KUMARAGURU COLLEGE OF TECHNOLOGY,

An autonomous Institution affiliated to Anna University, Chennai

COIMBATORE – 641 049.

M.E. ENVIRONMENTAL ENGINEERING

REGULATIONS 2018

CURRICULUM AND SYLLABI

I to IV Semesters

Department of Civil Engineering

VISION

Department of Civil Engineering is striving to become as a world class Academic Centre for quality education and research in diverse areas of Civil Engineering, with a strong social commitment

MISSION

- Producing highly competent and technologically capable professionals and motivated young academicians
- Providing quality education in undergraduate and post graduate levels, with strong emphasis on professional ethics and social commitment.
- Developing a scholastic environment for the state of art research, resulting in practical applications.
- Undertaking professional consultancy services in diverse areas of Civil Engineering.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The Program Educational Objectives of Environmental Engineering Postgraduate Program are to prepare the students:

PEO1: To provide graduates the fundamental and the advanced knowledge on Environmental Engineering towards pursuing higher education, and to take part in providing feasible solutions considering the societal and technical constraints for sustainable management and development

PEO2: To be a platform that facilitates the graduates towards addressing environmental issues through research and development applying appropriate techniques

PEO3: To inculcate the ethics and the professionalism among the graduates that is to be practiced in their profession considering public health & safety, societal and environmental factors.

PROGRAM OUTCOMES (POs)

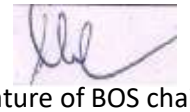
Graduates of the Environmental Engineering Postgraduate Program should have the ability to:

PO1: Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyse and synthesise existing andnew knowledge.

PO2: Analyse complex engineering problems, apply independent judgement for synthesising information to make intellectual and/or creative advances for conducting research in a wider theoretical and practical context.

PO3: Think laterally and originally, conceptualise and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health, safety and environmental factors in the core areas of expertise.

PO4: Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments,



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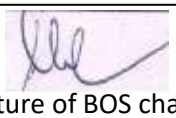
analyse and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.

PO5: Create, select, learn and apply appropriate techniques, resources, and technological advancement, including prediction and modelling, to complex engineering activities with an understanding of the limitations.

PO6: Communicate with the engineering community and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend, write effective reports and design documentation by adhering to appropriate standards



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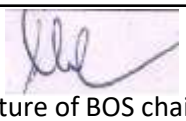
KUMARAGURU COLLEGE OF TECHNOLOGY, COIMBATORE – 641 049
REGULATIONS 2018
M.E. (ENVIRONMENTAL ENGINEERING)
REGULATION R -18 CURRICULUM – VERSION 2

Semester I							
Course Code	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**
P18MAT0001	Statistical Methods For Environmental Engineers	Theory	3	0	0	0	3
P18EEI1201	Environmental Chemistry & Microbiology	Embedded	3	0	2	0	4
P18EET1002	Physio-chemical process for water and wastewater treatment	Theory	3	0	0	0	3
P18EET1003	Biological treatment of wastewater	Theory	3	0	0	0	3
P18EET1004	Solid and Hazardous Waste Management	Theory	3	0	0	0	3
P18EEP1005	Environmental Processing Laboratory	Practical	0	0	2	0	1
						Total Credits	**17**
						Total Hours per week	**19**
SEMESTER-II							
Course Code	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**
P18EEI2201	Air & Noise pollution Control	Embedded	3	0	2	0	4
P18EET2002	Water Quality Modelling	Theory	3	0	0	0	3
P18EEP2003	Air and Water Quality Modelling Laboratory	Practical	0	0	2	0	1
P18EEE_____	Program Elective – I	Theory	3	0	0	0	3
P18EEA_____	Audit course	Theory	3	0	0	0	0
						Total Credits	**11**
						Total Hours per week	**16**



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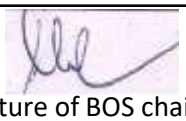
SEMESTER-III							
Course Code	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**
P18EET3001	Environmental Impact Assessment	Theory	3	0	0	0	3
P18EEE_____	Program Elective II	Theory	3	0	0	0	3
P18EEP3701*	Industrial/Research Internship	Project	0	0	0	0	2
P18EEP3702	Project Phase I / Industry Project	Project	0	0	0	24	12
						Total Credits	**20**
						Total Hours per week	**30**
*Internship for a period of two weeks at the end of second semester							
SEMESTER-IV							
Course Code	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**
P18EEP4701	Project Phase II	Project	0	0	0	36	18
						Total Credits	**18**
						Total Hours per week	**36**

Grand Total Credits: 66



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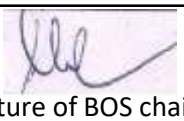
List of Program Electives

Code No.	Course Title	Course Type	L	T	P	J	C
P18EEE0001	Cleaner Production & Environmental Auditing	Theory	3	0	0	0	3
P18EEE0002	Climate Change and Adaptation	Theory	3	0	0	0	3
P18EEE0003	Environmental Analysis: Techniques & Instrumentation	Theory	3	0	0	0	3
P18EEE0004	Environmental Policies & Legislations	Theory	3	0	0	0	3
P18EEE0005	Environmental System Analysis	Theory	3	0	0	0	3
P18EEE0006	Industrial Wastewater treatment	Theory	3	0	0	0	3
P18EEE0007	Introduction to soft computing	Theory	3	0	0	0	3
P18EEE0008	Nanotechnology in Environmental Engineering	Theory	3	0	0	0	3
P18EEE0009	Occupational Health & Safety	Theory	3	0	0	0	3
P18EEE0010	Remote Sensing and GIS for Environmental Planning & Management	Theory	3	0	0	0	3
P18EEE0011	Research Methodology	Theory	3	0	0	0	3
P18EEE0012	Transport of water and wastewater	Theory	3	0	0	0	3

Details	Credits to be earned
List of Core Course	28
Internship/Training	2
Project	30
List of Elective Courses	6
Total Credits	**66**

List of Mandatory Audit Courses (Zero Credit Course)

S.No.	Course Code	Course Title	Course Type
1	P18EEA0001	English for research paper writing	Theory
2	P18EEA0002	Disaster management	Theory
3	P18EEA0003	Sanskrit for Technical knowledge	Theory
4	P18EEA0004	Value addition	Theory
5	P18EEA0005	Constitution of India	Theory
6	P18EEA0006	Pedagogy studies	Theory
7	P18EEA0007	Stress Management by Yoga	Theory
8	P18EEA0008	Personality Development through Life Enlightenment skills	Theory
9	P18INR0001	Research Ethics	Theory



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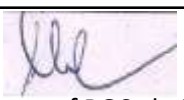
List of Mandatory Open Elective Courses

S.No.	Course Code	Course Title	Course Type
1	P18EEO0001	Business Analytics	Theory
5	P18EEO0005	Composite Materials	Theory
4	P18EEO0004	Cost Management of Engineering Projects	Theory



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2	P18EEO0002	Industrial Safety	Theory
3	P18EEO0003	Operations Research	Theory
6	P18EEO0006	Waste to Energy	Theory

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SEMESTER I

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P18MAT0001	STATISTICAL METHODS FOR ENVIRONMENTAL ENGINEERS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Discriminate theory of Statistical estimation

CO2: Test hypothesis using various tests for small and large samples.

CO3: Gain knowledge in Multiple and partial correlation and regression.

CO4: Analyse experiments based on one-way, two – way and Latin square classifications

CO5: Analyse multivariate data.

Pre-requisite: Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S				
CO2	S	S				
CO3	S	S				
CO4	S	S				
CO5	S	S				

Course Assessment Methods

Direct
1. Mid Term Examination 2. Research Assignment, Group Presentation 3 End Semester Examination
Indirect
1. Course-end survey

ESTIMATION THEORY **9 Hours**

Estimators: Unbiasedness, Consistency, Efficiency and Sufficiency – Maximum Likelihood Estimation – Method of moments.

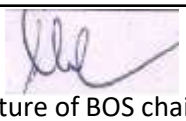
TESTING OF HYPOTHESIS **10 Hours**

Testing of hypothesis for large samples (single mean, difference of means, single proportion, difference of proportion) – Small samples – t – test (single mean, difference of means, paired t-test) – F – test (variance ratio test) – Chi-square test – Tests for independence of attributes.

CORRELATION AND REGRESSION **12 Hours**

Multiple and Partial Correlation - Method of Least Squares- Plane of Regression - Properties of Residuals - Coefficient of Multiple Correlation - Coefficient of Partial Correlation - Multiple Correlation with total and partial correlations - Regression and Partial correlations in terms of lower order coefficients.

DESIGN OF EXPERIMENTS **7 Hours**



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Principles of experimental design – Completely randomized design– Randomized block design – Latin square design.

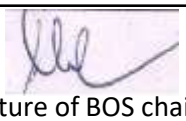
MULTIVARIATE ANALYSIS **9 Hours**

Random vectors and Matrices – Mean vectors and Covariance matrices – Multivariate Normal density and its properties – Principal components: Population principal components–Principal components from standardized variables.

Theory: 45 Hrs **Tutorial: 0 Hrs** **Practical: 0 Hrs** **Project: 0** **Total: 45 Hrs**

References:

1. Devore, J.L., Probability and statistics for Engineering and the Sciences, Thomson and Duxbury, Singapore, 8th Edition,2012.
2. Freund, J.E., Mathematical Statistics, Prentice Hall of India, 5th Edition,2001.
3. Gupta S.C, and Kapur J.N., Fundamentals of Mathematical Statistics, 10th Revised Edition, 2000, Sultan &Chand, Publishers, New Delhi, Reprint 2002.
4. Johnson, R.A., and Wichern, D.W., Applied Multivariate Statistical Analysis, Pearson Education, Asia, 6th Edition, 2007
5. Johnson. R. A., Miller & Freund's Probability and Statistics for Engineers, 7th Edition, Pearson Education, Delhi, 2005.
6. Spiegel, M.R. and Stephens, L.J. Schaum's outlines,-Statistics, Tata McGraw-Hill, 3rd Edition, 2000.



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P18EEI1201	ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply basic chemical concepts to analyze chemical processes involved in different environmental problems

CO2: Solve and analyse the chemical kinetics involved in the water and waste treatment processes

CO3: Use the appropriate degradation technology based on the surface chemistry of the fluids

CO4: Identify and analyse the role of microbial metabolism and techniques in a wastewater treatment plant.

CO5: Monitor the impact of the pollution, by identifying the various bioremediation and biodegradation processes

CO6: Analysis the microbial techniques in wastewater treatment

Course Objectives

This course educate the students and impart knowledge on the transformation of chemicals and their kinetics in the environment. The course provides a basic understanding and microbiological significance in environmental engineering.

