governmental, Citizen Forums.

**Biomedical Waste management** – sources, treatment and disposal

**REFERENCES:**

1. Tchobanoglous G., Theissen H., and Eliassen R.(1991), **"Solid Waste Engineering - Principles and**
**Management Issues**", McGraw Hill, New York.
2. Pavoni J.L(1973)., "**Handbook of Solid Waste Disposal**".
3. Peavy, Rowe and Tchobanoglous (1985), "**Environmental Engineering**", McGraw Hill Co. 4th Edition
4. Mantell C.L., (1975), "**Solid Waste Management**", John Wiley.
5. CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental
Engineering Organisation, Government of India, New Delhi, 2000.
6. WHO Manual on Solid Waste Management.
7. Vesiland A.(2002), "**Solid Waste Engineering**", Thompson Books.
8. Hazardous waste (management and handling) rules, 2001
9. Biomedical (Handling and Management) Rules 2008

## ADVANCED COMPUTATIONAL METHODS AND OPTIMIZATION

| | |
|---|---|
| Subject Code **: 10 CEE-151** | IA Marks : 50 |
| No. of Lecture Hrs/ Week : 04 | Exam Hrs : 03 |
| Total no. of Lecture Hrs. : 52 | Exam Marks : 100 |

**Numerical Methods** - Partial differential equations, Newton-Raphson method,

**Finite difference, finite element,** method of characteristics, different methods, Successive over relaxation methods.

**Optimization** – classification and importance in Environmental Studies.

**Single and multivariable** optimization without and with constraints.

**Linear Programming –** different methods, linear approximation of non-linear optimization.

**Statistics -** Significance Tests **,** Frequency Distribution, Characteristics of Distributions, Method of Least Squares and Regrssion, Multiple Regression

**Probability** – Concepts, Methods, Binomial, Poisson and Normal distribution,

**Risk and uncertainty** analysis

**REFERENCES:**


1. Rao. S.S.(1979) **Optimization: Theory & Applications Techniques**, Wiley Eastern Ltd New Delhi.
2. Taha H.A.,(2007), "**Optimization Research":An introduction**, Pear son Prentice Hall, 8th Edition
3. Shanthakumar M.S., **Numerical Methods and Analysis,** Tata McGrawhill Pubs.
4. Ross S.M.,(1987) "**Introduction to Probability and Statistics for Engineers and Scientists"**, John Wiley Publications.3rd Edition, Acedimic press
5. Stanton(1961) R.G –" **Numerical methods for science and engineers"**.Prentice Hall, Trade Edition
6. Kreyszig Erwin(2006),9th Edition" **Advanced Engineering Mathematics"**, Wiley Eastern Publications.
7. Berthouex P M.,and Brown L. C.(1994), "**Statistics for Environmental Engineers"**, Lishers publication, 2nd Edition


## OCCUPATIONAL SAFETY AND HEALTH

| | |
|---|---|
| Subject Code **: 10 CEE-152** | IA Marks : 50 |
| No. of Lecture Hrs/ Week : 04 | Exam Hrs : 03 |
| Total no. of Lecture Hrs. : 52 | Exam Marks : 100 |

**Introduction**, Occupational Safety and Health Act, Occupational Safety and Health Administration, Right to know Laws.

**Indian Acts** – Labour Act, Factories Act, OSHA

**Accident** – Causation, investigation methods and different models.

**Ergonomics** – need, Task Analysis, Preventing Ergonomic Hazards, Ergonomics Programme.

**Occupational Hazard and Control** - Hazard Analysis, Human Error and Fault Tree Analysis, Emergency Response. Hazards and their control in different manufacturing and processing industries.

**Fire Prevention and Protection** - types of Fire, Fire Development and its Severity, Effect, Extinguishing Fire, Electrical Safety, Product Safety.

**Occupational Health** - Health and Safety Considerations, Personal Protective Equipment.

**Health problems in different types of industries** – construction, textile, steel and food processing, pharmaceutical, occuptupational Health and Safety considerations in Wastewater Treatment Plants.

**REFERENCES:**


1. Goetsch D.L., (1999), "**Occupational Safety and Health for Technologists**", Engineers and Managers", Prentice Hall.
2. Heinrich H.W.(1959), **"Industrial Accident Prevention",** McGraw Hill Publication , Newyork.
3. Colling D.A.(1990), "**Industrial Safety Management and Technology**", Prentice Hall, New Jersey.
4. Della D.E., and Giustina, (1996), "**Safety and Environmental Management**", Van Nostrand Reinhold
   International Thomson Publishing Inc.
5. CPHEEO, (1999) **Manual on Sewerage and Sewage Treatment,** Ministry of Urban Development, GOI, New Delhi.
6. National Safety Council and Associate (Data) Publishers Pvt. Ltd., (1991), "**Industrial Safety and Pollution Control Handbook**"


## REMOTE SENSING AND GIS IN ENVIRONMENTAL ENGINEERING

| | |
|---|---|
| Subject Code **: 10 CEE-153** | IA Marks : 50 |
| No. of Lecture Hrs/ Week : 04 | Exam Hrs : 03 |
| Total no. of Lecture Hrs. : 52 | Exam Marks : 100 |

**Remote Sensing: Definition** – Ideal Remote Sensing System – Sensors and Types – Remote Sensing Satellite – IRS and INSAT specifications – Applications of remote sensing – DIP Techniques.

