AFFILIATED INSTITUTIONS

ANNA UNIVERSITY , CHENNAI

REGULATIONS - 2009

CURRICULUM I SEMESTER (FULL TIME)

M. E. / M.TECH ENVIRONMENTAL SCIENCE AND ENGINEERING

SEMESTER I

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MA9323	Statistics for Environmental Engineers	3	1	0	4
2.	ES9311	Environmental Chemistry	3	0	0	3
3.	ES9312	Biochemical Engineering	3	0	0	3
4.	ES9313	Environmental Chemodynamics	3	0	0	3
5.	ES9314	Principles and Design of Physico-Chemical Treatment Systems	3	0	0	3
6	ES9315	Air Pollution Control	3	0	0	3
PRACTICAL						
1.	ES9316	Environmental Chemistry Laboratory	0	0	3	2
2.	ES9317	Environmental Microbiology Laboratory	0	0	3	2
		TOTAL	**18**	**1**	**6**	**23**

MA9323 STATISTICS FOR ENVIRONMENTAL ENGINEERS **L T P C**
3 1 0 4

OBJECTIVE:

- To train the students in the analysis of environmental data using statistical tools.

UNIT I EMPIRICAL STATISTICS **9+3**

Types of Sampling – Description of discrete and continuous data – Measures of Central tendency and dispersion for grouped and ungrouped data – Measures of position – Box and Whisker plot.

UNIT II ESTIMATION THEORY **9+3**

Unbiased Estimators – Method of Moments – Maximum Likelihood Estimation – Curve fitting by Principle of least squares – Regression Lines.

UNIT III TESTING OF HYPOTHESES **9+3**

Sampling distributions – Type I and Type II errors – Tests based on Normal, t, χ^2 and F distributions for testing of mean, variance and proportions – Tests for independence of attributes and Goodness of fit.

UNIT IV DESIGN OF EXPERIMENTS **9+3**

Analysis of variance – One-way and two-way classifications – Completely randomized design – Randomized block design – latin square design.

UNIT V STATISTICAL QUALITY CONTROL **9+3**

Statistical quality control – Statistical process control – χ and R or S control chart – Attribute control charts – P Chart and U chart – Control chart performance.

TOTAL (L:45+T:15): 60 PERIODS

REFERENCES:

1. Montgomery, D.C. and Runger, G.C., "Applied Statistics and Probability for Engineers", Wiley Student Edition, 2007.
2. Walpole, R.E., Myers,R.H., Myers,S.L. and Ye K, "Probability and Statistics for Engineers and Scientists" Pearson Education, Asia, 8th edition, 2007.
3. Mann. P.S., "Introductory Statistics", John Wiley and Sons, Inc 5th edition, 2004.
4. Johnson, R.A. and Gupta, C.B, "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 7th edition, 2007.

ES9311 ENVIRONMENTAL CHEMISTRY **L T P C**
3 0 0 3

OBJECTIVE:

- To educate the students in the area of water, air and soil chemistry and give an exposure in the laboratory for the determination of pollutants.

UNIT I INTRODUCTION 9

Stoichiometry and mass balance-Chemical equilibria, acid base, solubility product(Ksp) ,heavy metal precipitation, amphoteric hydroxides,CO_2 solubility in water and species distribution – Chemical kinetics , First order, Colloids, electrical properties, double layer theory, environmental significance of colloids,coagulation

UNIT II AQUATIC CHEMISTRY 11

Water quality parameters- environmental significance and determination; Fate of chemicals in aquatic environment, volatilization, partitioning, hydrolysis, photochemical transformation– Degradation of synthetic chemicals-Metals, complex formation, oxidation and reduction , Eh – pH diagrams, redox zones, Fe – sorption- Chemical speciation-

UNIT III ATMOSPHERIC CHEMISTRY 7

Atmospheric structure –-chemical and photochemical reactions – photochemical smog. Ozone layer depletion – greenhouse gases and global warming, CO_2 capture – Acid rain- origin and composition of particulates. Air quality parameters-effects and determination

UNIT IV SOIL CHEMISTRY 9

Nature and composition of soil-Clays- cation exchange capacity-acid base and ion-exchange reactions in soil – Reclamation of contaminated land.

UNIT V EMERGING AREAS 9

Principles of green chemistry, Atom economy, mass index- Nano materials, CNT, titania, composites, environmental applications.