Pre-requisites : Nil

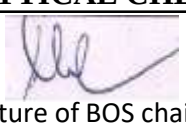
CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	M				
CO2	S	M		S		
CO3	S	M		S		
CO4	S	M		M		
CO5	S	M		M		
CO6		S	S			

Course Assessment methods

Direct
1. Mid Term Examination Presentation (Theory component) 2. Research Assignment, Group Presentation Presentation (Theory component) 3 Pre/Post - experiment Test/Viva; Experimental Report for each experiment (Lab component) 4. Model examination (Lab component) 5. End Semester Examination (Theory and Lab components)
Indirect
1. Course-end survey

BASIC PRINCIPLES OF ANALYTICAL CHEMISTRY **9 Hours**



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Concentration of solutions-Calculations- Ionic equilibrium of weak electrolytes – common

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ion effect - Buffer solutions-Change of pH with salt concentrations, Buffer index-Solubility product, Hydrolysis of salts, Problems- EMF and Electrode potential–Applications of potentiometry in pH measurements, glass electrodes, ion selective electrodes- Fluoride and Nitrate

CHEMICAL KINETICS **9 Hours**

Rate constants of first and second order reactions – problems – effect of temperature on reaction rates – Derivation of Arrhenius equation – problems – consecutive reactions – basic concepts of enzymes, cofactors – enzyme catalyzed reactions – Temperature dependence of enzyme activity– Enzyme kinetics- Michalei's Menton equation – significance Biochemical activity of carbohydrates, proteins, vitamins**,** oils and fats – Bacterial decomposition under aerobic and anaerobic conditions.

9 Hours

COLLOIDS AND SURFACE CHEMISTRY

Colloids – types, properties (electrical origin of changes and optical) – Electro kinetic properties – Applications. Schulz Hardy rule - Destabilization and destruction of colloids. Hydrophilic colloids - Liquid-liquid systems, Gas in liquid systems – Colloidal electrolytes – surfactants, soaps and detergents – types of detergents, ingredients – Biodegradation of detergents and environmental significance.

CHARACTERISTICS AND METABOLISM OF MICROORGANISMS 9 Hours

Classification of microorganisms – prokaryotic, eukaryotic, cell structure, characteristics, Preservation of microorganisms, DNA, RNA, replication, Recombinant DNA technology. Nutrition and metabolism in microorganisms, growth phases, carbohydrate, protein, lipid metabolism – respiration, aerobic and anaerobic-fermentation, glycolysis, Kerb's cycle, hexose monophosphate pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, Bioenergetics.

BIOREMEDIATION & BIODEGRADATION **9 Hours**

Xenobiotics, Classification of pollutants. Biotransformation -important factors, Biodegradation - Enzymatic processes in Biodegradation, Bioconcentration, Bio magnification, Bio monitoring, Ecotoxicology. Case studies

LIST OF EXPERIMENTS **15 Hours**

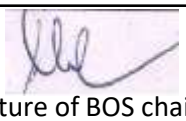
ENVIRONMENTAL MICROBIOLOGY

1. Preparation of culture media, serial dilution and plating
2. Measurement of growth of microorganisms
3. Sampling of microorganisms from air, water and soil, staining simple and gram staining
4. Effect of pH, temperature on microbial growth
5. Pollutant removal using microbes from industrial effluent.

Theory: 45 Hrs Tutorial: 0 Hrs Practical: 15 Hrs Project: 0 Total: 60Hrs

REFERENCES:

1. Bhatia S.C., Hand Book of Environmental Microbiology", Part 1 and 2, Atlantic Publisher Gabriel Bitton, Wastewater Microbiology, 2nd Edition, 2005
2. Colin Baird., Environmental Chemistry, Freeman and company, New York, 5th Edition, 2012.
3. Frank C. Lu and Sam Kacew, LU"s Basic Toxicology, Taylor & Francis, London 4th Edition, 2002.



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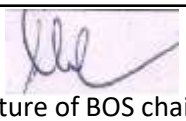
4. Hurst, C.J. Manual of "Environmental Microbiology". ASM PRESS, Washington, D.C. 2nd Edition. 2002.
5. Raina M. Maier, Ian L. Pepper, Charles P. Gerba, "Environmental Microbiology", Academic Press. 2009
6. Ronald A. Hites , Elements of Environmental Chemistry, Wiley, 2nd Edition, 2012
7. Sawyer, C.N., Mccarty, P.L. and Parkin, G.F., Chemistry for Environmental Engineering and Science, Tata McGraw – Hill, 5th Edition, New Delhi 2011.



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P18EET1002	PHYSIO-CHEMICAL PROCESS FOR WATER AND WASTEWATER TREATMENT	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Implement the working principles and mechanisms of various Unit operation/Processes reactors

CO2: Design the various water/wastewater Unit operation/treatment processes

CO3: Apply the suitable advanced wastewater treatment processes in conjunction with the unit operation/processes

CO4: Design and select an appropriate biological treatment processes based on the kinetics study and organic loading

CO5: Design of low cost and natural water treatment systems

Course Objectives

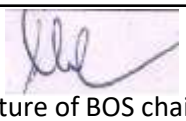
To educate the students on the principles and process designs of various physio-chemical treatment systems for water and wastewater and students should gain competency in the process employed in design of treatment systems and the components comprising such systems, leading to the selection of specific process

Pre-requisites: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S		S		M	
CO2	S		S		M	
CO3	S		S		M	
CO4	S		S		M	
CO5	S		S		M	

Course Assessment methods:

Direct
1. Mid Term Examination 2. Research Assignment, Group Presentation 3 End Semester Examination
Indirect
1. Course-end survey



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INTRODUCTION **6 Hours**

Pollutants in water and wastewater – Characteristics and Standards - Significance of physico-chemical treatment – Selection criteria - types of reactor- reactor selection-batch-continuous type-kinetics

TREATMENT PRINCIPLES **10 Hours**

Physical treatment - Screening – Mixing, Equalization – Sedimentation – Filtration – Evaporation – Incineration – gas transfer – mass transfer coefficient Adsorption – Isotherms – Membrane separation, Reverse Osmosis, nano filtration, ultrafiltration and hyper filtration electrodialysis, distillation – stripping and crystallization – Recent Advances. Principles of Chemical treatment – Coagulation flocculation – Precipitation – flotation, solidification and stabilization – Disinfection, Ion exchange, Electrolytic methods, Solvent extraction – advanced oxidation /reduction – Recent Trends

DESIGN OF MUNICIPAL WATER TREATMENT PLANTS **10 Hours**

Selection of Treatment – Design of municipal water treatment plant units – Aerators – chemical feeding – Flocculation – clarifier – tube settling – filters – Rapid sand filters, slow sand filter, pressure filter, dual media Disinfection - Displacement and gaseous type - Flow charts – Layouts –Hydraulic Profile, PID - construction and O&M aspects – case studies, Residue management – Upgradation of existing plants – Recent Trends

DESIGN OF WASTEWATER TREATMENT PLANTS **10 Hours**

Design of municipal wastewater treatment units-screens-detritus tank - grit chamber-settling tanks-sludge thickening-sludge dewatering systems-sludge drying beds - Design of Industrial Wastewater Treatment Units-Equalization- Neutralization-Chemical Feeding Devices-mixers-floatation units-oil skimmer Flow charts – Layouts –Hydraulic Profile, PID, construction and O&M aspects – case studies, Retrofitting - Residue management – Upgradation of existing plants – Recent Trends.

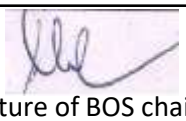
NATURAL WASTEWATER TREATMENT SYSTEMS **9 Hours**

Ponds and lagoons - Wetlands and root - zone systems - Surface and ground water treatment for potable water supply- Rural water supply - Low cost sanitation - Septic tanks - Soak-pits - Bioremediation.

Theory: 45 Hrs **Tutorial: 0 Hrs** **Practical: 0 Hrs** **Project: 0** **Total: 45 Hrs**

REFERENCES:

1. David Hendricks, "Fundamentals of Water Treatment Process", CRC Press New York, 2nd Edition, 2011
2. Metcalf and Eddy. Inc., Wastewater Engineering, Treatment, Disposal and Reuse, Tata McGraw Hill Publishing Company Limited, New Delhi, 4th edition, 2003.
3. Peavy, H. S., Rowe, D. R., Tchobanoglous, G. Environmental Engineering, McGraw Hills, New York, 1st Edition 2013.
4. Qasim, S.R., Motley, E.M. and Zhu.G. "Water works Engineering – Planning, Design and Operation", Prentice Hall, New Delhi, 2002.
5. Spellman, F.R. "Hand Book of Water and Wastewater Treatment Plant operations", CRC Press, New York, 2009.
6. Weber, W. J. Physicochemical processes for water quality control, John Wiley and sons, Newyork, 2003.



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P18EET1003	BIOLOGICAL TREATMENT OF WASTEWATER	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Develop conceptual schematics required for biological treatment of wastewater
CO2: Design the microbial kinetics and process unit of Aerobic wastewater treatment
CO3: Design the microbial kinetics and process unit of Anaerobic wastewater treatment
CO4: Identify the composition of sludge generated and their treatment methodology
CO5: Understand the troubleshooting and implement a proper construction and maintenance concepts

Course Objectives:

The course will provide a basic understanding of the principles and practice of the various aerobic and anaerobic biological wastewater treatment processes. An understanding of the practical design, operation and monitoring of biological wastewater treatment systems will also be inculcated to the students.

Pre-requisites: Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium,W-Weak

COs	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S				M
CO2	S	S				M
CO3	S	S				M
CO4	S	S				M
CO5	S	S				M

Course Assessment methods:

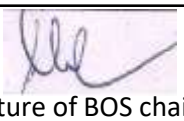
Direct
1. Mid Term Examination 2. Research Assignment, Group Presentation 3 End Semester Examination
Indirect
1. Course-end survey

INTRODUCTION **9 Hours**

Objectives of biological treatment – Significance – Principles of aerobic and anaerobic treatment - Kinetics of biological growth – Factors affecting growth – attached and suspended growth - Determination of Kinetic coefficients for organics removal – Biodegradability assessment - selection of process- reactors-batch-continuous type.

AEROBIC TREATMENT OF WASTEWATER **9 Hours**

Design of sewage treatment plant units - kinetics–Activated Sludge process and variations, Sequencing Batch reactors, Membrane Biological Reactors-Trickling Filters-Bio Tower-Moving Bed Reactors- fluidized bed reactors, aerated lagoons, waste stabilization ponds – Nutrient removal systems – O & M difficulties – Recent trends



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ANAEROBIC TREATMENT OF WASTEWATER **9 Hours**

Design of attached and suspended growth - kinetics – UASB, Up flow filters, Fluidized beds MBR,– Nutrient removal systems – Flow chart, Layout and Hydraulic profile – O & M difficulties – Recent trends

SLUDGE TREATMENT AND DISPOSAL **9 Hours**

Design of sludge management facilities, sludge thickening, sludge digestion, biogas generation, sludge dewatering (mechanical and gravity) Layout, PID, hydraulics profile – upgrading existing plants – ultimate residue disposal – O & M difficulties – Recent trends

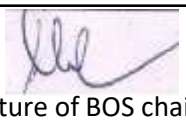
CONSTRUCTION OPERATIONS AND MAINTENANCE ASPECTS **9 Hours**

Construction and Operational Maintenance problems – Trouble shooting – Planning, Organizing and Controlling of plant operations – capacity building - Retrofitting Case studies – sewage treatment plants – sludge management facilities.

