BMS COLLEGE OF ENGINEERING, BANGALORE – 560 019
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DEPARTMENT OF CIVIL ENGINEERING
M. TECH – ENVIRONMENTAL ENGINEERING - SCHEME 2016-2017

I Semester

CREDIT BASED

Course Code	Name of the Course	Credits				CREDITS
		L	T	P	S	
16CVEN1CCM	Applied Environmental Chemistry & Microbiology	3	0	1	0	4
16 CVEN1CWT	Water Treatment Technology	4	0	0	0	4
16CVEN1CWR	Water Resources Engineering & Applied Hydraulics	3	1	0	0	4
16CVEN1CWW	Wastewater Treatment Engineering	3	0	1	0	4
16CVEN1EXX	Elective - I	3	0	0	0	3
16CVEN1EXX	Elective – II	3	0	0	1	4
16EPIM1CRM	Research Methodology	2	--	--	--	2
Total						**25**

L – Lecture; T - Tutorial; P – Practical ; S – Self Study

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Elective - I		**Elective - II**	
16CVEN1ESC	Statistics and Computational Methods	16CVEN1ERG	Remote Sensing & GIS in Environmental Engineering
16CVEN1ELP	Environmental Legal Aspects And Policy Guidelines	16CVEN1ESW	Solid Waste Engineering and Management
16CVEN1ERF	Renewable Energy and Alternative fuels	16CVEN1EGC	Global warming and climate change

Note : one elective to be chosen from each group of electives :
Elective will be offered for a minimum strength of six candidates (out of 18) / eight candidates (out of 24)

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I SEMESTER

APPLIED ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY

Course Name	Applied Environmental Chemistry And Microbiology	**Course Code**	16CVEN1CCM	**SEE Duration**	03 Hrs
Credits	**04**	**L-T-P-S**	3-0-1-0	**CIE+SEE**	50+50

Course Objectives: The course provides a in depth knowledge of various branches of Chemistry, microbiology and its application in treatment and characterization of environmental pollutants.

Course Outcomes: On completion of this course, students are able to

CO1: Apply the principles of Physical and Electrochemistry in Environmental engineering.

CO2: Explain the principles of Colloidal and Analytical chemistry in Environmental Engineering process.

CO3: Evaluate water and wastewater quality parameters through experiments.

CO4: Explain basic morphology, metabolism of different microorganisms and its role in ecological and treatment processes.

Introduction: Importance of Environmental Chemistry, types of reactions, redox reactions, reaction kinetics. Physical and equilibrium chemistry – fundamentals and applications.

Electrochemistry: Electrolytes, types of electrodes and its applications. pH **–** Principle, Measurement, Numerical Examples, Buffers and Buffer index.

Colloidal Chemistry – Properties of colloids, colloidal dispersions, stability of colloids and applications.

Instrumental Method of analysis: Colorimetry - Principles and applications. Applications of Analytical Chemistry – emission and absorption techniques.

Water and Wastewater analysis: Acidity, alkalinity, Hardness, DO, BOD and COD. Trace Contaminants and their analyses.

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 - Morphology, classification and their importance.

Fungi - Protozoa - morphology, classification and their importance.

Virology - Types, characteristics and enumeration methodology.

Enzymes - classification, kinetics - Michaelis-Menten equation, factors influencing enzyme reaction.

Laboratory Experiments:

Testing the samples for turbidity, Conductivity, Total Hardness, Iron, Fluorides, Nitrates, Phosphates, Heavy Metals. Plate Count test, MPN Tests and MFT Tests.

REFERENCES:

1. Sawyer C.N. and McCarty, P.L ., (2003), **"Chemistry for Environmental Engineering and Science"**, 5th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
2. Stumn and Morgan(1995), "**Aquatic Chemistry",** 3rd Edition**,** John Willey & Sons Newyork.
3. Pelczar M.J ,Chan ECS, Krieg, NR(1998) **"Textbook of Microbiology"** 5th edition Tata McGraw Hill Publishing Co. Ltd., New Delhi.

4. McKinney R.E.(1962) "**Microbiology for Sanitary Engineers**", Newyork McGraw Hill.
5. Gaudy and Gaudy (1980), "**Microbiology for Environmental Scientists and Engineers**", McGraw Hill.
6. APHA, (2002), "**Standard Methods for Examination of Water and Wastewater**"; 21st Edition.
7. Relevant Journals.

e- sources:

1. http://nptel.ac.in/courses/103107084/4
2. http://nptel.ac.in/courses/103108100/41

WATER TREATMENT TECHNOLOGY

Course Name	Water Treatment Technology	**Course Code**	16 CVEN1CWT	**SEE Duration**	03 Hrs
Credits	04	**L-T-P-S**	4-0-0-0	**CIE+SEE**	50+50

Course Objectives: The course is designed to train students in the practical aspects of operating and design of water treatment plants, emphasizing safe practices and procedures.