**GIS: Definition** – Data and Types – Sources of data - Global Positioning System (GPS) – Data Structure – Types of Analysis – Errors – Applications of GIS.

**Optimal Routing of Solidwastes using GIS – Case Study.**

Environmental Siting of Industri

**es and Zoning Atlas Development. Re-**

**modelling of Water Distribution System using**

**GIS – Case Study. Sustainable Urban**

**Development Planning using GIS.**

**Environmental Degradation Assessment using**

**RS and GIS.**

**Ground water vulnerability modeling**

**using GIS REFERENCES:**


1. Burrough P.A., (1986), "**GIS for Land Resource Assessment",** Oxford University Press, U.K.
2. Star J.L., and Estes J.E., (1990), "**Geographic Information Systems; An Introduction**", Prentice Hall Publications.
3. Laurini R. and Thompson D., (1992), "**Fundamentals of Spatial Information Systems**", Academic Press.
4. Mishra H.C., (1997), "**GIS Handbook**", GIS India, Shanthi Nivas, Hyderabad.
5. Anji Reddy, (2001), "**Remote Sensing and GIS**", B.S. Publications, Hyderabad.
6. Floyd F.Sabins,(1996) "**Remote Sensing – Principles and Interpretations**", W.H. Freeman & Co.
7. Michael N. Demas, (2000), "**Fundamentals of GIS**", John Wiley & Sons, Inc.
8. **"Photonirvachak",** ISRS Journal Publications.

SCHEME OF TEACHING AND EXAMINATION

M.TECH. - ENVIRONMENTAL ENGINEERING

II SEMESTER

| Subject Code | Name of the Subject | No. of Hrs. / week | | Duration of Exam in Hours | Marks for | | Total Marks |
|---|---|---|---|---|---|---|---|
| | | Lecture | Practical/field Work/Assignment | | I A | Exam | |
| 10 CEE 21 | Atmospheric Environmental Pollution and Control | 4 | 2 | 3 | 50 | 100 | 150 |
| 10 CEE 22 | Ecology & Environmental Impact Assessment | 4 | 2 | 3 | 50 | 100 | 150 |
| 10 CEE 23 | Wastewater Treatment Engineering | 4 | 2 | 3 | 50 | 100 | 150 |
| 10 CEE 24 | Transport Processes and Modeling of Aquatic Systems | 4 | 2 | 3 | 50 | 100 | 150 |
| 10 CEE 25x | Elective - II | 4 | 2 | 3 | 50 | 100 | 150 |
| 10 CEE 26 | Seminar – II (Lab + Seminar) | - | 3 | - | 50 | -- | 50 |
| | *Project Phase I (6 weeks) | - | 3 | - | - | - | - |
| | **Total** | **20** | **16** | **15** | **300** | **500** | **800** |

Note: Lab – Atmospheric and Wastewater Characteristics Analysis Lab
Out of 50 marks, 25 each for Seminar and Lab

*Note: After availing a vacation of 2 weeks between II and III semesters

ELECTIVE- II

| Subject Code | Name of the Subject |
|---|---|
| 10 CEE 251 | Environmental Planning and Management |
| 10 CEE 252 | Hazardous Waste Management |
| 10 CEE 253 | Global Warming and Climate Change |

## II SEMESTER

## ATMOSPHERIC ENVIRONMENTAL POLLUTION AND CONTROL

Subject Code **: 10 CEE-21** IA Marks : 50
No. of Lecture Hrs/ Week : 04 Exam Hrs : 03
Total no. of Lecture Hrs. : 52 Exam Marks : 100

**Introduction:** sources, effects on **–** ecosystems, characterization of atmospheric pollutants, air pollution episodes of environmental importance.

**Meteorology** - composition and structure of the atmosphere, wind circulation, solar radiation, lapse rates, atmospheric stability conditions, wind velocity profile, Maximum Mixing Depth (MMD), Temperature Inversions, Windrose diagram.

General characteristics of stack emissions, plume behaviour, heat island effect.

**Monitoring of particulate matter and gaseous pollutants** – respirable, non-respirable and nano - particulate matter. CO, CO2, Hydrocarbons (HC), SOX and NOX, photochemical oxidants.

**Pollutants dispersion models** – description and application of point, line and areal sources.

**Air Pollution Control equipment for particulate matter & gaseous pollutants** – gravity settling chambers, centrifugal collectors, wet collectors, fabric filters, electrostaticprecipitator (ESP).
– adsorption, absorption, scrubbers, condensation and combustion.

**Indoor Air Pollution** – sources, effects and control.

**Noise -** sources, measurements, effects and occupational hazards. Standards, Noise mapping, Noise attenuation equations and methods, prediction equations, control measures, Legal aspects of noise.