Theory: 45 Hrs **Tutorial: 0 Hrs** **Practical: 0 Hrs** **Project: 0** **Total: 45 Hrs**

REFERENCES:

1. Arceivala S.J., and Asolekar S.R "Wastewater Treatment for Pollution Control and reuse "McGraw Hill, 3rd Edition, New Delhi, 2007.
2. CPHEEO Manual on Sewerage and Sewage Treatment Systems Part A, B & C, Ministry of Urban Development, Government of India, New Delhi, 2013.
3. Metcalf & Eddy, INC, „Wastewater Engineering – Treatment and Reuse, 4th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003.
4. Qasim, S. R. "Wastewater Treatment Plant, Planning, Design & Operation", Technomic Publications, New York, 1994.
5. Spellman, F.R., "Hand Book of Water and Wastewater Treatment Plant operations", CRC Press, New York 2009.



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P18EET1004	SOLID AND HAZARDOUS WASTE MANAGEMENT	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Manage solid and hazardous waste constituents based on Indian legislation
CO2: Analyse and characterize the solid waste for source reduction
CO3: Optimize the solid waste collection and transport systems
CO4: Apply various steps involved in the Solid waste treatment and disposal techniques
CO5: Economically implement the onsite vs. offsite waste management options

Course Objectives

The students will understand the problems created due to various types of solid and hazardous wastes to environment and health. The knowledge of legal, institutional and financial aspects of management of solid and hazardous wastes would be understood by the student. The students will also be able to apply appropriate engineering, financial and technical options for waste management

Pre-requisites : Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium,W-Weak

COs	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S				
CO2	S	S				
CO3	S	S				
CO4	S	S				

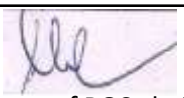
Course Assessment methods

Direct
1. Mid Term Examination 2. Research Assignment, Group Presentation 3 End Semester Examination
Indirect
1. Course-end survey

SOURCES, CLASSIFICATION AND REGULATORY FRAMEWORK **9 Hours**

Types and Sources of solid and hazardous wastes - Need for solid and hazardous waste management –- Salient features of Indian legislations on management and handling of municipal solid wastes, hazardous wastes, biomedical wastes, nuclear wastes - lead acid batteries, electronic wastes, plastics and fly ash – Elements of integrated waste management and roles of stakeholders - Financing and Public Private Participation for waste management- Integrated solid waste management.

WASTE CHARACTERIZATION AND SOURCE REDUCTION 9 Hours



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Waste generation rates and variation - Composition, physical, chemical and biological properties of solid wastes – Hazardous Characteristics – TCLP tests – waste sampling and characterization plan - Source reduction of wastes –Waste exchange - Extended producer responsibility - Recycling and reuse

STORAGE, COLLECTION AND TRANSPORT OF WASTES 9 Hours

Handling and segregation of wastes at source – storage and collection of municipal solid wastes – Analysis of Collection systems - Need for transfer and transport – Transfer stations Optimizing waste allocation– compatibility, storage, labeling and handling of hazardous wastes – hazardous waste manifests and transport

WASTE PROCESSING TECHNOLOGIES 9 Hours

Objectives of waste processing – material separation and processing technologies – biological and chemical conversion technologies – methods and controls of Composting - thermal conversion technologies and energy recovery – incineration – solidification and stabilization of hazardous wastes- treatment of biomedical wastes – Odour control technologies for waste management -Health considerations in the context of operation of facilities.

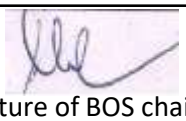
WASTE DISPOSAL 9 Hours

Waste disposal options – Disposal in landfills - Landfill Classification, types and methods – site selection - design and operation of sanitary landfills, secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – Rehabilitation of open dumps-remediation of contaminated sites.

Theory: 45 Hrs Tutorial: 0 Hrs Practical: 0 Hrs Project: 0 Total: 45 Hrs

REFERENCES

1. Charles A. Wentz, Hazardous Waste Management, 2nd Edition, Pub: McGraw Hill International Edition, New York, 1995.
2. CPHEEO, Manual on Municipal Solid waste management, Central public health and Environmental Engineering organization, Government of India, New Delhi, 2000.
3. Hilary Theisen and Samuel A, Vigil, George Tchobanoglous, Integrated Solid Waste Management, McGraw- Hill, New York, 1993
4. Michael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans and Environmental Resources Management, Hazardous waste Management, Mc-Graw Hill International edition, New York, 2001.
5. Vesilind P.A., Worrell W and Reinhart, Solid waste Engineering, Thomson Learning Inc., Singapore, 2002.



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P18EEP1005	ENVIRONMENTAL PROCESSING LABORATORY	L	T	P	J	C
		0	0	2	0	1

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Adopt appropriate sampling methods and techniques for water/wastewater analysis

CO2: Characterize various physio-chemical parameters of water/effluent samples using volumetric analysis

CO3: Characterize the toxic heavy metals in water/effluent samples using analytical instruments

CO4: Conduct the performance studies of the various Unit operations and processes

Course Objectives

The students will understand the sampling procedures and characterization of water/effluents. Also the students would gain in-depth and practical knowledge on Unit operation and process treatments. Hands on training with sophisticated analytical instruments to meet the industrial requirements would be given to students.

Pre-requisites : Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium,W-Weak

COs	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		S				
CO2		S				
CO3		S				
CO4		S				

Course Assessment methods

Direct
1. Pre-Post – Experimental Test/Viva; Experimental report for each experiment 2. Model Examination 3. End semester Examination
Indirect
2. Course-end survey

LIST OF EXPERIMENTS **30 Hours**

1. Sampling and preservation methods and signification of characterization of water and wastewater – A Case study
2. Performance efficiency and optimum dosage of a coagulant for a domestic/Industrial effluent (determine the suitable physio-chemical parameters using volumetric and analytical methods)
3. Estimate the dosage of chlorine for a domestic water supply and determine the breakpoint chlorination
4. Performance efficiency of a filter bed media (determine the suitable physio-chemical parameters using volumetric and analytical methods)
5. Performance studies of Type – I and Type – II settling
6. Determine the kinetic constants of batch adsorption studies by isothermal curves for a

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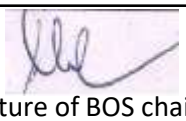
dyeing effluent

7. Performance efficiency of a Water softener (determine the suitable physio-chemical parameters using volumetric and analytical methods)
8. Determine the kinetic coefficient on biological growth under different phases
9. Determination of Sludge Volume Index based on the MLSS/MLVSS concentration
10. Performance of Advanced Oxidation process using Photo-catalysis (determine the suitable physio-chemical parameters using volumetric and analytical methods)

Theory: 0 Hrs Tutorial: 0 Hrs Practical: 30 Hrs Project: 0 Total: 30 Hrs

REFERENCES

1. AEESP Environmental Processes Laboratory Manual, Association of Environmental Engineering and Science Professors Foundation, Washington, 6th Ed. 2002.
2. APHA, AWWA, WEF. Standard Methods for Examination of water and wastewater. 22nd Ed. Washington: American Public Health Association; 2012.
3. Lee, C.C. and Shundar Lin. Handbook of Environmental Engineering Calculations, 2nd Ed. Mc Graw Hill, New York, 2007
4. Metcalf & Eddy, Inc. Wastewater Engineering: Treatment and Reuse. 4th Edition. McGraw-Hill, New York, NY. 2003.
5. Sawyer, C.N., McCarty, P.L., and Parkin, G.F. Chemistry for Environmental Engineering 5th Edition. Tata McGraw-Hill Publishing Company Limited. 2003.



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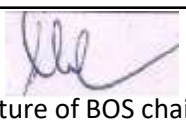
SEMESTER II



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P18EEI2201 **AIR AND NOISE POLLUTION CONTROL** **L T P J C**
3 0 2 0 4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Categorize the various sources, types and nature of air pollutants and their effects on living and non-living beings

CO2: Monitor the air quality standards and the different sampling techniques

CO3: Determine the principle involved in the pollutant removal and their control measures

CO4: Understand the sources and effects of Indoor and Outdoor Noise Pollution

Course Objectives:

The students will get an overview of air and noise pollution including methods for prevention, control, measures and management of the pollution.

Pre-requisites: Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S					
CO2	S				S	M
CO3	S				S	M
CO4	S					M

Course Assessment methods

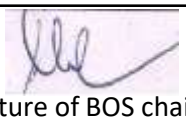
Direct
1. Mid Term Examination Presentation (Theory component) 2. Research Assignment, Group Presentation Presentation (Theory component) 3 Pre/Post - experiment Test/Viva; Experimental Report for each experiment (Lab component) 4. Model examination (Lab component) 5. End Semester Examination (Theory and Lab components)
Indirect
1. Course-end survey

SOURCES OF POLLUTION, AMBIENT AIR QUALITY STANDARDS AND MONITORING **9 Hours**

Definition of clean air, nature, air pollutants, sources of air pollutants, effects of air pollution on man, animal, vegetation and properties. Harmful concentration – geographical factors in air pollution – Air pollution control legislation and regulations - Air pollution: Global and Indian scenario with case studies

SAMPLING, METEOROLOGY AND AIR QUALITY MODELLING **9 Hours**

Classification of sampling techniques - monitoring atmospheric pollution - Sampling and measurement of particulate and gaseous pollutants - Ambient air sampling - Stack sampling. Environmental factors - Meteorology - temperature lapse rate and stability – Adiabatic lapse rate - Wind Rose - Inversion – Wind velocity and turbulence - Plume behaviour - Dispersion of air pollutants - Maximum mixing depth - Dispersion model - Gaussian plume derivation-



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modifications of Gaussian plume equation - Fixed Box models – Multiple cell models - Estimation of plume rise - Stack design.

AIR POLLUTION AND CONTROL MEASURES **9 Hours**

Source correction methods - Control equipments - Particulate control methods - ;;;;;; Settling chamber - cyclone separators - inertial devices - Electrostatic precipitator - scrubbers - Control of gaseous emissions - Absorption - Absorption equipments - adsorption and combustion devices: Catalytic combustion – Catalytic oxidation and decomposition

INDOOR AIR POLLUTION **9 Hours**

Sources types and control of indoor air pollutants - Volatile Organic Compounds, Inorganic Gaseous Pollutants Respirable Particulates Bioaerosols, Radon and its decay products-Infectious disease transmission- A/C units in indoor- Odours and types of sick building syndrome

NOISE POLLUTION **9 Hours**

Sound and noise; sources of noise pollution, environmental and industrial noise; effects of noise pollution: measures for prevention and control of noise; environmental and industrial noise; Noise pollution (regulation & Control) rules, 2000 - noise control legislation.

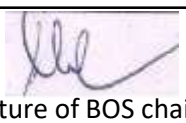
LIST OF EXPERIMENTS: **15 Hours**

1. Air Sampling techniques and methods – Study Experiment
2. Particulate Sampling – Dust Fall, Pollution Suspended Particulates and Total Particulate Matters using High Volume Sampler
3. Experiment on Respirable Dust – Estimating RPM.
4. Estimating Sulphur Dioxide, NOx in Ambient Air Using High Volume Air Sampler.
5. Stack Sampling Techniques and Demonstration of Stack Monitoring.
6. To Determine Smoke test for Petrol and Diesel Vehicles using Auto Exhaust Analyser
7. Determination of Equivalent noise level.
8. Determination of Light Intensity using Luxmeter
9. Demonstration on Wind Monitoring and Analysis of Data for Windrose Diagrams.