Course Outcomes: On completion of this course, students are able to

CO1: Select the sources of water for various water uses.

CO2: Explain the principles and operation of water treatment systems.

CO3: Explain the processes and design coagulation, flocculation, adsorption, filtration, and disinfection units.

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. APHA, (2002), "**Standard Methods for Examination of Water and Wastewater**"; 21st Edition.
. World Health Organization, Geneva, (2004), Guidelines for Drinking Water Quality, Third Edition, Volumes 1-3.

WATER RESOURCES ENGINEERING AND APPLIED HYDRAULICS

Course Name	Water Resources Engineering And Applied Hydraulics	**Course Code**	16CVEN1CWR	**SEE Duration**	03 Hrs
Credits	04	**L-T-P-S**	3-1-0-0	**CIE+SEE**	50+50

Course Objectives: To make the knowledge base of the student in Hydrology and Hydraulics stronger and broader so that they can handle the design and analysis of the environmental systems with confidence.

Course Outcomes: On completion of this course, students are able to

CO1: Estimate rainfall, optimum rain gauges and consistency with the concept hydrology.

CO2: Solve problems on hydrograph, low and high flow.

CO3: Estimate discharge in rivers, streams and overland peak flows, design of storm drains and outfall sewer.

CO4: Apply the concepts of hydraulics to design water mains, steady state groundwater problems; Outline application of GIS to water resources engineering

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.

WASTEWATER TREATMENT ENGINEERING

Course Name	Wastewater Treatment Engineering	**Course Code**	16CVEN1CWW	**SEE Duration**	03 Hrs
Credits	04	**L-T-P-S**	3-0-1-0	**CIE+SEE**	50+50

Course Objective: To provide a basic description and understanding of the principal unit operations and processes used in the treatment of wastewater. This will include coverage of the scientific basis of each unit process, as well as the conventional approach to their engineering design.

Course Outcomes: On completion of this course, students are able to

CO1: Select appropriate treatment units for municipal effluents and explain the concept of a unit operations and unit processes.

CO2: Explain the principles and design the unit operations and processes for wastewater treatment.

CO3: Propose how residuals from wastewater treatment plants and wastewater from rural places can be managed.

CO4: Choose advanced treatment technologies for wastewater treatment.

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.

Laboratory Experiments:

Testing the samples for pH, Alkalinity, total solids, total dissolved solids, DO, BOD and COD.

REFERENCES:

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

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

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

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

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

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

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

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

9. APHA, (2002), "**Standard Methods for Examination of Water and Wastewater**"; 21st Edition.

STATISTICS AND COMPUTATIONAL METHODS

Course Name	statistics and computational methods	**Course Code**	16CVEN1ESC	**SEE Duration**	03 Hrs
Credits	04	**L-T-P-S**	4-0-0-0	**CIE+SEE**	50+50

Course Objective: To enable the students apply Numerical techniques, basic optimization concept and statistics to various areas of environmental engineering like sampling and analysis, modelling etc.

Course Outcomes: On completion of this course, students are able to

CO1: Apply statistical techniques to examine experimental data.

CO2: Solve engineering problems that involve constrained resource allocation.

CO3: Solve the governing equations of partial differential in nature applied to engineering problems.

Statistics - Statistical methods, scope and limitations, population and sample, frequency distribution-measure of central tendency-measures of Dispersion-Mean, Median ,Mode, standard deviation, coefficient of variation, skewness and their applications. Frequency Distribution, Method of Least Squares and Regrssion, Multiple Regression .

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

Statistical decisions: Hypothesis testing, significance levels Significance Tests.

Optimization – classification and importance in Environmental Studies, introduction to optimization without and with constraints, **Linear Programming –** different methods.

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

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

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

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ENVIRONMENTAL LEGAL ASPECTS AND POLICY GUIDELINES

Course Name	Environmental Legal Aspects And Policy Guidelines	**Course Code**	16CVEN1ELP	**SEE Duration**	03 Hrs
Credits	04	**L-T-P-S**	4-0-0-0	**CIE+SEE**	50+50

Course Objective: The course provides an overview of some of the major environmental statutes in India. The course addresses the variety of regulatory tools and concepts that can be used to prevent environmental harm, focusing on the proper match between regulatory tool and environmental harm.