REFERENCES:


7. Wark K ., Warner C.F., and Davis W.T., (1998), "**Air Pollution - Its Origin and Control**", Harper & Row Publishers, New York.
8. Lee C.C., and Lin S.D., (1999), **"Handbook of Environmental Engineering Calculations**", McGraw Hill, New York.
9. Perkins H.C.(1974), "**Air Pollution**", McGraw Hill.
10. Crawford M.,(1976) "**Air Pollution Control Theory**", TATA McGraw Hill.
11. Stern A.C., "**Air Pollution**", Vol I, II, III.
12. Seinfeld N.J., (1975), "**Air Pollution",** McGraw Hill.
13. Stern A.C.(1968), (ed) Vol. V, "**Air Quality Management**".


## ECOLOGY AND ENVIRONMENTAL IMPACT ASSESSMENT

| | |
|---|---|
| Subject Code **: 10 CEE-22** | IA Marks : 50 |
| No. of Lecture Hrs/ Week : 04 | Exam Hrs : 03 |
| Total no. of Lecture Hrs. : 52 | Exam Marks : 100 |

**Ecology** - Classification of Ecosystems, Structure and Function of Ecosystems, Energy flow in Ecosystems, Ecological Niche and succession, Bio-geo-chemical cycles, Ecological Pyramids.

**Aquatic and Terrestrial Ecosystems** - Diversity and dominance Indices, Ecosystem Models.

Climate change and biodiversity

**Lake Ecosystem** – trophic levels, nutrient loading, nutrient enrichment, Leibig's Law, control of eutrophication.

**Environmental Impact Assessment** – Definition, Objectives, Types – Rapid and Comprehensive EIA, EIS, FONSI. Step-by-step procedure for conducting EIA and Limitations of EIA, Prevention of Significant
Deterioration (PSD) Programme.

**Frame work of Impact assessment**, scope and contents of EIA, methodologies and techniques of EIA.

**Attributes, Standards and Value functions**. Public participation in EIA. Environmental Management Plan (EMP) and Disaster Management Plan (DMP).

**EIA Case Studies** –Thermal Power Plant, Mining, Fertilizer, Construction Projects, Air port, Water and Wastewater Treatment Plants.

REFERENCES:

6. Kormondy, (1960), "**Concepts of Ecology**", Prentice Hall Publication, New Jersey.
7. Odum, (1961), "**Fundamentals of Ecology",** Adisson Co.
8. Krebs J.,(1985) "**Ecology - The Experimental Analysis of Distribution and Abundance**", I Edition,
Harper International.
9. Hall C.A.S., and Day J.W.(1977), "**Ecosystem Modeling in Theory and Practice: An Introduction with Case Histories**", John Willey.
10. Canter L., (1995), "**Environmental Impact Assessment**", McGraw Hill.
11. Jain R.K., Urban L.V., Stacey G.S., (1977), "**Environmental Impact Analysis – A New Dimension in Decision Making**", Van Nostrand Reinhold Co.
12. Clark B.C. Bisett and Tomlinson P, (1985), "**Perspective on Environmental Impact Assessment**", Allied Publishers.
13. Rau and Wooten, (1981), "**Environmental Impact Assessment Handbook**". McGraw Hill.
14. Relevant Journals **:**

## WASTEWATER TREATMENT ENGINEERING

| | |
|---|---|
| Subject Code **: 10 CEE-23** | IA Marks : 50 |
| No. of Lecture Hrs/ Week : 04 | Exam Hrs : 03 |
| Total no. of Lecture Hrs. : 52 | Exam Marks : 100 |

**Objectives of wastewater treatment,** characteristics, flow variations, types of reactors and reactors analysis. Wastewater Treatment Flow Diagrams and Hydraulic Profile.

**Theoretical principles and design** - screens, equalization basin, grit chamber, primary and secondary settling tanks.

**Kinetics of biological treatment systems** – biokinetic constants and their determination, batch and continuous systems.

**Theoretical principles and design** – suspended growth system - conventional activated sludge process and its modifications.

**Theoretical principles and design** – attached growth system – trickling filter, bio-towers and rotating biological contactors. Principles and design of stabilization ponds

**Sludge Processing** – separation - sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic.

**Advanced Wastewater Treatment** – Need and technologies used. Nitrification and Denitrification Processes, Phosphorous removal. Wastewater disinfection.

**Rural wastewater systems** – septic tanks, two-pit latrines, eco-toilet, soak pits.

REFERENCES:

8. Benefield R.D., and Randal C.W., (1980), **"Biological Process Design for Wastewater Treatment"**, Prentice Hall, Englewood Chiffs, New Jersey.

9. Metcalf and Eddy Inc., (2003), **"Wastewater Engineering - Treatment and Reuse",** 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

10. Karia G.L., and Christian R.A., (2001**), "Wastewater Treatment Concepts and Design Approach",** Prentice Hall of India Pvt. Ltd., New Delhi.

11. Ronand L., and Droste, (1997),"**Theory and Practice of Water and Wastewater Treatment**", John Wiley and Sons Inc.

12. Fair G.M., Geyer J.G and Okun, "**Water-wastewater Engineering**".

13. Lee C.C., and Lin S.D., (1999), **"Handbook of Environmental Engineering Calculations",** McGraw Hill, New York.

14. Gaudy,(1972) "**Advanced Wastewater Treatment".**

15. **"Industrial Safety and Pollution Control Handbook", (1991),** National Safety Council and Associate (Data) Publishers Pvt. Ltd.,

## TRANSPORT PROCESSES AND MODELLING OF AQUATIC SYSTEMS

| | |
|---|---|
| Subject Code **: 10 CEE24** | IA Marks : 50 |
| No. of Lecture Hrs/ Week : 04 | Exam Hrs : 03 |
| Total no. of Lecture Hrs. : 52 | Exam Marks : 100 |

**Modelling** – Introduction, applications in environmental management. **Physical phenomena** – advection, diffusion, dispersion, Fick's laws of diffusion and convective - diffusion equations for turbulent & shear flow regimes.