Theory: 45 Hrs **Tutorial: 0 Hrs** **Practical: 15 Hrs** **Project: 0** **Total: 60 Hrs**

REFERENCES

1. Anjaneyulu D., “Air Pollution and Control Technologies”, Allied Publishers,Mumbai, 2002.
2. Cunniff P.F, “Environmental Noise Pollution”, John Wiley & Sons, New York. 1977.
3. Docks H.M., “Environmental Pollution”, John Wiley & Sons. New York 1981.
4. Patrick C.F., ”Environmental noise pollution”, John Wiley & Sons, 1977.
5. Rao M.N., and Rao H. V. N., Air Pollution Control, Tata-McGraw-Hill, 2017
6. Rao, C.S. Environmental Pollution Control Engineering, New Age International Publishers; 3rd Ed. 2018
7. Stern A.C. (Ed), “ Air Pollution Vol. I, II & III”, Academic Press, New York, 1968



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P18EET2002	WATER QUALITY MODELLING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Develop conceptual schematics required for modeling
CO2: Assess the surface water quality modeling performance
CO3: Design the transport phenomena for different reactor models
CO4: Predict groundwater flow and contaminant transport
CO5: Develop Numerical models to simulate the water quality

Course Objectives:

The course would educate the students to formulate and apply water quality models to natural and engineered systems. This course enhances the students understanding towards selection ofsuitable modelling framework for assessing the water quality.

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S			S	M	
CO2	S			S	M	
CO3	S			S	M	
CO4	S			S	M	
CO5	S			S	M	

Course Assessment methods

Direct
1. Mid Term Examination 2. Research Assignment, Group Presentation 3 End Semester Examination
Indirect
1. Course-end survey

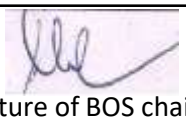
MODELING PERCEPTIONS **9 Hours**

Engineers and Mathematical models-Water quality models – Historical development – Different types of models-- Steps in model development - Importance of model building.- Calibration and verification of models- conservation of mass and momentum - Chemical reaction kinetics – Law of mass action, Rate constants, reaction order, types of reactions, equilibrium principles.

SURFACE WATER QUALITY MODELING **9 Hours**

Water quality modeling of streams, lakes and impoundments and estuaries – Water quality – model sensitivity – assessing model performance; Models for dissolved oxygen, pathogens and BOD-Streeter Phelps model for point and distributed sources - Modified Streeter Phelps equations -Toxicant modeling in flowing water.

POLLUTANT TRANSPORT AND REACTOR MODELING **9 Hours**



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Transport phenomena – Advection, diffusion, dispersion- simple transport models – Plug flow models- Application of PFR and MFR model - Steady state and time variable solutions-completely mixed systems, concept and models in Completely Stirred Tank Reactors, mass balance equations, loading types, feed forward vs. feed back reactor systems.

GROUNDWATER QUALITY MODELING **9 Hours**

Groundwater flow and mass transport of solutes, Degradation of organic compounds, application of concepts to predict groundwater contaminant movement, seawater intrusion – basic concepts and modelling

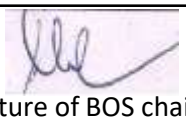
Numerical Modelling **9 Hours**

Surface and groundwater governing equation - types , method of discretization, finite difference methods- numerical schemes, scheme stability condition; application to water quality modelling

Theory: 45 Hrs **Tutorial: 0 Hrs** **Practical: 0 Hrs** **Project: 0** **Total: 45 Hrs**

REFERENCES

1. Aliev R. A, and Aliev Rashad, Soft Computing and its Applications, World Scientific Publications Co. Pte. Ltd. Singapore, 2014.
2. Chepra S. C. and Canele R. P., Numerical Methods for Engineers, McGraw-Hill, a business unit of The McGraw-Hill Companies, Inc., 1221 Avenue of the Americas, New York, NY 10020. 6th Ed. 2014.
3. Thomann, V R, and Muller, J A, Principles of Surface Water Quality Modeling and Control, Pearson Publication, 2011



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P18EEP2003	AIR AND WATER QUALITY MODELLING LABORATORY	L	T	P	J	C
		0	0	2	0	1

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Develop simulation models that may predict variables at one dimension and two dimension

CO2: Analyse and infer the outputs of the developed simulation models

CO3: Visualize the developed simulation inference both with time and space

Course Objectives

The course is framed in a way to expose the students on the various environmental modelling platforms. This course is also designed to encourage the students towards developing numerical / data based models and compare the same with analytical models.

Pre-requisites : Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium,W-Weak

COs	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S			S	
CO2	S	S			S	
CO3	S	S			S	

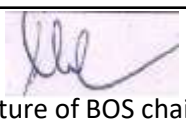
Course Assessment methods

Direct
1. Pre-Post – Experimental Test/Viva; Experimental report for each experiment 2. Model Examination 3. End semester Examination
Indirect
1. Course-end survey

LIST OF EXPERIMENTS **30 Hours**

1. Development of one dimensional river water quality simulation model
2. Development of two dimensional river water quality simulation model
3. Development of leachate generation simulation model
4. Development of one dimensional air plume dispersion model
5. Exposure to CMB and PMF models
6. Regression Model development based on the historical environmental database

Theory: 0 Hrs **Tutorial: 0 Hrs** **Practical: 30 Hrs** **Project: 0** **Total: 30 Hrs**



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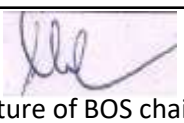
REFERENCES

1. Data-Driven Modeling: Using MATLAB in Water Resources and Environmental Engineering, Springer; 1st Ed. 2014.
2. Kotteguda, N.T., and Renzo Resso, Statistics, "Probability and Reliability for Civil and Environmental Engineers", McGraw Hill Companies Inc., New York, 2008.
3. Mathews J. H. and Fink K.D. , "Numerical methods using MATLAB", Pearson Education 2010.



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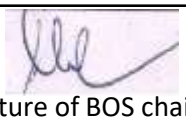
SEMESTER III



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P18EET3001 ENVIRONMENTAL IMPACT ASSESSMENT

L	T	P	J	C
3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Classify the need of EIA/EIS process and regulatory aspects involved

CO2: Implement the appropriate methodologies for environmental impact prediction and assessment

CO3: Quantify the environmental impacts on the ecosystem (land, air, water) and Socio Economic Aspects

CO 4: Mitigate the negative environmental impacts on various eco system

CO 5: Conduct EIA for developmental projects

Course Objectives:

In this course, the students are exposed to learn the need, methodology, documentation and usefulness of environmental impact assessment and to develop the skill to prepare environmental management plan. Scientific aspects such as predictions and evaluation methods as well as democratic aspects relating to public participation are also explained to the students.

Pre-requisite: Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S				
CO2	S	S				
CO3	S	S				
CO4	S	S				
CO5	S	S				

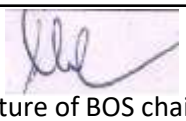
Course Assessment Methods

Direct
1. Mid Term Examination 2. Research Assignment, Group Presentation 3 End Semester Examination
Indirect
1. Course-end survey

INTRODUCTION **9 Hours**

EIA Definition - Historical development and need for Environmental Impact Assessment (EIA) – Environmental Impact Statement (EIS) – EIA in project cycle - Capability and limitations – Legal and Regulatory aspects in India – EIA process - Types and Stages of EIA – MoEF guidelines for performing EIA of development projects - Cross sectoral issues and terms of reference in EIA – Public Participation in EIA

IMPACT IDENTIFICATION AND PREDICTION **9 Hours**



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Matrices – Networks – Checklists –Cost benefit analysis – Analysis of alternatives – Software packages for EIA – Expert systems in EIA. Prediction tools for EIA – Mathematical modeling for impact prediction – Assessment of impacts – air, water, soil, noise, biological, social & cultural activities and on flora & fauna- Mathematical models- Public participation - Cumulative Impact Assessment

SOCIAL IMPACT ASSESSMENT AND EIA DOCUMENTATION 9 Hours

Social impact assessment - Relationship between social impacts and change in community and institutional arrangements. Individual and family level impacts. Communities in transition Documentation of EIA findings – planning – organization of information and visual display materials – Report preparation.

ENVIRONMENTAL MANAGEMENT PLAN 9 Hours

Environmental Management Plan - preparation, implementation and review - Mitigation and Rehabilitation Plans – Policy and guidelines for planning and monitoring programmes – Addressing the issues related to the project affected people - Post project monitoring - Post project audit – Ethical and Quality aspects of Environmental Impact Assessment

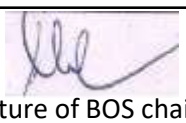
CASE STUDIES 9 Hours

EIA for infrastructure projects – Dams – Highways – Multi-storey Buildings Water Supply and Drainage Projects – Wastewater treatment plants – Localized area specific industrial projects.

Theory: 45 Hrs Tutorial: 0 Hrs Practical: 0 Hrs Project: 0 Total: 45 Hrs

REFERENCES

1. Canter R.L., "Environmental Impact Assessment", McGraw Hill Inc., New Delhi, 1996.
2. Environmental Assessment Source book", Vol. I, II & III. The World Bank, Washington, D.C., 1991.
3. John G. Rau and David C Hooten "Environmental Impact Analysis Handbook", McGraw Hill Book Company, 1990.
4. Judith Petts, "Handbook of Environmental Impact Assessment Vol. I & II", Blackwell Science, 1999.
5. Shukla, S.K. and Srivastava, P.R., "Concepts in Environmental Impact Analysis", Common Wealth Publishers, New Delhi, 1992.



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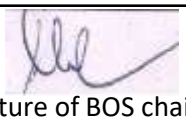
PROFESSIONAL ELECTIVES



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P18EEE0001	CLEANER PRODUCTION AND ENVIRONMENTAL AUDITING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Provide applied knowledge and understanding of strategies and technologies for a cleaner industrial production and their legislation

CO2: Apply an integrated preventive environmental strategy to processes, products, and services to increase overall efficiency, and reduce risks to humans and the environment.

CO3: Plan and apply the concept of Cleaner Production

CO4: Incorporate the knowledge on Life Cycle Assessment and Environmental Auditing

CO5: Apply concepts of Cleaner Production technologies and Environmental Audit in Industrial projects

Course Objectives:

To introduce the importance and different approaches of cleaner production in industries and to impart knowledge on environmental management tools applying cleaner production principle.