Course outcomes: On completion of this course, students are able to

CO1: Assess the lawfulness of administrative agency and private action towards the environment by application of the relevant environmental statute or agency regulation.

CO2: Explain the role of the Central and state judiciaries, as well as state legislatures and agencies, in formulating and implementing environmental policy.

Environment Definitions and Acts: Environment definition in Indian law- Different environmental protection legislations- History of Environmental protection in India - Provisions in Indian Penal Code for Environmental protection-The constitutions of India – Union list- State list – Concurrent list - Panchayats and Municipalities role

Water (prevention & control of Pollution) Act & Air (prevention & control of Pollution) Act : Water pollution – definition – Water (Conservation and protection) Act 1974 – Objectives of Water Act – Legislation to control water pollution – Functions of CPCB and SPCB - Local bodies role – Water (prevention & control of pollution) Act 1974 as amended by Amendment Act 1988. Water (prevention and control of pollution) Rules 1975 - Water (prevention & control of

Pollution) Cess Act 1977 as amended by Amendment Act 1987 and relevant notifications - Tolerance limits for effluents discharge and drinking water - Constitution and Resources management and pollution control – Air (prevention & control of Pollution) Act 1981-Sections of Air (prevention & control of Pollution) Act 19, 20, 21, 22-Penalties -Ambient air quality standards-Noise and the Laws.

Environmental (Protection) Act 1986 : Environment and pollution - definition as per Environmental law-General powers of Central and state Government under EPA-Important Notification in EPA 1986- The Indian Forest Act 1927- Forest Conservation Act 1980 - Wild Life (Protection) Act - Constitution of Pollution Control Boards - Powers, functions, Accounts, Audit etc. – Equitable remedies for pollution control

Municipal Solid Waste Management Rules Solid waste management – Hazardous Wastes (Handling and Management) Rules 1998-Bio-medical Wastes (Handling and Management) Rules 1998-Recyclled plastics (Manufacture and Usage) Rules, 1999-Municipal Solid Waste Management Act 2003- Rules - E.I.A and Public Hearing- Eco-labeling-Eco Mark.

Coastal Regulation Zone Notification and Green Benches Coastal Regulation Zone - definition-Importance of coral reef-Regulation activities in CRZ - The Biological Diversity Act 2002-Bio diversity Rules 2004-The Intellectual Property Rights (IPR)-National Environment Appellate Authority –Environmental Tribunal and Green Benches - Some Important cases on Environment - International Conventions - Protocols for protection of the Environment

REFERENCES:

1. Constitutional Law of India – J.N. Pandey 1997 (31st Edn.) Central Law Agency Allahabad.
2. Administrative Law U.P.D. Kesari 1998. Universal Book Trade Delhi.

3. Environmental Law H.N. Tiwari, Allahabad Law. Agency 1997.

4. Environmental, A., Divan and Noble M. Environmental Law and Policy in India (cases, Materials and Statutes) 1991 Tripathi Bombay.

5. Environmental Policy. Forest Policy. Bare Acts – Government Gazette Notification.

6. Environmental Laws of India-C.P.R. Environmental Education Centre.

RENEWABLE ENERGY AND ALTERNATIVE FUELS

Course Name	Renewable Energy And Alternative Fuels	**Course Code**	16CVEN1ERF	**SEE Duration**	03 Hrs
Credits	04	**L-T-P-S**	4-0-0-0	**CIE+SEE**	50+50

Course Objective:

This course creates awareness in students about importance of alternative fuels, combustion and emission characteristics of various gaseous and liquid alternative flues.

Course outcomes: On completion of this course, students are able to

CO1: Outline the need and application of various alternative fuels.

CO2: Explain various methods/technologies to harness various renewable energy sources.

CO3: Outline limitation of fossil fuels and combustion characteristics fuels

Introduction to energy and resources – Renewable energy sources - Availability of solar energy – Sun-earth relationships - - Solar radiation measurement – Flat plate collectors – Solar water heating systems – Evacuated Tubular Concentrators - Solar air heating systems and applications – Concepts on solar drying, cooking, desalination, solar ponds and solar cooling - Passive heating and cooling of buildings – Basics of solar concentrators and types Solar thermal power generation

Biomass to energy conversion processes – Anaerobic digestion, process parameters, biogas composition, digester types, high rate anaerobic conversion systems – Alcohol from biomass – Biodiesel: preparation, characteristics and application - Biomass combustion and power generation – Briquetting – Gasification: Process, types of gasifiers, applications – Waste to energy technologies.