**Steady-state water quality modelling -** models for conservative and non-conservative substances.

**Data collection and analysis** - specialized water quality surveys,estimation of decay and reareation rates.

**1-D Oxygen balance models** - Streeter-Phelps equation, critical point method.

**Calibration and verification of 1**-D oxygen model. Error measures.

**Mixing zones in rivers** – types of outfalls and mixing regimes. Steady-state 2-D analysis. Field study methodology. Parameter estimation – lateral mixing co-efficient - critical point method – simple numerical problems. Dissolved oxygen models for lakes under completely mixed and stratified conditions.

**Eutrophication models** - simplified nutrient loading models for rivers and lakes.

**Ocean disposal of wastewater -** Siting and design of outfalls.

REFERENCES:

7. Rich L.G., **"Environmental Systems Engineering",** McGraw Hill.
8. Thomann R.V., and Mueller J.A., (1987), **"Principles of Water Quality Management and Control"**, Harper & Row Publications.
9. Schnoor J.L., **"Environmental Modelling – Fate and Transport of Pollutants in Water, Air and Soil**", John Wiley and Sons.
10. Thomann R.V., (1980), **"Systems Approach to Water Quality Management"**, McGraw Hill.
11. Lee C.C., and Lin S.D., (1999), **"Handbook of Environmental Engineering Calculations"**, McGraw Hill, New York.

## ENVIRONMENTAL PLANNING AND MANAGEMENT

| | |
|---|---|
| Subject Code **: 10 CEE-251** | IA Marks : 50 |
| No. of Lecture Hrs/ Week : 04 | Exam Hrs : 03 |
| Total no. of Lecture Hrs. : 52 | Exam Marks : 100 |

**Environment and Sustainable Development -** carrying capacity, relationship with quality of life, carrying capacity and resource utilization.

**Engineering Methodology in Planning and its Limitations –** carrying capacity based short and long term regional planning.

**Environmental Protection** - Economic development and social welfare consideration in socio economic developmental policies and planning.

**Total cost of development and environmental protection cost**. Case studies on Regional carrying capacity.

**Engineering Economics** – Value Engineering, Time Value of Money, Cash Flows, Budgeting and Accounting.

**Environmental Economics**: Introduction, economic tools for evaluation, Green GDP, Cleaner development mechanisms and their applications.

**Environmental Audit** – methods, procedure, reporting and case studies.

**Total Quality Management in environmental management and protection –** ISO 9000, 14000 and 18000 series of standards.

REFERENCES:

10. Lohani B.N (1984)., "**Environmental Quality Management**",South Asian Publishers, New Delhi
11. Chanlett, (1973)"**Environmental Protection**", McGraw Hill Publication, Newyork.
12. Danoy G.E., and Warner R.F., (1969), "**Planning and Design of Engineering Systems**",Unwin Hyman Publications.
13. MOEF, Government of India, "**Carrying Capacity Based Developmental Planning Studies for the**

**National Capital Region"**, 1995-96.
14. NEERI, Nagpur, Annual Reports 1995 & 1996.
15. UNEP / UNDP – "**Environmental Sustainable Development**".

## HAZARDOUS WASTE MANAGEMENT

Subject Code **: 10 CEE-252** IA Marks : 50
No. of Lecture Hrs/ Week : 04 Exam Hrs : 03
Total no. of Lecture Hrs. : 52 Exam Marks : 100

**Introduction, Sources, Classification,** Regulations for Hazardous Waste Management.

**Hazardous Waste Characterization**, Designated Hazardous Wastes.

**Waste Minimization and Resource Recovery** – Approaches, Development of a Waste Tracking System, Selection of waste Minimization Process, Case Studies.

**Transportation of Hazardous Waste** – requirements, regulations, containers, bulk and non-bulk transport, Emergency Response.

**Physico-chemical, Chemical and Biological Treatment of hazardous waste**.

**Thermal treatment -** Incineration and pyrolysis.

**Sanitary landfill –** design approach, leachate and gaseous collection system. Facility Siting and Process Selection for treatment, storage, disposal facility (TSDF).