Pre-requisite: Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S		S			
CO2			S			
CO3			S			S
CO4			S			
CO5			S			S

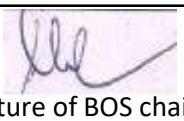
Course Assessment Methods

Direct
1. Mid Term Examination 2. Research Assignment, Group Presentation 3 End Semester Examination
Indirect
1. Course-end survey

SUSTAINABLE DEVELOPMENT **9 Hours**

Sustainable Development-Indicators of Sustainability-Sustainability Strategies Barriers to Sustainability-Industrial activity and Environment-Industrialization and sustainable development-Industrial Ecology-Cleaner Production (CP) in Achieving Sustainability-Prevention versus Control of Industrial Pollution-Environmental Policies and Legislations-Regulations to Encourage Pollution Prevention and Cleaner Production-Regulatory versus Market Based Approaches.

POLLUTION PREVENTION **9 Hours**



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Definition-Importance-Historical evolution-Benefits-Promotion-Barriers-Role of Industry, Government and Institutions - Environmental Management HierarchySource Reduction Techniques-Process and equipment optimization, reuse, recovery, recycle, raw material substitution-Internet Information and Other CP Resources.

CONCEPT OF CLEANER PRODUCTION **11 Hours**

Overview of CP Assessment Steps and skills, Preparing for the site visit, Information Gathering, and process flow diagram, material balance, CP Option Generation Technical and Environmental feasibility analysis-Economic valuation of alternatives total cost analysis-CP Financing-Establishing a program-Organizing a program preparing a program plan-Measuring progress-pollution prevention and cleaner production Awareness plan -Waste audit-Environmental Statement.

LIFE CYCLE ASSESSMENT (LCA) **9 Hours**

Elements of LCA-Life Cycle Costing -Eco Labelling-Design for the Environment- International Environmental Standards-ISO 14001-Enironmental audit.

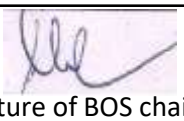
CASE STUDIES **7 Hours**

Industrial application of CP, LCA, EMS and Environmental Audits.

Theory: 45 Hrs **Tutorial: 0 Hrs** **Practical: 0 Hrs** **Project: 0** **Total: 45 Hrs**

REFERENCES

1. Paul L Bishop, Pollution Prevention Fundamental and Practice, McGraw-Hill International, 2000.
2. World Bank Group, Pollution Prevention and Abatement Handbook-Towards Cleaner Production, World Bank and UNEP, Washington D.C, 2005.
3. Prasad modak, C.Visvanathan and Mandarparasnis, Cleaner Production Audit, Environmental System Reviews, Asian Institute of Technology, Bangkok, 2005.



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P18EEE0002 CLIMATE CHANGE AND ADAPTATION

L	T	P	J	C
3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the different concept of climate change and its consequences
CO2: Adopt the methodologies in finding the changes in climate
CO3: Apply basic climatic modelling
CO4: Predict climate changes and downscaling techniques
CO5: Identify impacts of climate changes

Course Objectives:

At the end of the course, the students should understand the Earth's Climate System and the concept of Global Warming. The students should be able to comprehend the impact of climate change on society and its mitigation measures.

Pre-requisite: Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		S				S
CO2		S				S
CO3		S				S
CO4		S				S
CO5		S				S

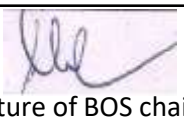
Course Assessment Methods

Direct
1. Mid Term Examination 2. Research Assignment, Group Presentation 3 End Semester Examination
Indirect
1. Course-end survey

EARTH'S CLIMATE SYSTEM **9 Hours**

Introduction-Climate in the spotlight - The Earth's Climate Machine – Climate Classification - Global Wind Systems – Trade Winds and the Hadley Cell – The Westerlies - Cloud Formation and Monsoon Rains – Storms and Hurricanes - The Hydrological Cycle – Global Ocean Circulation – El Nino and its Effect - Solar Radiation –The Earth's Natural Green House Effect – Green House Gases and Global Warming – Carbon Cycle.

OBSERVED CHANGES AND ITS CAUSES **9 Hours**



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Observation of Climate Change – Changes in patterns of temperature, precipitation and sea level rise – Observed effects of Climate Changes – Patterns of Large Scale Variability Drivers of Climate Change – Climate Sensitivity and Feedbacks – The Montreal Protocol UNFCCC – IPCC –Evidences of Changes in Climate and Environment – on a Global Scale and in India – climate change modeling.

MODELLING CLIMATE CHANGE **9 Hours**

Basics of Modelling – Governing equations, parameters; Current climate models- climate model evaluation, evaluation of climate model components, sensitivity, updates from IPCC

CLIMATE PREDICTION **9 Hours**

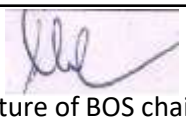
Short term climate forecast, medium range climate forecast, long range prediction, predictiability for regional climate – Global climatic models, Statistical downscaling techniques

POTENTIAL IMPACTS OF CLIMATE CHANGE **9 Hours**

Impacts of Climate Change on various sectors – Agriculture, Forestry and Ecosystem – Water Resources – Human Health – Industry, Settlement and Society

Theory: 45 Hrs Tutorial: 0 Hrs Practical: 0 Hrs Project: 0 Total: 45 Hrs REFERENCES

1. Dash Sushil Kumar, Climate Change – An Indian Perspective, Cambridge University Press India Pvt. Ltd, 2007
2. IPCC Fourth Assessment Report – The AR4 Synthesis Report, 2007
3. Jan C. van Dam, Impacts of Climate Change and Climate Variability on Hydrological Regimes, Cambridge University Press, 2003.



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		L	T	P	J	C
P18EEE0003	**ENVIRONMENTAL ANALYSIS: TECHNIQUES AND INSTRUMENTATION**	**3**	**0**	**0**	**0**	**3**

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Classify principle mechanism, capabilities and limitations of analytical instruments

CO2: Perform experiments using analytical instruments in water quality monitoring

CO3: Apply analytic techniques in wastewater quality monitoring

CO4: Develop flow measuring devices using sensors and instruments for air quality monitoring

CO5: Identify the analytical techniques for various pollution management

Course Objectives:

This course will make the students develop an understanding of the range and theories of instrumental methods available in analytical chemistry by appropriate selection of instruments for the successful analysis of complex mixtures, reviewing and reporting experiments. The students also develop a skill in installing indigenous analytical techniques with sensor application for monitoring Air, Water, Soil, Solid and Noise quality parameters

Prerequisite: Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		S		S		
CO2		S		S		
CO3		S		S		
CO4		S		S		
CO5		S		S		

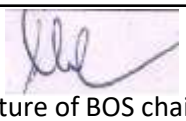
Course Assessment methods:

Direct
1. Mid Term Examination 2. Research Assignment, Group Presentation 3 End Semester Examination
Indirect
1. Course-end survey

INTRODUCTION **9 Hours**

Necessity of Instrumentation & Control for environment, sensor requirement for environment. Instrumentation methodologies: Ultraviolet analyzers, total hydrocarbon analyzers using flame ionization detector, Gas chromatography in environmental analysis, photo ionization, portable & stationary analytical instruments.

WATER QUALITY PARAMETERS **9 Hours**



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Thermal conductivity, detectors, Opacity monitors, pH analyzers & their application, conductivity analyzers & their application. Ground water monitoring: Instrumentation in ground water monitoring, instrumentation in assessment of soil & ground water pollution. Instrumentation for Site Safety and Rapid Detection of Organics in the Field.

WASTE WATER MONITORING **9 Hours**

Automatic wastewater sampling, optimum waste water sampling locations, and waste water measurement techniques. Instrumentation set up for waste water treatment plant. Latest methods of wastewater treatment plants.

AIR MONITORING AND FLOW MEASUREMENTS **9 Hours**

Measurement of ambient air quality. Flow monitoring: Air flow measurement, gas flow, non- open channel flow measurement, open channel wastewater flow measurement. Rain water harvesting: necessity, methods, rate of NGOs municipal corporation, Govt., limitations. Quality assurance of storage water.

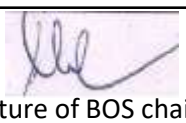
POLLUTION MANAGEMENT **9 Hours**

Types and methods of Analysis and Techniques - Pollution Management: Management of radioactive pollutants, Noise level measurement - techniques, Noise pollution and its effects, Solid waste management techniques, social and political involvement in the pollution management system

Theory: 45 Hrs Tutorial: 0 Hrs Practical: 0 Hrs Project: 0 Total: 45 Hrs

REFERENCES:

1. Randy D. Down and Jay H. Lehr, Environmental Instrumentation & Analysis Handbook, JohnWiley & Sons.
2. Skoog, Holler, Nieman, Principles of Instrumental Analysis by, Thomson books-cole publications, 6th Ed., 2006.



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P18EEE0004	ENVIRONMENTAL POLICIES AND LEGISLATIONS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Describe the relevant sections of Indian Penal Code and Criminal Procedure Code for Environmental Protection

CO2 : Discriminate the power & functions of regulatory agencies

CO3: understand the roles, responsibilities of Air Act

CO4: understand the roles, responsibilities of Environmental Act

CO5: Draft writ petitions and Public Interest litigation

Course Objectives:

This course work provides an in-depth understanding of the vast field of Environmental law and policy and the study would be familiar with the overall legal regime of the country as well as international obligations. To impart knowledge on the policies, legislations, institutional framework and enforcement mechanism for environmental management in India.

Prerequisite: Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S		S			
CO2			S			
CO3			S			S
CO4			S			
CO5			S			S

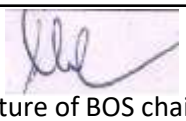
Course Assessment methods:

Direct
1. Mid Term Examination 2. Research Assignment, Group Presentation 3 End Semester Examination
Indirect
1. Course-end survey

INTRODUCTION **9 Hours**

Indian Constitution and Environmental Protection – National Environmental policies – Precautionary Principle and Polluter Pays Principle – Concept of absolute liability – multilateral environmental agreements and Protocols – Montreal Protocol, Kyoto agreement, Rio declaration– Environmental Protection Act, Water (P&CP) Act, Air (P&CP) Act – Institutional framework(SPCB/CPCB/MoEF)

WATER (P&CP) ACT, 1974 **8 Hours**



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Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Water Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

AIR (P&CP) ACT, 1981 8 Hours

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Air Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

ENVIRONMENT (PROTECTION) ACT 1986 13 Hours

Genesis of the Act – delegation of powers – Role of Central Government - EIA Notification – Sitting of Industries – Coastal Zone Regulation - Responsibilities of local bodies mitigation scheme etc., for Municipal Solid Waste Management - Responsibilities of Pollution Control Boards under Hazardous Waste rules and that of occupier, authorisation – Biomedical waste rules - responsibilities of generators and role of Pollution Control Boards

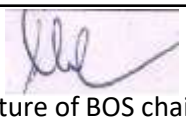
OTHER TOPICS 7 Hours

Relevant Provisions of Indian Forest Act, Public Liability Insurance Act, CrPC, IPC -Public Interest Litigation - Writ petitions - Supreme Court Judgments in Landmark cases.