Power in the wind - Types of wind mills – WEG components, Power curves and energy estimation– Indian wind potential. Small Hydro Power: Types, site identification, head and flow measurement, discharge curve, estimation of power potential and system components. Technologies for harnessing renewable energy sources like geothermal, wave, tidal and ocean thermal energy.

Fossil fuels and their availability - Potential alternative liquid and gaseous fuels - Merits and demerits of various alternative fuels – Engine requirements Methods of production - Properties - Blends of gasoline and alcohol - Performance in SI engines – Adaptability - Combustion and emission characteristics - Performance in CI engines - Emission characteristics - Properties of alcohol esters. Production and properties of CNG, LPG, hydrogen gas, biogas and producer gas - Performance and Storage, distribution and safety aspects

Various vegetables oils - Properties - Esterification - Performance and emission characteristics - Bio-diesel: Feed stock, characteristics, preparation (lab and commercial), storage, applications, environmental impacts, economics, and policy.

REFERENCES:

1. Frank Kreith and D.Yogi Goswami (2007), Handbook of Energy Efficiency and Renewable Energy, CRC Press.
2. John Twidell and Tony Weir (2006), Renewable Energy Resources, 2nd Edition, Taylor & Francis, USA.

3. John A. Duffie and William A. Beckman (2006),

4. Solar Engineering of Thermal Process, 3rd Edition, John Wiley & Sons.

5. Gilbert M. Masters (2004), Renewable and Efficient Electric Power Systems, Wiley Interscience.

6. Osamu Hirao and Richard Pefley (1988), Present and Future Automotive Fuels, Wiley Interscience Publication, New York

7. Alcohols and Motor Fuels: Progress in Technology - Series No. 19 - SAE Publication USA C

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REMOTE SENSING AND GIS IN ENVIRONMENTAL ENGINEERING

Course Name	Remote Sensing And GIS In Environmental Engineering	**Course Code**	16CVEN1ERG	**SEE Duration**	03 Hrs
Credits	04	**L-T-P-S**	3-0-0-1	**CIE+SEE**	50+50

Course Objective: To enable understanding of basics in remote sensing ,gis and applications in environmental engineering

Course outcomes: On completion of this course, students are able to

CO1: Explain the basic principles of Remote sensing and GIS.

CO2: Outline the importance and concept of image processing

CO3: Apply knowledge of RS-GIS for various environmental problems

Fundamentals Of Remote Sensing

Definition, Physics of Remote Sensing, Electromagnetic Radiation and its interactions with atmosphere, Spectral reflectance of earth features, Resolution spectral, spatial, Temporal and Radiometric.

Platforms and Sensors

Aerial Photographs, Active and passive sensors, Data products, Various satellites in orbit and their sensors. Image Processing- Visual and digital image, Interpretation ,Interpretation keys, Methodology , Training sets, Ground truth verification, Image analysis, Image enhancement, Rectification, Classification methods, Users accuracy, producers accuracy and overall accuracy.

Introduction To GIS

Data entry, storage and maintenances, Data output. Data analysis, Hardware and software.

Applications of Remote Sensing And GIS

Application of remotely sensed data for identifying solid waste disposal, forest fire mapping, EIA studies etc., Optimal routing of solid waste using GIS – Case Study, Environmental siting of industries and zoning atlas development, Remodeling of water distribution system using GIS, Environmental degradation assessment using RS and GIS.

REFERENCES:

1. Lillies and T.M. and Kiefer, R.W., " **Remote Sensing and Image Interpretation",** John Wiley and Sons, 1994.

2. Burrough, P.A. and McDonnell, R.A., **"Principles of Geographical Information Systems"**, Oxford University press, 1998

3. Lintz,J. and simonet, **" Remote sensing of Environment"**, Addison Wesley Publishing Company, 1994

4. Mishra H.C., (1997), "**GIS Handbook**", GIS India, Shanthi Nivas, Hyderabad.

5. Syed R. Qasim, Edward M. Motley & Guang Zhu, **"Water Works Engineering: Planning, Design and Operation",** Eastern Economy Edition, PHI Learning Private Limited, New Delhi.

SOLID WASTE ENGINEERING AND MANAGEMENT

Course Name	Solid Waste Engineering And Management	**Course Code**	16CVEN1ESW	**SEE Duration**	03 Hrs
Credits	04	**L-T-P-S**	3-0-0-1	**CIE+SEE**	50+50

Course Objective: To familiarize the students on segregation, collection, transportation, recycling and disposal of municipal solid waste in such a way that its impact is minimal on environment, economy and community.