**Soil contamination and site remediation** – bioremediation processes, monitoring of disposal sites.

REFERENCES:

10. Lehman, (1983), **"Hazardous Waste Disposal"**, Plenum Press.
11. LaGrega M.D., Buckingham P.L., and Evans J.C., (1994), **"Hazardous Waste Management**", McGraw Hill International Edition.
12. Wentz C.A., (1989), "**Hazardous Waste Management**", McGraw Hill.
13. Dawson and Mercer, (1981), **"Hazardous Waste Management**", John Wiley.
14. Fawcett, (1984), "**Hazardous and Toxic Materials: Safe Handling and Disposal"**, John Wiley.
15. National Safety Council and Associate (Data) Publishers Pvt. Ltd., (1991), "**Industrial Safety and Pollution Control Handbook"**

## GLOBAL WARMING AND CLIMATE CHANGE

Subject Code **: 10 CEE-253** IA Marks : 50
No. of Lecture Hrs/ Week : 04 Exam Hrs : 03

Total no. of Lecture Hrs. - 52 Exam Marks : 100

**Energy Issues and Climate Change ,** Alternate Energy Sources

**Green-House Effect** as a Natural Phenomenon, Green House Gases GHGs) and their Emission Sources

Quantification of $CO_2$ Emission, Global Warming Potential (GWP) of GHGs

Modeling Climate change, Ozone layer depletion and its control

**Impacts of climate change** – Global and India, Temperature Rise, Sea Level rise, Coastal Erosion and landslides, Coastal Flooding, Wetlands and Estuaries loss

**Kyoto Protocol** – Importance, Significance and its role in Climate Change

**Carbon Trading** - Mechanisms , Various Models (European, Indian) Global and Indian Scenario **Cleaner Development Mechanisms** – Various Projects related to $CO_2$ Emission Reduction **Alternatives of Carbon Sequestration** – Conventional and non-conventional techniques , Role of Countries and Citizens in Containing Global Warming

References:


8. Barry R.G., and Chorley R.L., (1992), **"Atmosphere, Weather and Climate",** 4th Edition, ELBS Publication.
9. Bolin B., (Ed.), (1981), **"Carbon Cycle Modelling",** John Wiley and Sons Publications.
10. Corell R.W., and Anderson P.A., (Eds.), (1991), **"Global Environmental Change",** Springler Verlog Publishers.
11. Francis D., (2000), **"Global Warming: The Science and Climate Change",** Oxford University Press.
12. Frame B., Medury Y., and Joshi Y., (Eds.), (1992), **"Global Climate Change: Science, Impact and Responses".**
13. Linden E., (2006), **"The Winds of Change: Climate, Weather and the Destruction of Civilizations",** Simon and Schuster Publications.
14. Mintzer I.M., (Ed.), (1982), **"Confronting Climate Change, Risks, Implications and Responses"**, Cambridge University Press.
15. Srivatsava A.K., (2007), **"Global Warming",** APH Publications.
16. Wyman R.L., (Ed.), (1991), **"Global Climate Change and Life on Earth",** Chapman and Hall Publications.
17. Yadav, Chander and Bhan, (2005), **"Global Warming: India's Response and Strategy",** RPH Publications.

SCHEME OF TEACHING AND EXAMINATION

M.TECH. - ENVIRONMENTAL ENGINEERING

II SEMESTER

| Subject Code | Name of the Subject | No. of Hrs. / week | | Duration of Exam in Hours | Marks for | | Total Marks |
|---|---|---|---|---|---|---|---|
| | | Lecture | Practical/field Work/Assignment | | I A | Exam | |
| 10 CEE 21 | Atmospheric Environmental Pollution and Control | 4 | 2 | 3 | 50 | 100 | 150 |
| 10 CEE 22 | Ecology & Environmental Impact Assessment | 4 | 2 | 3 | 50 | 100 | 150 |
| 10 CEE 23 | Wastewater Treatment Engineering | 4 | 2 | 3 | 50 | 100 | 150 |
| 10 CEE 24 | Transport Processes and Modeling of Aquatic Systems | 4 | 2 | 3 | 50 | 100 | 150 |
| 10 CEE 25x | Elective - II | 4 | 2 | 3 | 50 | 100 | 150 |
| 10 CEE 26 | Seminar – II (Lab + Seminar) | - | 3 | - | 50 | -- | 50 |
| | *Project Phase I (6 weeks) | - | 3 | - | - | - | - |
| | **Total** | **20** | **16** | **15** | **300** | **500** | **800** |

Note: Lab – Atmospheric and Wastewater Characteristics Analysis Lab
Out of 50 marks, 25 each for Seminar and Lab

*Note: After availing a vacation of 2 weeks between II and III semesters

ELECTIVE- II

| Subject Code | Name of the Subject |
|---|---|
| 10 CEE 251 | Environmental Planning and Management |
| 10 CEE 252 | Hazardous Waste Management |
| 10 CEE 253 | Global Warming and Climate Change |

## II SEMESTER

## ATMOSPHERIC ENVIRONMENTAL POLLUTION AND CONTROL

Subject Code **: 10 CEE-21** IA Marks : 50
No. of Lecture Hrs/ Week : 04 Exam Hrs : 03
Total no. of Lecture Hrs. : 52 Exam Marks : 100

**Introduction:** sources, effects on **–** ecosystems, characterization of atmospheric pollutants, air pollution episodes of environmental importance.

**Meteorology** - composition and structure of the atmosphere, wind circulation, solar radiation, lapse rates, atmospheric stability conditions, wind velocity profile, Maximum Mixing Depth (MMD), Temperature Inversions, Windrose diagram.

General characteristics of stack emissions, plume behaviour, heat island effect.

**Monitoring of particulate matter and gaseous pollutants** – respirable, non-respirable and nano - particulate matter. CO, CO2, Hydrocarbons (HC), SOX and NOX, photochemical oxidants.