Theory: 45 Hrs Tutorial: 0 Hrs Practical: 0 Hrs Project: 0 Total: 45 Hrs

REFERENCES:

1. Braun, Robert D., Introduction to Instrumental Analysis by Pharma Book Syndicate, Hyderabad. 2006.
2. Layzer, J. “The Environmental Case: Translating Values into Policy”, 3rd edition, CQ Press, 2012.
3. Randy D. Down and Jay H. Lehr, Environmental Instrumentation & Analysis Handbook, JohnWiley & Sons. 1st Ed. 2005.
4. Skoog, Holler, Nieman, Principles of Instrumental Analysis by Thomson books-cole publications, ed., 6th Ed. 2006.
5. Vig, N. J. and Kraft, M. E. “Environmental Policy: New Directions for the Twenty-First Century”, 8th edition, CQ Press, 2013.



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U18PEEE0005 Environmental System Analysis

L	T	P	J	C
3	0	0	0	3

Course Objectives

- To introduce the concepts of systems and system approach
- To expose the learner towards solving algorithms that assist decision making in case of a system

Course Outcome

After successful completion of this course, the students should be able to

CO1: Identify a system and its behaviour
CO2: Formulate a system for an Environmental process
CO3: Suggest the choice of Linear / Non-linear algorithm based on the system constraints
CO4: Understand the process or parameters or criteria that may influence a decision
CO5: appreciate the role of systems thought in LCA, circular economy and sustainable development

Pre-requisites: Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(POs)								
	PO1	PO2	PO3	PO4	PO5	PO6	PEO1	PEO2	PEO3
CO1	S	S		M	S			M	M
CO2	S	S		M	S			M	M
CO3	S	S		M	S			M	M
CO4	S	S		M	S			M	M

Course Assessment methods:

Direct
1. Continuous Assessment Test I and II (Theory component) 2. Assignment and presentations (Theory component) 3. End Semester Examination (Theory component)

Systems Theory **4 Hours**

Introduction to system – Types of system- Properties of system – complex system behavior

Systems Approach **8 Hours**

Establishing objectives, decision variables, constraints for Environmental Engineering Planning & Design; Introduction to Linear and Non-Linear systems

Solution Algorithms **13 Hours**

Linear programming – Slack & Surplus Variables; Non-Linear Programming; Introduction to problem solving using evolutionary algorithms; objective function sensitivity

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Decision Analysis **12 Hours**

Multi criteria analysis – solution using alternate objectives- pareto optimality and tradeoffs; Trade evaluation (Environmental, Economic, social criteria) – Cost benefit analysis – Analytical Hierarchy process – matrix method for generating scores and weights.

Application **8 Hours**

Introduction to Life Cycle Assessment (LCA) – Stages, Phases and types; Introduction to sustainable development indicators and Circular economy

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. Vedula S and Mujumdar P P, 2005. "Water Resources Systems", Tata McGraw-Hill Publishing Company Limited, NewDelhi.
2. Dieter M Imboden and Stefan Pfenninger, 2013. "Introduction to system analysis – Mathematical modeling Natural systems ", Springer.
3. Ravindran A, Philips T Don, and Solberg T James. 2007/ "Operations Research – Principles and Practice", Wiley INDIA.

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P18EEE0006	INDUSTRIAL WASTEWATER TREATMENT	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Identify the environmental standards and the industrial waste stream characteristics from several major industrial categories

CO2: Develop an overall treatment strategy for an industrial waste stream

CO3: Specify design criteria for physical, chemical and biological unit operations and processes

CO4: Estimate capital and operating cost for industrial waste treatment systems

Course Objectives:

The course will impart knowledge on the concept and application of Industrial pollution prevention, cleaner technologies, industrial wastewater treatment and residue management. The student will understand the principles of various processes applicable to industrial wastewater treatment.

Pre-requisite: Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S		S	M		
CO2	S		S	M		
CO3	S		S	M		
CO4	S		S	M		

Course Assessment Methods

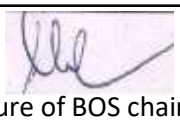
Direct

1. Mid Term Examination
2. Research Assignment, Group Presentation

3 End Semester Examination

Indirect

1. Course-end survey



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INTRODUCTION	8 Hours
Industrial scenario in India– Industrial activity and Environment - Uses of Water by industry – Sources and types of industrial wastewater – Nature and Origin of Pollutants - Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater – Industrial waste survey – Industrial wastewater monitoring and sampling - generation rates, characterization and variables –Toxicity of industrial effluents and Bioassay tests – Major issues on water quality management.	

INDUSTRIAL POLLUTION PREVENTION & WASTE MINIMISATION 8 Hours

Prevention vis a vis Control of Industrial Pollution – Benefits and Barriers – Waste management Hierarchy - Source reduction techniques – Periodic Waste Minimisation Assessments – Evaluation of Pollution Prevention Options – Cost benefit analysis – Pay-back period – Implementing & Promoting Pollution Prevention Programs in Industries.

INDUSTRIAL WASTEWATER TREATMENT 10 Hours

Flow and Load Equalisation – Solids Separation – Removal of Fats, Oil & Grease- Neutralisation – Removal of Inorganic Constituents – Precipitation, Heavy metal removal, Nitrogen & Phosphorous removal, Ion exchange, Adsorption, Membrane Filtration, Eletrodialysis & Evaporation – Removal of Organic Constituents – Biological treatment Processes, Chemical Oxidation Processes, Advanced Oxidation processes – Treatability Studies.

WASTEWATER REUSE AND RESIDUAL MANAGEMENT 9 Hours

Individual and Common Effluent Treatment Plants – Joint treatment of industrial and domestic wastewater - Zero effluent discharge systems - Quality requirements for Wastewater reuse – Industrial reuse, Present status and issues - Disposal on water and land – Residuals of industrial wastewater treatment – Quantification and characteristics of Sludge – Thickening, digestion, conditioning, dewatering and disposal of sludge – Management of RO rejects.

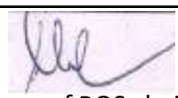
CASE STUDIES 10 Hours

Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – metal finishing – Oil Refining–Pharmaceuticals–Sugar and Distilleries

Refer Environmental economics theory & practice by Ben White, Jason & Nick

Theory: 45 Hrs Tutorial: 0 Hrs Practical: 0 Hrs Project: 0 Total: 45 Hrs References:

1. Industrial wastewater management, treatment & disposal, Water Environment, Federation Alexandria Virginia, Third Edition, 2008.
2. Lawrance K.Wang, Yung Tse Hung, Howard H.Lo and Constantine Yapijakis “handbook of Industrial and Hazardous waste Treatment”, Second Edition, 2004.
3. Metcalf & Eddy/ AECOM, "water reuse Issues, Technologies and Applications", The Mc Graw- Hill companies, 2007.
4. Nelson Leonard Nemerow, “ Industrial waste Treatment”, Elsevier, 2007.
5. Soli. J. Arceivala, Shyam. R. Asolekar, Wastewater Treatment for pollution control and reuse by Tata Mcgraw Hill, 2007
6. Wesley Eckenfelder W.,“Industrial Water Pollution Control”, Second Edition, Mc Graw Hill, 1989.



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P18EEE0007	INTRODUCTION TO SOFT COMPUTING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Identify and describe soft computing techniques and their roles in building intelligent machines

CO2: Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems

CO3: Apply neural networks to pattern classification and regression problems

CO4: Apply genetic algorithms to combinatorial optimization problems

CO5: Apply the appropriate concept techniques of data analysis in Environmental Engineering

Course Objectives:

At the end of the course the student should have learnt the key concepts of Soft computing and Neural Networks. The students should have learnt the fuzzy logic components and gained an insight on to neuro fuzzy modelling and control. They should know about the components and building block hypothesis of genetic algorithm.

Pre-requisite: Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		S		S	S	
CO2		S		S	S	
CO3		S		S	S	
CO4		S		S	S	
CO5		S		S	S	

Course Assessment Methods

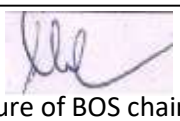
Direct
1. Mid Term Examination 2. Research Assignment, Group Presentation 3 End Semester Examination
Indirect
2. Course-end survey

INTRODUCTION TO SOFT COMPUTING **9 HOURS**

Bassic concepts of soft computing, need compared to classical modeling, concepts on – certainity and uncertainity

FUZZY LOGIC **9 Hours**

Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion. Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications & Defuzzificataions



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ARTIFICIAL NEURAL NETWORKS **9 Hours**

Architecture: perceptron model, solution, single layer artificial neural network, the multilayer perception model; back propagation learning methods, the effect of learning rule co-efficient; back propagation algorithm, factors affecting back propagation training, applications.

INTRODUCTION TO OPTIMIZATION **9 Hours**

Basic concept of optimization; working principle and its application of Genetic algorithm, ant colony optimization, particle swarm optimization, simulated annealing

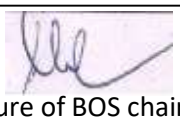
INTRODUCTION TO DATA ANALYSIS **9 Hours**

Basic statistics, introduction to probability, basic concepts and application of linear regression, decision tree, support vector machine into environmental engineering

Theory: 45 Hrs Tutorial: 0 Hrs Practical: 0 Hrs Project: 0 Total: 45 Hrs

References:

1. Miguel F. Acevedo Data, Analysis and Statistics for Geography, Environmental Science, and Engineering, 2013
2. Padhy, N.P, Artificial Intelligence and Intelligent Systems, Oxford University Press., 2005
3. Rajsekaran, S and Vijayalakshmi Pai, G.A., Neural Networks, Fuzzy Logic and Genetic Algorithm:Synthesis and Applications, 2nd Ed. 2019, Prentice Hall of India,
4. Siman Haykin, Neural Netowrks – A Comprehensive foundation, Prentice Hall of India, 3rd Ed. 2009
5. Timothy J. Ross, Fuzzy Logic with Engineering Applications Wiley India, 4th Ed. 2016.