TOTAL: 45 PERIODS

REFERENCES:

1. Sawyer,C.N., MacCarty, P.L. and Parkin, G.F., Chemistry for Environmental Engineering and Science, Tata McGraw – Hill, Fifth edition, New Delhi 2003.
2. Colin Baird 'Environmental Chemistry', Freeman and company, New York, 1997.
3. Manahan, S.E., Environmental Chemistry, Eighth Edition, CRC press,2005.
4. Ronbald A. Hites ,Elements of Environmental Chemistry, Wiley, 2007.

ES9312 BIOCHEMICAL ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- To educate the students in Biochemical Engineering and its applications in environmental engineering, and to train them in experiments related to microbiological examination of water.

UNIT I INTRODUCTION TO MICROBIOLOGY 8

Biophysics and Cell doctrine; Structure of cells- Prokaryotic, Eukaryotic and cell fractionation, Importance of cell types- Bacteria, Yeasts, Molds, Algae and Protozoa, animals and plant cells. Lipids. Chemicals of Life-Lipids, Sugars and Polysaccharides, Nucleotides to RNA and DNA, amino acids into Proteins, Hybrid Biochemical and the Hierarchy of cellular organization

UNIT II KINETICS OF ENZYME AND MOLECULAR GENETICS 10

Catalyzed reactions – The enzyme substrate complex and enzyme actions, Simple enzyme kinetics with one and two substrates, Determination of elementary-step rate constants, Other patterns of substrate concentration dependence, modulation and regulation of enzymatic activity, Other influences on enzyme activity, Enzyme deactivation, Enzyme reaction in heterogenous systems. Molecular genetics, Alteration of cellular DNA, Recombinant DNA Technology, Growth and Reproduction of a single cell

UNIT III METABOLIC STOICHIOMETERY AND ENERGETIC: **10**

Thermodynamics principles, Metabolic reaction coupling, Carbon catabolism, Respiration, Photosynthesis, Biosynthesis, Transport across cell membranes, Metabolic organization and regulation, End product metabolisms, Stoichiometery of cell growth and product formation.

UNIT IV ANALYSIS OF MULTIPLE INTERACTING MICROBIAL POPULATIONS. **7**

Positive interaction, Classification of interaction between two species, Competition, Predation and parasitism, Effects of the number of species and their web of interactions. Spatial patterns

UNIT V MIXED MICROBIAL POPULATION AND ITS APPLICATION IN ENVIRONMENT 10

Uses of well defined mixed population, Indicator organisms of water-coli forms-total coliforms- E.coli – control of microorganisms microbial participation in the natural cycles of matter, biological wastewater treatment, anaerobic treatment, phosphorous removal, bioaccumulation, bioassay, biomonitoring and bioleaching

TOTAL PERIODS 45

REFERENCES

1. James E. Bailey and David F. Ollis. Biochemical Engineering Fundamentals. McGraw-Hill International editions, 1986
2. Mcdiagrm, M.T , Martinko J M and Parkin J, Brock Biology of Microorganisms, Printice Hall Int. Inc., India,2003.

ES9313	ENVIRONMENTAL CHEMODYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVE:

To educate the students on the mechanism of material transfer between environmental components – air, water and soil.

UNIT I EQUILIBRIUM AT ENVIRONMENTAL INTERFACE 10

Ideal solutions – air – water equilibrium occurrences – pure gases in contact with water-pure liquid in contact with air – partition coefficient for the air – water system. Earthern solid – waste equilibrium occurrences – pure solid and liquid chemicals in contact with water and earthern solids. Earthern solid – air equilibrium occurrences – water – liquid chemical equilibrium occurrences – thermal equilibrium at environmental interfaces.

UNIT II TRANSPORT MECHANISMS 9

Diffusion and mass transfer – molecular diffusion – eddy diffusion – mass transfer theories – mass transfer coefficients – binary mass transfer coefficients in two phases and two resistance theory of interphase mass transfer turbulence in the environment – fundamentals of heat transfer – analogy theories of momentum, heat and mass transfer.

UNIT III EXCHANGE RATES BETWEEN AIR AND WATER 8

Desorption of gases and liquids from aerated basins and rivers – completely mixed basin – plug flow basin – gas exchange rates between the atmosphere and the surface of rivers – exchange of chemical across the air – water interface of lakes and oceans.