**Pollutants dispersion models** – description and application of point, line and areal sources.

**Air Pollution Control equipment for particulate matter & gaseous pollutants** – gravity settling chambers, centrifugal collectors, wet collectors, fabric filters, electrostaticprecipitator (ESP).
– adsorption, absorption, scrubbers, condensation and combustion.

**Indoor Air Pollution** – sources, effects and control.

**Noise -** sources, measurements, effects and occupational hazards. Standards, Noise mapping, Noise attenuation equations and methods, prediction equations, control measures, Legal aspects of noise.

REFERENCES:


14. Wark K ., Warner C.F., and Davis W.T., (1998), "**Air Pollution - Its Origin and Control**", Harper & Row Publishers, New York.
15. Lee C.C., and Lin S.D., (1999), **"Handbook of Environmental Engineering Calculations**", McGraw Hill, New York.
16. Perkins H.C.(1974), "**Air Pollution**", McGraw Hill.
17. Crawford M.,(1976) "**Air Pollution Control Theory**", TATA McGraw Hill.
18. Stern A.C., "**Air Pollution**", Vol I, II, III.
19. Seinfeld N.J., (1975), "**Air Pollution",** McGraw Hill.
20. Stern A.C.(1968), (ed) Vol. V, "**Air Quality Management**".


## ECOLOGY AND ENVIRONMENTAL IMPACT ASSESSMENT

| | |
|---|---|
| Subject Code **: 10 CEE-22** | IA Marks : 50 |
| No. of Lecture Hrs/ Week : 04 | Exam Hrs : 03 |
| Total no. of Lecture Hrs. : 52 | Exam Marks : 100 |

**Ecology** - Classification of Ecosystems, Structure and Function of Ecosystems, Energy flow in Ecosystems, Ecological Niche and succession, Bio-geo-chemical cycles, Ecological Pyramids.

**Aquatic and Terrestrial Ecosystems** - Diversity and dominance Indices, Ecosystem Models.

Climate change and biodiversity

**Lake Ecosystem** – trophic levels, nutrient loading, nutrient enrichment, Leibig's Law, control of eutrophication.

**Environmental Impact Assessment** – Definition, Objectives, Types – Rapid and Comprehensive EIA, EIS, FONSI. Step-by-step procedure for conducting EIA and Limitations of EIA, Prevention of Significant
Deterioration (PSD) Programme.

**Frame work of Impact assessment**, scope and contents of EIA, methodologies and techniques of EIA.

**Attributes, Standards and Value functions**. Public participation in EIA. Environmental Management Plan (EMP) and Disaster Management Plan (DMP).

**EIA Case Studies** –Thermal Power Plant, Mining, Fertilizer, Construction Projects, Air port, Water and Wastewater Treatment Plants.

REFERENCES:

15. Kormondy, (1960), "**Concepts of Ecology**", Prentice Hall Publication, New Jersey.
16. Odum, (1961), "**Fundamentals of Ecology",** Adisson Co.
17.Krebs J.,(1985) "**Ecology - The Experimental Analysis of Distribution and Abundance**", I Edition,
Harper International.
18. Hall C.A.S., and Day J.W.(1977), "**Ecosystem Modeling in Theory and Practice: An Introduction with Case Histories**", John Willey.
19. Canter L., (1995), "**Environmental Impact Assessment**", McGraw Hill.
20. Jain R.K., Urban L.V., Stacey G.S., (1977), "**Environmental Impact Analysis – A New Dimension in Decision Making**", Van Nostrand Reinhold Co.
21. Clark B.C. Bisett and Tomlinson P, (1985), "**Perspective on Environmental Impact Assessment**", Allied Publishers.
22. Rau and Wooten, (1981), "**Environmental Impact Assessment Handbook**". McGraw Hill.
23. Relevant Journals **:**

## WASTEWATER TREATMENT ENGINEERING

| | |
|---|---|
| Subject Code **: 10 CEE-23** | IA Marks : 50 |
| No. of Lecture Hrs/ Week : 04 | Exam Hrs : 03 |
| Total no. of Lecture Hrs. : 52 | Exam Marks : 100 |

**Objectives of wastewater treatment,** characteristics, flow variations, types of reactors and reactors analysis. Wastewater Treatment Flow Diagrams and Hydraulic Profile.

**Theoretical principles and design** - screens, equalization basin, grit chamber, primary and secondary settling tanks.

**Kinetics of biological treatment systems** – biokinetic constants and their determination, batch and continuous systems.

**Theoretical principles and design** – suspended growth system - conventional activated sludge process and its modifications.

**Theoretical principles and design** – attached growth system – trickling filter, bio-towers and rotating biological contactors. Principles and design of stabilization ponds

**Sludge Processing** – separation - sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic.

**Advanced Wastewater Treatment** – Need and technologies used. Nitrification and Denitrification Processes, Phosphorous removal. Wastewater disinfection.