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P18EEE0008	NANOTECHNOLOGY IN ENVIRONMENTAL ENGINEERING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Identify and understand various approaches for nanomaterial synthesis
CO2: Synthesis nano materials and their mechanism in biological systems
CO3: Analyse and characterize nanomaterial
CO4: Apply nano synthesis in energy conversion and storage
CO5: Identify the impact of nanoparticle and its toxicity to the environment

Course Objectives:

The course is designed to make the learners understand the synthesis and fabrication of nanomaterials. It also would provide the learners to synthesis and apply nanotechnology in diverse research and industrial fields and to access their impacts onto the environment

Pre-requisite: Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S		S	M		
CO2	S		S	M		
CO3	S		S	M		
CO4	S		S	M		

Course Assessment Methods

Direct
1. Mid Term Examination 2. Research Assignment, Group Presentation 3 End Semester Examination
Indirect
1. Course-end survey

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INTRODUCTION AND SYNTHESIS OF NANOMATERIALS 9 Hours

History –Overview of existing application of nanomaterials in water and wastewater treatment;: Synthesis of nanomaterials: magnetic nanoparticles, Carbonaceous nanoparticles; nanocomposites; clay supported nanoparticles, aerogels- Methods of synthesis: Sol-Gel method, microemulsion method, electrospinning method, plasma technique, Chemical Vapour Deposition (CVD)

METHODS FOR STRUCTURAL AND CHEMICAL CHARACTERIZATION OF NANOMATERIALS 8 Hours

Separation techniques- Morphology studies: scanning electron microscopy (SEM) - Surface charge and optical properties of nanoparticles: zeta potential, UV-Vis spectrometry-Elemental composition of single nanoparticles using EDAX, elemental composition of bulk nanoparticles-X-ray diffraction (XRD) - FTIR

MEMBRANE PROCESSES 10 Hours

Overview of membrane technology- Types of membrane filtration, microfiltration, ultra filtration, nanofiltration, reverse osmosis – Transport principles-Membrane fabrication and characterization- Nanoparticle membrane reactor

NANOMATERIALS AS ADSORBENTS AND OXIDANTS 9 Hours

Metals oxides (Titanium oxides, Iron oxides, Copper, Zinc) – Carbon nanoadsorbents: CNTs (single and multiwaled), Fullerenes- Molecularly imprinted polymers for removal of micropollutants- Advanced Oxidation Process: Photocatalytic oxidation, Fenton process

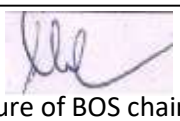
FATE AND TOXICITY OF NANOPARTICLES AND NANOMATERIALS 10 Hours

Processes determining the fate of NMs /NPs in environment: aggregation, reaction, adsorption, deposition; ecotoxicity of NMs/NPs;- Effect on human health and environment- Introduction to nanosensors

Theory: 45 Hrs Tutorial: 0 Hrs Practical: 0 Hrs Project: 0 Total: 45 Hrs

References:

1. Ajay Kumar Mishra, “Application of Nanotechnology in Water Research”, Scrivener Publishing LLC. 2014
2. Eugene T, Michele De Kwaadsteniest, “Nanotechnology in Water Treatment Applications”, Caister Academic Press, 2010
3. Handbook of Nanotechnology, Edi-Bharat Bhushan, Springer, 2004
4. Lens P., Virkutyte J., Jegatheesan V., and Al-Abed S., “Nanotechnology for Water and Wastewater Treatment’, IWA Publishing, 2013



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P18EEE0009	OCCUPATIONAL HEALTH & SAFETY	L	T	P	P	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Incorporate the health and safety systems by the legal code and practice

CO2: Categorize and monitor the health hazards and risks

CO3: Implement satisfactory and safe design of work premises

CO4: Assess the plant safety and control techniques

CO5: train in Environmental health and safety management

Course Objectives

To educate the students interrelatedness of public health, management, employees, and the government to the goals of occupational health and safety. The student will be taught to Identify education, engineering, and enforcement controls for the prevention of occupational health and safety problems by identifying a conceptual framework for the practice of occupational health and safety

Pre-requisites : Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			S			
CO2			S			
CO3			S			
CO4			S			
CO5			S			

Course Assessment methods

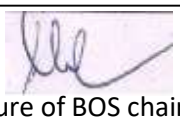
Direct
1. Mid Term Examination 2. Research Assignment, Group Presentation 3 End Semester Examination
Indirect
1. Course-end survey

INTRODUCTION **9 Hours**

Need for developing Environment, Health and Safety systems in work places - Accident Case Studies - Status and relationship of Acts - Regulations and Codes of Practice - Role of trade union safety representatives. International initiatives - Ergonomics and work place

OCCUPATIONAL HEALTH AND HYGIENE **9 Hours**

Definition of the term occupational health and hygiene - Categories of health hazards - Exposure pathways and human responses to hazardous and toxic substances - Advantages and limitations of environmental monitoring and occupational exposure limits - Hierarchy of control measures for occupational health risks - Role of personal protective equipment and the selection criteria - Effects on humans - control methods and reduction strategies for noise, radiation and excessive stress.



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WORKPLACE SAFETY AND SAFETY SYSTEMS **9 Hours**

Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and colour, Ventilation and Heat Control – Electrical Safety – Fire Safety – Safe Systems of work for manual handling operations – Machine guarding – Working at different levels – Process and System Safety.

HAZARDS AND RISK MANAGEMENT **9 Hours**

Safety appraisal - analysis and control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques – major accident hazard control – Onsite and Offsite emergency Plans.

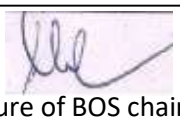
ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT **9 Hours**

Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and methods of its effective implementation and review – Elements of Management Principles – Education and Training – Employee Participation.

Theory: 45 Hrs Tutorial: 0 Hrs Practical: 0 Hrs Project: 0 Total: 45 Hrs

REFERENCES:

1. Bill Taylor, Effective Environmental, Health, and Safety Management Using the Team Approach by Culinary and Hospitality Industry Publications Services, 2005.
2. Brian Gallant, The Facility Manager's Guide to Environmental Health and Safety by Government Inst Publ., 2007.
3. Mistry K U, Siddharth Prakashan, Fundamentals of Industrial Safety and Health by 2012
4. Nicholas P. Cheremisinoff and Madelyn L. Graffia, Environmental and Health and Safety Management by William Andrew Inc. NY, 1995.



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P18EEE0010	REMOTE SENSING AND GIS FOR ENVIRONMENTAL PLANNING & MANAGEMENT	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Impart knowledge on principles and applications of remote sensing , GIS for environmental engineering

CO2: Understand the usage of GIS software and processing of data

CO3: Apply the basic understanding of GIS concepts in geospatial analysis

CO4: Apply Remote sensing data in GIS

CO5: Monitor Environmental issues using Remote sensing and GIS data

Course Objectives

The course will provide exposure to students in gaining knowledge on concepts and applications leading to modeling of earth resources management using Remote Sensing. Also the students will learn to acquire skills in storing, managing digital data for planning and development.

Pre-requisites : Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1				S	S	
CO2				S	S	
CO3				S	S	
CO4				S	S	
CO5				S	S	

Course Assessment methods

Direct
1. Mid Term Examination 2. Research Assignment, Group Presentation 3 End Semester Examination
Indirect
1. Course-end survey

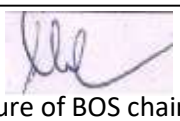
REMOTE SENSING **9 Hours**

Basic Concepts of remote sensing - Electromagnetic radiation (EMR), Interaction of EMR with atmosphere, earth surface, soil, water and vegetation - Remote sensing platforms – Monitoring atmosphere, land and water resources - LANDSAT, SPOT, ERS, IKONOS – Scanners, radiometers - Data types and format

DIGITAL IMAGE PROCESSING **9 Hours**

Satellite Data analysis - Image interpretation: multi-spectral, multi-temporal and multi-sensoral – Digital image processing – Image preprocessing – Image enhancement – Image classification – Data Merging

GEOGRAPHICAL INFORMATION SYSTEM **9 Hours**



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Definition – Components of GIS – Map projections and co-ordinate systems – Data structures: raster, vector – Spatial Relationship – Topology – Geodatabase models: hierarchical, network, relational, object oriented models – Integrated GIS database - Sources of error – Data quality: Macro, Micro and Usage level components - Meta data - Spatial data transfer standards

REMOTE SENSING DATA APPLICATIONS IN GIS 9 Hours

Land cover classification, Urban Greens, monitoring of deforestation process, watershed and Environmental impact assessment

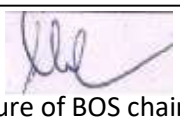
REMOTE SENSING AND GIS APPLICATIONS 9 Hours

Monitoring and management of environment, Conservation of resources, Sustainable land use, Coastal zone management, solidwaste handling, waste water management, air quality – Limitations

Theory: 45 Hrs Tutorial: 0 Hrs Practical: 0 Hrs Project: 0 Total: 45 Hrs

REFERENCES:

1. Bhatta, B, Remote Sensing and GIS, Oxford University Press, 2011
2. Burrough, P.A. and McDonnell, R.A., Principles of Geographic Information systems Oxford University Press, NewYork, 2001.
3. Joseph, G and Jeganathan, C, Fundamentals of reote Sensing, Universities Press, 2018
4. Lillesand, T.M. and Kiefer, R.W, Remote sensing and image interpretation, John Wiley and sons,NewYork, 2004.
5. Lintz, J and Simonet, Remote sensing of Environment, Addison Wesley Publishing Company,New Jersey, 1998.



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P18EEE0011	RESEARCH METHODOLOGY	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Describe research concepts

CO2: Acquire adequate knowledge about mathematical modelling

CO3: Describe Experimental Modelling

CO4: Understand analysis of results.

CO5: Practice about report writing

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		S		S		
CO2		S		S		
CO3		S		S		
CO4		S		S		
CO5		S		S		

Course Assessment Methods

Direct
1. Mid Term Examination 2. Research Assignment, Group Presentation 3 End Semester Examination
Indirect
2. Course-end survey

RESEARCH CONCEPTS **9 Hours**

Concepts – meaning – objectives – motivation - types of research – approaches - research (Descriptive research, Conceptual, Theoretical, Applied & Experimental). Formulation of Research Task – Literature Review, Importance & Methods, Sources, quantification of Cause Effect Relations, Discussions, Field Study, Critical Analysis of Generated Facts, Hypothetical proposals for future development and testing, selection of Research task.

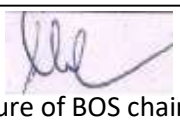
MATHEMATICAL MODELING AND SIMULATION **9 Hours**

Concepts of modelling - Classification of Mathematical Models - Modelling with Ordinary differential Equations, Difference Equations - Partial Differential equations – Graphs - Simulation - Process of formulation of Model based on Simulation.

EXPERIMENTAL MODELING **9 Hours**

Definition of Experimental Design – Examples, Single factor Experiments - Guidelines for designing experiments. Process Optimization and Designed experiments -Methods for study of response surface, determining optimum combination of factors, Taguchi approach to parameter design.

ANALYSIS OF RESULTS **9 Hours**



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Parametric and Non-parametric, descriptive and Inferential data - types of data - collection of data (normal distribution - calculation of correlation coefficient) – processing - analysis, error analysis - different methods - analysis of variance - significance of variance - analysis of covariance - multiple regression - testing linearity and non-linearity of model.

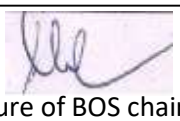
REPORT WRITING **9 Hours**

Types of reports - layout of research report - interpretation of results - style manual - layout and format, style of writing – typing – references – tables –figures – conclusion - appendices.

Theory: 45 Hrs **Tutorial: 0 Hrs** **Practical: 0 Hrs** **Project: 0** **Total: 45 Hrs**

References:

1. Wilkinson K. L, Bhandarkar P. L, „Formulation of Hypothesis", Himalaya Publication.
2. Schank Fr.,"Theories of Engineering Experiments", Tata Mc Graw Hill Publication.
3. Douglas Montgomery, "Design of Experiments", Statistical Consulting Services, 1990.
4. Cochran and Cocks, „Experimental Design", John Willy & Sons.
5. John W. Besr and James V. Kahn, „Research in Education", PHI Publication.
6. Adler and Granovky, "Optimization of Engineering Experiments", Meer Publication.