UNIT IV EXCHANGE RATES BETWEEN WATER AND THE EARTHERN MATERIAL 9

Dissolution of chemicals on the bottom of flowing streams – geometric forms – stream bottom mass transfer coefficients – natural convection dissolution – the upsurge of chemicals from the sediment – water interface of lakes – a Fikian analysis – annual upsurge rate at sediment – water interface – mass transfer coefficients at the sediment – water interface. Flux of chemicals between sediment and the overlying seawater – movement of chemicals through the benthic boundary layer.

UNIT V EXCHANGE RATES BETWEEN AIR AND SOIL 9

Turbulence above the air – soil interface – the Richardson number – chemical flux rates through the lower layer of the atmosphere – Thronthwaite – Holzman equation – evaporation of liquid chemicals spilled on land – chemical flux rates through the upper layer of earthern material.

TOTAL : 4 5

REFERENCES

1. Thibodeaux, L.J, “Environmental Chemo dynamics: Movement Of Chemicals In Air, Water and Soil”, edition 2., Wiley - Interscience, New York, 1996.
2. Cusssler, E.L, “Diffusion: Mass Transfer In Fluid Systems, “Cambridge University press, 1994

ES9314 PRINCIPLES AND DESIGN OF PHYSICO-CHEMICAL TREATMENT SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVE:

To educate the students on the working principles and design of various physical and chemical treatment systems for water and wastewater.

UNIT I CLASSIFICATION OF POLLUTANTS 5

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

UNIT II PHYSICAL TREATMENT PRINCIPLES 8

Principles of Screening – Mixing, Equalization – Sedimentation – Filtration – Modeling back washing – Evaporation – Incineration – gas transfer – mass transfer coefficient Adsorption – Isotherms – Principles, kinetics, regeneration membrane separation, Reverse Osmosis, nano filtration, ultra filtration and hyper filtration electrodialysis, distillation – stripping and crystallization – Recent Advances.

UNIT III CHEMICAL TREATMENT PRINCIPLES 7

Principles of Chemical treatment – Coagulation flocculation – Precipitation – flotation solidification and stabilization – Disinfection, Ion exchange, Electrolytic methods, Solvent extraction – advanced oxidation /reduction – Recent Trends

UNIT IV DESIGN OF MUNICIPAL WATER TREATMENT PLANTS 15

Selection of Treatment – Design of municipal water treatment plant units – Aerators – chemical feeding – Flocculation – clarifies – tube settling – filters – Rapid sand filters slow sand filter, pressure filter, Dual media inlets Displacement and gaseous type. Design of Industrial Water Treatment Units- Selection of process – Design of softeners – Demineralisers –Reverse osmosis plants –flow charts – Layouts –Hydraulic Profile PID construction and O&M aspects – case studies, Residue management – Upgradation of existing plants – Recent Trends – Software application.

UNIT V DESIGN OF WASTEWATER TREATMENT PLANTS 10

Design of municipal wastewater treatment units-screens-detritors-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, Residue management – Upgradation of existing plants – Recent Trends – Software application.

TOTAL: 45 PERIODS

REFERENCES:

1. Metcalf and Eddy, Wastewater Engineering, Treatment and Reuse, Tata McGraw Hill, New Delhi, 2003.
2. Qasim, S.R., Motley, E.M. and Zhu.G. Water works Engineering – Planning, Design and Operation, Prentice Hall, New Delhi, 2002.
3. Lee, C.C. and Shun dar Lin, Handbook of Environmental Engineering Calculations, Mc Graw Hill, New York, 1999.
4. Hendricks, D. 'Water Treatment Unit Processes – Physical and Chemical' CRC Press, New York, 2006.

ES9315 AIR POLLUTION CONTROL L T P C
3 0 0 3

OBJECTIVE:

To impart knowledge on the principle and design of control of Indoor/ particulate/ gaseous air pollutant and its emerging trends.

UNIT I INTRODUCTION 7

Structure and composition of Atmosphere – Definition, Scope and Scales of Air Pollution – Sources and classification of air pollutants and their effect on human health, vegetation, animals, property, aesthetic value and visibility- Ambient Air Quality and Emission standards – Air Pollution Indices – Emission Inventories – Ambient and stack sampling and Analysis of Particulate and Gaseous Pollutants.

UNIT II METEOROLOGY 5

Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Atmospheric Diffusion Theories – Dispersion models, Software application, Plume rise, Effective stack height .