**Rural wastewater systems** – septic tanks, two-pit latrines, eco-toilet, soak pits.

REFERENCES:
16. Benefield R.D., and Randal C.W., (1980), **"Biological Process Design for Wastewater Treatment"**,
Prentice Hall, Englewood Chiffs, New Jersey.
17. Metcalf and Eddy Inc., (2003), **"Wastewater Engineering - Treatment and Reuse",** 4th Edition, Tata
McGraw Hill Publishing Co. Ltd., New Delhi.
18. Karia G.L., and Christian R.A., (2001**), "Wastewater Treatment Concepts and Design Approach",**
Prentice Hall of India Pvt. Ltd., New Delhi.
19. Ronand L., and Droste, (1997),"**Theory and Practice of Water and Wastewater Treatment**",
John Wiley and Sons Inc.
20. Fair G.M., Geyer J.G and Okun, "**Water-wastewater Engineering**".
21. Lee C.C., and Lin S.D., (1999), **"Handbook of Environmental Engineering Calculations",** McGraw
Hill, New York.
22. Gaudy,(1972) "**Advanced Wastewater Treatment".**
23. **"Industrial Safety and Pollution Control Handbook", (1991),** National Safety Council and Associate
(Data) Publishers Pvt. Ltd.,

## TRANSPORT PROCESSES AND MODELLING OF AQUATIC SYSTEMS

| | |
|---|---|
| Subject Code **: 10 CEE24** | IA Marks : 50 |
| No. of Lecture Hrs/ Week : 04 | Exam Hrs : 03 |
| Total no. of Lecture Hrs. : 52 | Exam Marks : 100 |

**Modelling** – Introduction, applications in environmental management. **Physical phenomena** – advection, diffusion, dispersion, Fick's laws of diffusion and convective - diffusion equations for turbulent & shear flow regimes.

**Steady-state water quality modelling -** models for conservative and non-conservative substances.

**Data collection and analysis** - specialized water quality surveys,estimation of decay and reareation rates.

**1-D Oxygen balance models** - Streeter-Phelps equation, critical point method.

**Calibration and verification of 1**-D oxygen model. Error measures.

**Mixing zones in rivers** – types of outfalls and mixing regimes. Steady-state 2-D analysis. Field study methodology. Parameter estimation – lateral mixing co-efficient - critical point method – simple numerical problems. Dissolved oxygen models for lakes under completely mixed and stratified conditions.

**Eutrophication models** - simplified nutrient loading models for rivers and lakes.

**Ocean disposal of wastewater -** Siting and design of outfalls.

REFERENCES:

12. Rich L.G., **"Environmental Systems Engineering",** McGraw Hill.
13. Thomann R.V., and Mueller J.A., (1987), **"Principles of Water Quality Management and Control"**, Harper & Row Publications.
14. Schnoor J.L., **"Environmental Modelling – Fate and Transport of Pollutants in Water, Air and Soil**", John Wiley and Sons.
15. Thomann R.V., (1980), **"Systems Approach to Water Quality Management"**, McGraw Hill.
16. Lee C.C., and Lin S.D., (1999), **"Handbook of Environmental Engineering Calculations"**, McGraw Hill, New York.

## ENVIRONMENTAL PLANNING AND MANAGEMENT

| | |
|---|---|
| Subject Code **: 10 CEE-251** | IA Marks : 50 |
| No. of Lecture Hrs/ Week : 04 | Exam Hrs : 03 |
| Total no. of Lecture Hrs. : 52 | Exam Marks : 100 |

**Environment and Sustainable Development -** carrying capacity, relationship with quality of life, carrying capacity and resource utilization.

**Engineering Methodology in Planning and its Limitations –** carrying capacity based short and long term regional planning.

**Environmental Protection** - Economic development and social welfare consideration in socio economic developmental policies and planning.

**Total cost of development and environmental protection cost**. Case studies on Regional carrying capacity.

**Engineering Economics** – Value Engineering, Time Value of Money, Cash Flows, Budgeting and Accounting.

**Environmental Economics**: Introduction, economic tools for evaluation, Green GDP, Cleaner development mechanisms and their applications.

**Environmental Audit** – methods, procedure, reporting and case studies.

**Total Quality Management in environmental management and protection –** ISO 9000, 14000 and 18000 series of standards.

REFERENCES:

16. Lohani B.N (1984)., "**Environmental Quality Management**",South Asian Publishers, New Delhi
17. Chanlett, (1973)"**Environmental Protection**", McGraw Hill Publication, Newyork.
18. Danoy G.E., and Warner R.F., (1969), "**Planning and Design of Engineering Systems**",Unwin Hyman Publications.
19. MOEF, Government of India, "**Carrying Capacity Based Developmental Planning Studies for the**

**National Capital Region"**, 1995-96.
20. NEERI, Nagpur, Annual Reports 1995 & 1996.
21. UNEP / UNDP – "**Environmental Sustainable Development**".

## HAZARDOUS WASTE MANAGEMENT

Subject Code **: 10 CEE-252** IA Marks : 50
No. of Lecture Hrs/ Week : 04 Exam Hrs : 03
Total no. of Lecture Hrs. : 52 Exam Marks : 100

**Introduction, Sources, Classification,** Regulations for Hazardous Waste Management.

**Hazardous Waste Characterization**, Designated Hazardous Wastes.

**Waste Minimization and Resource Recovery** – Approaches, Development of a Waste Tracking System, Selection of waste Minimization Process, Case Studies.

**Transportation of Hazardous Waste** – requirements, regulations, containers, bulk and non-bulk transport, Emergency Response.