Course Outcomes:

CO1: Outline sources, types and composition of solid waste with methods of handling, sampling and storage of solid waste.

CO2: Select the appropriate method for solid waste collection, transportation, segregation and its treatment.

CO3: Describe methods of disposal of Municipal solid waste and Biomedical waste.

CO4: Outline the recent developments in resource recovery and role of GO's and NGO's in waste management.

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 EIiassen 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. Vesiland A.(2002), "**Solid Waste Engineering**", Thompson Books.

7. Biomedical (Handling and Management) Rules 2008

e- sources:

http://nptel.ac.in/courses/120108005/

GLOBAL WARMING AND CLIMATE CHANGE

Course Name	Global Warming And Climate Change	**Course Code**	16CVEN1EGC	**SEE Duration**	03 Hrs
Credits	04	**L-T-P-S**	3-0-0-1	**CIE+SEE**	50+50

Course Objective: To enable the students to learn important issues and aspects of Climate change, and control methods like cleaner technologies and carbon sequestration.

Course Outcomes: On completion of this course, students are able to

CO1: Identify the various issues pertaining to climate change.

CO2: Outline the various impacts of climate change globally and on regional scale.

CO3: Write on cleaner technologies and carbon sequestration.

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:

1. Barry R.G., and Chorley R.L., (1992), **"Atmosphere, Weather and Climate",** 4th Edition, ELBS Publication.

2. Bolin B., (Ed.), (1981), **"Carbon Cycle Modelling",** John Wiley and Sons Publications.

3. Corell R.W., and Anderson P.A., (Eds.), (1991), **"Global Environmental Change",** Springler Verlog Publishers.

4. Francis D., (2000), **"Global Warming: The Science and Climate Change",** Oxford University Press.

5. Frame B., Medury Y., and Joshi Y., (Eds.), (1992), **"Global Climate Change: Science, Impact and Responses".**

6. Linden E., (2006), **"The Winds of Change: Climate, Weather and the Destruction of Civilizations",** Simon and Schuster Publications.

7. Mintzer I.M., (Ed.), (1982), **"Confronting Climate Change, Risks, Implications and Responses"**, Cambridge University Press.

8. Srivatsava A.K., (2007), **"Global Warming",** APH Publications.

9. Wyman R.L., (Ed.), (1991), **"Global Climate Change and Life on Earth",** Chapman and Hall Publications.

10. Yadav, Chander and Bhan, (2005), **"Global Warming: India's Response and Strategy",** RPH Publications.

RESEARCH METHODOLOGY

Course Name	Research Methodology	**Course Code**	16EPIM1CRM	**SEE Duration**	03 Hrs
Credits	02	**L-T-P-S**	2-0-0-0	**CIE+SEE**	50+50

Module 1:

Meaning, Objectives and Characteristics of research - Research methods Vs Methodology -Types of research - Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs Qualitative, Conceptual Vs. Empirical - Research process - Criteria of good research - Developing a research plan.

Module 2:

Defining the research problem - Selecting the problem - Necessity of defining the problem -Techniques involved in defining the problem **-** Importance of literature review in defining a problem **- S**urvey of literature - Primary and secondary sources - Reviews, treatise, monographspatents - web as a source - searching the web - Identifying gap areas from literature review -Development of working hypothesis.

Module 3:

IPRs- Invention and Creativity- Intellectual Property-Importance and Protection of Intellectual Property Rights (IPRs)- A brief summary of: Patents, Copyrights,

Trademarks, Industrial Designs- Integrated Circuits-Geographical Indications-Establishment of WIPO-Application and Procedures.

Module 4:

Aim of this part of the course: is to strengthen students minds towards high quality research through publications, patents and also to learn research ethics.

Publications

Research concepts, Research importance on economy, Research in India and abroad, Importance of publications, Why, where, when to publish?

Publication ethics , Plagiarism (how to use turn it in effectively), International ethics on research, What and what not to publish, Ethical guidelines, Case studies

Quality vs quantity Searching literature with high quality, Impact factor, Citations (google scholar vs web of science), H-index, Case studies

How to write paper, In High quality journals, Conference Articles, Poster preparation, PhD thesis, Inclusion of References

Journal reviewing process, Selection of the good journal, Knowledge bout journal template, Refereeing process, Research topic selection, Research today and tomorrow, Lab scale to Industry, Traditional research to Technology based research

Module 5: Self study

Interpretation and report writing - Techniques of interpretation - Structure and components of scientific reports - Different steps in the preparation - Layout, structure and language of the report - Illustrations and tables - Types of report - Technical reports and thesis

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