UNIT III CONTROL OF PARTICULATE CONTAMINANTS 11

Factors affecting Selection of Control Equipment – Gas Particle Interaction, – Working principle, Design and performance equations of Gravity Separators (cyclone) , Centrifugal separators Fabric filters, Particulate Scrubbers, Electrostatic Precipitators – Operational Considerations - Process Control and Monitoring – Costing of APC equipment – Case studies for stationary and mobile sources.

UNIT IV CONTROL OF GASEOUS CONTAMINANTS 11

Factors affecting Selection of Control Equipment – Working principle, Design and performance equations of absorption, Adsorption, condensation, Incineration, Bio scrubbers, Bio filters – Process control and Monitoring - Operational Considerations - Costing of APC Equipment – Case studies for stationary and mobile sources.

UNIT V INDOOR AIR QUALITY MANAGEMENT 11

Sources types and control of indoor air pollutants, sick building syndrome types – Radon Pollution and its control – Membrane process - UV photolysis – Internal Combustion Engines - Sources and Effects of Noise Pollution – Measurement – Standards –Control and Preventive measures.

TOTAL: 45 PERIODS

REFERENCES:

1. Lawrence K. Wang, Norman C. Parelra, Yung Tse Hung, Air Pollution Control Engineering, Tokyo, 2004.
2. Noel de Nevers, Air Pollution Control Engineering, Mc Graw Hill, New York, 1995.
3. David H.F. Liu, Bela G. Liptak ‘Air Pollution’, Lweis Publishers, 2000.
4. Anjaneyulu. Y, ‘Air Pollution and Control Technologies’, Allied Publishers (P) Ltd., India, 2002.
5. Arthur C.Stern, ‘ Air Pollution (Vol.I – Vol.VIII)’, Academic Press, 2006.
6. Wayne T.Davis, ‘Air Pollution Engineering Manual’, John Wiley & Sons,Inc.,2000.

ES9316 ENVIRONMENTAL CHEMISTRY LABORATORY

L	T	P	C
0	0	3	2

OBJECTIVE:

- To train in the analysis of physico-chemical parameters with hands on experience of various sources.

1. Good Laboratory Practices, Quality control, calibration of Glassware **3**
2. Sampling and Analysis of water (pH, alkalinity, hardness chloride, sulphate turbidity EC, TDS, nitrate, fluoride) **12**
3. Wastewater analysis (BOD, COD, Phosphate, TKN, Oil & Grease, Surfactant and heavy metals. **12**
4. Sampling and analysis of air pollutants Ambient & Stack (SPM, RPM, SO_2, NOx and CO) **9**
5. Sampling characterization of soil. (CEC & SAR, pH, heavy metals). **9**

TOTAL: 45 PERIODS

REFERENCES:

1. APHA, Standard Methods for the Examination of Water and Wastewater, 21st Ed. Washington, 2005.
2. Laboratory Manual for the Examination of water, wastewater soil Rump, H.H. and Krist, H. – Second Edition, VCH, Germany, 1992.
3. Methods of air sampling & analysis ,James P.Lodge Jr(Editor) 3rd Edition, Lewis publishers,Inc,USA,1989.

ES9317 ENVIRONMENTAL MICROBIOLOGY LABORATORY

L	T	P	C
0	0	3	2

OBJECTIVE:

- To train in the analysis of biological parameters with hands on experience of various sources.

1. Preparation of media,
2. Isolation and Identification of Microorganisms
3. Culturing of microorganisms,
4. Dehydrogenase activity of soil microbes,
5. Degradation of 2, 4-D,
6. Biodegradation of organic matter in waste water Analysis of air borne microorganisms,
7. Measurement of growth of microorganisms,
8. Staining of bacteria.
9. Effect of pH, temperature
10. Growth of Bacteria on carbon source.
11. Bacteriological analysis of wastewater (Coliforms, E-Coli, Streptococcus) – MPN
12. Bacteriological analysis of wastewater (Coliforms, Streptococcus) - MF techniques,
13. Microscopic study of phyto & Zooplankton,
14. Metal toxicity to microorganisms.
15. Detection of Anaerobic bacteria (clostridium sp.)

TOTAL: 45 PERIODS

REFERENCES:

1. Standard methods for the examination of water and wastewater, American public health Association (21st edition) 2005.
2. Pepper. L and Charles P. Gerba, Environmental Microbiology: A laboratory manual, Elsevier Publications, 2004.