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P18EEE0012	TRANSPORT OF WATER AND WASTEWATER	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to
CO1: Identify the pipe losses and determine the flow measurement
CO2: Decide the suitable pumping mains based on their maintenance
CO3: Analyze various pipe distribution networks
CO4: Estimate Storm water drainage flow
CO5: Design Hydraulic sewers and outfalls

Course Objectives
To educate the students in detailed design concepts related to water transmission mains, water distribution system, sewer networks and storm water drain and computer application on design.
Pre-requisites : Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S		M	S	
CO2	S	S		M	S	
CO3	S	S		M	S	
CO4	S	S		M	S	
CO5	S	S		M	S	

Course Assessment methods

Direct
1. Mid Term Examination 2. Research Assignment, Group Presentation 3 End Semester Examination
Indirect
2. Course-end survey

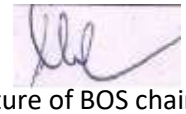
GENERAL HYDRAULICS AND FLOW MEASUREMENT **9 Hours**

Fluid properties; fluid flow – continuity principle, energy principle and momentum principle; frictional head loss in free and pressure flow, minor heads losses, Carrying capacity – Flow measurement.

WATER TRANSMISSION **9 Hours**

Need for Transport of water and wastewater - Planning of Water System –Selection of pipe materials, concepts on water transmission mains - gravity and pumping main; Selection/Design of Pumps- characteristics – economics. Specials, Jointing, laying and maintenance

WATER DISTRIBUTION **9 Hours**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Water hammer analysis; Water distribution pipe networks: Design, analysis and optimization – appurtenances – corrosion prevention – minimization of water losses – leak detection - Storage reservoirs.

STORM WATER DRAINAGE **9 Hours**

Necessity- Design of Combined and separate system - Formulation of rainfall intensity duration and frequency relationships, Probable Maximum Precipitation - Estimation of storm water run-off - Rational methods

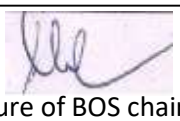
WASTEWATER COLLECTION AND CONVEYANCE **9 Hours**

Planning factors – Design of sanitary sewer; partial flow in sewers, economics of sewer design; Wastewater pumps and pumping stations- Sewer appurtenances –; material, construction, inspection and maintenance of sewers; Design of sewer outfalls - mixing conditions; conveyance of corrosive wastewaters

Theory: 45 Hrs Tutorial: 0 Hrs Practical: 0 Hrs Project: 0 Total: 45 Hrs

REFERENCES

1. CPHEEO, Manual on water supply and Treatment, Ministry of Urban Development, GoI, New Delhi, 2012.
2. CPHEEO, Manual on Sewerage and Sewage Treatment, Ministry of Urban Development, GoI, New Delhi, 2012.
3. Hammer. M.J., Water and Wastewater Technology, Regents/ Prentice Hall, New Jercy, 2001.



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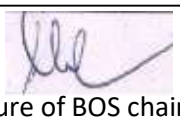
AUDIT COURSES



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		L	T	P	J	C
P18EEA0002	**DISASTER MANAGEMENT**	**3**	**0**	**0**	**0**	**0**

Course Outcome

After successful completion of this course, the students should be able to

CO1: Prepare disaster mapping using GIS.
CO2: Assess disaster vulnerability of a location.
CO3: Prepare disaster management plan

Course Objectives

The course is intended to provide a general concept in the dimensions of disasters caused by nature beyond the human control as well as the disasters and environmental hazards induced by human activities with emphasis on disaster preparedness, response and recovery.

Pre-requisites: Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			S	S		S
CO2			S	S		S
CO3			S	S		S

Course Assessment methods

Direct
1. Mid Term Examination 2. Research Assignment, Group Presentation 3 End Semester Examination
Indirect
1. Course-end survey

NATURAL DISASTERS **9 Hours**

Cyclones, Floods, Drought and Desertification - Earthquake, Tsunami, Landslides and Avalanche.

MAN MADE DISASTERS **9 Hours**

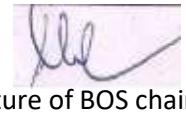
Chemical industrial hazards, major power breakdowns, traffic accidents, Fire, War, Atom bombs, Nuclear disaster- Forest Fire-Oil fire –accident in Mines.

GEOSPATIAL TECHNOLOGY **9 Hours**

Remote sensing, GIS and GPS applications in real time disaster monitoring, prevention and rehabilitation- disaster mapping.

RISK ASSESSMENT AND MITIGATION **9 Hours**

Hazards, Risks and Vulnerabilities. -Disasters in India,Assessment of Disaster Vulnerability of a location and vulnerable groups- Preparedness and Mitigation measures for various Disasters Mitigation through capacity building -Preparation of Disaster Management Plans



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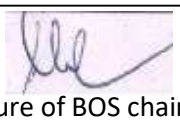
DISASTER MANAGEMENT **9 Hours**

Legislative responsibilities of disaster management- Disaster management act 2005- post disaster recovery & rehabilitation, Relief & Logistics Management; disaster related infrastructure development- Post Disaster, Emergency Support Functions and their coordination mechanism.

Theory: 45 **Tutorial: 0** **Practical: 0** **Project: 0** **Total: 45 Hours**

REFERENCES

1. Disaster Management in India- A Status Report- Published by the National Disaster Management Institute, Ministry of Home Affairs, Govt. of India.2004.
2. Khanna B K, All You Wanted to Know About Disasters, New India Publishing Agency, New Delhi, 2005.
3. Murthy D B N, Disaster Management: Text and Case Studies, Deep and Deep Publications (P) Ltd., New Delhi, 2007.
4. Rajdeep Dasgupta, Disaster Management and Rehabilitation, Mittal Publishers, New Delhi, 2007.
5. Ramana Murthy, Disaster Management, Dominant, New Delhi, 2004.
6. Sundar I and Sezhiyan T, Disaster Management, Sarup and Sons, New Delhi, 2007.



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		L	T	P	J	C
P18EEA0008	**PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTMENT SKILLS**	**3**	**0**	**0**	**0**	**0**

Course Outcome

After successful completion of this course, the students should be able to

CO1: Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life

CO2: The person who has studied Geeta will lead the nation and mankind to peace and prosperity

CO3: Study of Neetishatakam will help in developing versatile personality of students.

Course Objectives

The course is intended to awaken the wisdom in students to learn and achieve the highest goal happily. It also enables the younger generation to develop a personality with stable mind, pleasing personality and determination

Pre-requisites: Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						

Course Assessment methods

Direct
1. Mid Term Examination 2. Research Assignment, Group Presentation 3 End Semester Examination
Indirect
2. Course-end survey

NEETISATAKAM-HOLISTIC DEVELOPMENT OF PERSONALITY **15 Hours**

Verses- 19,20,21,22 (wisdom), Verses- 29,31,32 (pride & heroism), Verses- 26,28,63,65 (virtue), Verses- 52,53,59 (dont's), Verses- 71,73,75,78 (do's)

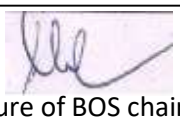
SHRIMAD BHAGWAD GEETA **15 Hours**

Approach to day to day work and duties: Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48, Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35, Chapter 18-Verses 45, 46, 48.

SHRIMAD BHAGWAD GEETA **15 Hours**

Statements of basic knowledge: Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68, Chapter 12 - Verses 13, 14, 15, 16,17, 18, Personality of Role model. Shrimad BhagwadGeeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39, Chapter18 – Verses 37,38,63

Theory: 45 **Tutorial: 0** **Practical: 0** **Project: 0** **Total: 45 Hours**



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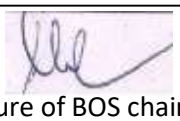
REFERENCES

1. “Srimad Bhagavad Gita” by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata
2. Bhartrihari’s Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.



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P18INR0001	RESEARCH ETHICS (Common to All PG programs)	L	T	P	J	C
		1	0	0	0	0

Course Outcomes:

After successful completion of this course, the students should be able to

CO1: Comprehend the importance of ethical practices in research.

CO2: Distinguish ethical practices from unethical practices in Research Design.

CO3: Understand ethical practices in conducting research and its dissemination

Pre-requisites: Nil

CO/PO Mapping

(S/M/W indicates strength of correlation)

S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				S						S		
CO2				S						S		
CO3				S			M	M		S		

Course Assessment methods

Direct
1. Continuous Assessment Tests
2. Assignment
3. End Examination (Internal evaluation)

INTRODUCTION TO ETHICAL PRACTICE IN RESEARCH	**2 Hours**

Values Underlying Research Integrity; Framework for Good Academic Research Practices

ETHICS IN RESEARCH DESIGN & CONDUCTING RESEARCH	**5 Hours**

Planning; Research Questions and Documentation; Literature Review; Data, Precision, Accuracy & errors, Research Execution, Documentation & Manuscript writing; Checks for Plagiarism, Falsification, Fabrication, and Misrepresentation;

COLLABORATIVE RESEARCH & IPR	**5 Hours**

Collaboration and Authorship; Sharing of Credits; Intellectual Property

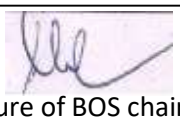
DISSEMINATION	**3 Hours**

Selection of the Right Medium for Publication; Choosing the Right Journal for Publication; Translation of Research

Theory: 15 Tutorial: 0 Practical: 0 Project: 0 Total: 15 Hours

REFERENCES:

1. Guidance Document: Good Academic Research Practices. New Delhi: University Grants Commission, Sep 2020 (https://www.ugc.ac.in/e-book/grap_29092020/mobile/index.html)



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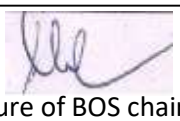
2. UGC Regulation: Promotion of Academic Integrity and Prevention of Plagiarism in HEI's, Regulation 2018 (https://www.ugc.ac.in/pdfnews/7771545_academic-integrity-Regulation2018.pdf) Books
3. P. Chaddah (2018) Ethics in Competitive Research: Do not get scooped; Do not get plagiarised, ISBN: 978-9387480865
4. Beall, J. (2012). Predatory publishers are corrupting open access. Nature News, 489(7415), 179.

Online Books/ Courses

5. Muralidhar, K., Ghosh, A., & Singhvi, A. K. (2019). Ethics in Science Education, Research and Governance. ISBN: 978-81-939482-1-7 (https://www.insaindia.res.in/pdf/Ethics_Book.pdf)
6. Griffiths, P. A., McCormick Adams, R., Albertis, B. M., Blout, E. R., Browder, F. E., Challoner, M. D., & Stine, D. D. (1995). On being a scientist: responsible conduct in research. Washington (DC): National Academy Press. (https://www.nap.edu/read/12192/chapter/1)
7. Steven D. Krause (2007) Process of Research writing (Open Textbook Library, University of Michigan) https://open.umn.edu/opentextbooks/textbooks/the-process-of-research-writing
8. Chery Lowry (2016) Choosing & Using sources: A guide to academic research (Open Textbook Library, University of Michigan), https://open.umn.edu/opentextbooks/textbooks/choosing-using-sources-a-guide-to-academic-research
9. Introduction to Research - NPTEL course (https://nptel.ac.in/courses/121/106/121106007/)
10. Research Ethics - Swayam course (https://onlinecourses.swayam2.ac.in/cec20_ge33/preview)



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