**Physico-chemical, Chemical and Biological Treatment of hazardous waste**.

**Thermal treatment -** Incineration and pyrolysis.

**Sanitary landfill –** design approach, leachate and gaseous collection system. Facility Siting and Process Selection for treatment, storage, disposal facility (TSDF).

**Soil contamination and site remediation** – bioremediation processes, monitoring of disposal sites.

REFERENCES:

16. Lehman, (1983), **"Hazardous Waste Disposal"**, Plenum Press.
17. LaGrega M.D., Buckingham P.L., and Evans J.C., (1994), **"Hazardous Waste Management**", McGraw Hill International Edition.
18. Wentz C.A., (1989), "**Hazardous Waste Management**", McGraw Hill.
19. Dawson and Mercer, (1981), **"Hazardous Waste Management**", John Wiley.
20. Fawcett, (1984), "**Hazardous and Toxic Materials: Safe Handling and Disposal"**, John Wiley.
21. National Safety Council and Associate (Data) Publishers Pvt. Ltd., (1991), "**Industrial Safety and Pollution Control Handbook"**

## GLOBAL WARMING AND CLIMATE CHANGE

Subject Code **: 10 CEE-253** IA Marks : 50
No. of Lecture Hrs/ Week : 04 Exam Hrs : 03

**Energy Issues and Climate Change ,** Alternate Energy Sources

**Green-House Effect** as a Natural Phenomenon, Green House Gases GHGs) and their Emission Sources

Quantification of $CO_2$ Emission, Global Warming Potential (GWP) of GHGs

Modeling Climate change, Ozone layer depletion and its control

**Impacts of climate change** – Global and India, Temperature Rise, Sea Level rise, Coastal Erosion and landslides, Coastal Flooding, Wetlands and Estuaries loss

**Kyoto Protocol** – Importance, Significance and its role in Climate Change

**Carbon Trading** - Mechanisms , Various Models (European, Indian) Global and Indian Scenario

**Cleaner Development Mechanisms** – Various Projects related to $CO_2$ Emission Reduction

**Alternatives of Carbon Sequestration** – Conventional and non-conventional

References:


18. Barry R.G., and Chorley R.L., (1992), **"Atmosphere, Weather and Climate",** 4th Edition, ELBS Publication.
19. Bolin B., (Ed.), (1981), **"Carbon Cycle Modelling",** John Wiley and Sons Publications.
20. Corell R.W., and Anderson P.A., (Eds.), (1991), **"Global Environmental Change",** Springler Verlog Publishers.
21. Francis D., (2000), **"Global Warming: The Science and Climate Change",** Oxford University Press.
22. Frame B., Medury Y., and Joshi Y., (Eds.), (1992), **"Global Climate Change: Science, Impact and Responses".**
23. Linden E., (2006), **"The Winds of Change: Climate, Weather and the Destruction of Civilizations",** Simon and Schuster Publications.
24. Mintzer I.M., (Ed.), (1982), **"Confronting Climate Change, Risks, Implications and Responses"**, Cambridge University Press.
25. Srivatsava A.K., (2007), **"Global Warming",** APH Publications.
26. Wyman R.L., (Ed.), (1991), **"Global Climate Change and Life on Earth",** Chapman and Hall Publications.
27. Yadav, Chander and Bhan, (2005), **"Global Warming: India's Response and Strategy",** RPH Publications.

SCHEME OF TEACHING AND EXAMINATION

M.TECH. - ENVIRONMENTAL ENGINEERING

IV SEMESTER

| Subject Code | Name of the Subject | No. of Hrs./Week | | Duration of Exam in Hours | Marks for | | Total Marks |
|---|---|---|---|---|---|---|---|
| | | Lecture | Practical/field Work | | IA | Exam | |
| 10 CEE 41 | Evaluation of Project Phase II | - | 3 | - | 50 | - | 50 |
| 10 CEE 42 | Evaluation of Project work and Viva-voce | - | - | 3 | *50 | **100+100 | 250 |
| | **Total** | **-** | **03** | **03** | **100** | **200** | **300** |
| | | | | | | **Grand Total (I to IV Semesters)** | **2400** |

*** 50 marks for Project seminar**
****100 marks for thesis / dissertation evaluation and another 100 marks for final thesis defense examination**

**Project Phase – I** : 6 weeks duration shall be carried out between II and III Semesters. Candidates in consultation with the guides shall carryout literature survey / visit to Industries to finalise the topic of dissertation. Evaluation of the same shall be taken up during the beginning of III Semester. Total Marks shall be 50. Colleges have to send the synopsis after Phase – I.

**Project Phase – II** : 16 weeks duration. 3 days for project work in a week during III Semester. Evaluation shall be taken during the first two weeks of the IV Semester. Total Marks shall be 50.

**Project Phase – III** : 24 weeks duration in IV Semester. Evaluation shall be taken up during the middle of IV Semester. Total Marks shall be 50. At the end of the Semester Project Work Evaluation and Viva-Voce Examinations shall be conducted.

21. The Marks of Project Phase – I shall be sent to the University along with III Semester I.A. Marks of other subjects.
22. The I.A. Marks of Project Phase – II & III shall be sent to the University along with Project Work report at the end of the Semester.