BOARD OF STUDIES MEETING

M.Tech Degree (Environmental Engineering) Program

First Semester

THIAGARAJAR COLLEGE OF ENGINEERING

(A Government Aided ISO 9001-2008 certified

Autonomous Institution affiliated to Anna University)

MADURAI – 625 015, TAMILNADU

Phone: 0452 – 2482240, 41

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Web: www.tce.edu

Approved in BOS Meeting 27.08.11 Approved in 43rd Academic Council Meeting 12.11.11

CURRICULUM AND DETAILED SYLLABI

FOR

M.Tech DEGREE (Environmental Engineering) PROGRAM

First Semester

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2011-2012 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided ISO 9001-2008 certified
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Department of Civil Engineering

Graduating Students of M.Tech program of Environmental Engineering will be able to

1. Investigate, plan, Design and monitor the water supply, sewage collection and municipal solid waste collection system.
2. Identify the sources of wastewater, solid waste, air pollutants and specify the options of their reduction, recycle and reuse.
3. Quantify and characterize the various waste generated and specify their viable treatment methods and safe disposal alternatives.
4. Assess the various environmental impacts of any developmental projects and suggest appropriate measures for the up keeping of environment.
5. Achieve the goals of sustainable development by suitable Environmental Management system and by abiding National and International policies and legislations.
6. Work in a team using common tools and environment to achieve project objectives.

Thiagarajar College of Engineering, Madurai-625015

Department of Civil Engineering (Environmental Engineering)

Scheduling of Courses

Semester	Theory Courses						Practical / Project	
4th (12)							EN 41 Project Phase- II 0:12	
3rd (16)	EN 31 Environmental and Socio-Economic Impact Assessment 4:0	Elective V 4:0	Elective VI 4:0				EN 34 Project Phase – I 0:4	
2nd (24)	EN 21 Transport of water and wastewater 3:0	EN 22 Biological Treatment Processes 3:1	Elective I 4:0	Elective II 4:0	Elective III 4:0	Elective IV 4:0	EN 27 Seminar 0:1	
1st (24)	EN 11 Applied Statistics and Optimization 3:1	EN 12 Environmental Chemistry 3:1	EN 13 Environmental Microbiology 3:0	EN 14 Physico - Chemical Treatment Processes 3:1	EN15 Air Pollution Engineering 3:1	EN 16 Solid and Hazardous Waste Management 4:0	EN 17 Environmental Engineering Laboratory 0:1	

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

M.Tech DEGREE (Environmental Engineering) PROGRAM

SUBJECTS OF STUDY

(For the candidates admitted from 2011-2012 onwards)

FIRST SEMESTER

Subject code	Name of the subject	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
EN11	Applied Statistics and Optimization	BS	3	1	-	4
EN12	Environmental Chemistry	ES	3	1	-	4
EN13	Environmental Microbiology	ES	3	-	-	3
EN14	Physico - Chemical Treatment Processes	DC	3	1	-	4
EN15	Air Pollution Engineering	DC	3	1	-	4
EN16	Solid and Hazardous Waste Management	DC	4	-	-	4
PRACTICAL						
EN17	Environmental Engineering Laboratory	P	-	-	3	1
Total			**19**	**4**	**3**	**24**

BS : Basic Science
ES : Engineering Science
DC : Department Core
DE : Department Elective
L : Lecture
T : Tutorial
P : Practical

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit
2/3 Hours Practical is equivalent to 1 credit

SECOND SEMESTER

Subject code	Name of the subject	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
EN 21	Transport of Water and Wastewater	DC	3	-	-	3
EN 22	Biological Treatment Processes	DC	3	1	-	4
EN 2W	Elective I	DE	4	-	-	4
EN 2X	Elective II	DE	4	-	-	4
EN 2Y	Elective III	DE	4	-	-	4
EN 2Z	Elective IV	DE	4	-	-	4
PRACTICAL						
EN 27	Seminar	P	-	-	3	1
Total			**22**	**1**	**3**	**24**

THIRD SEMESTER

Subject code	Name of the subject	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
EN 31	Environmental and Socio Economic Impact Assessment	DC	4	-	-	4
EN 3X	Elective V	DE	4	-	-	4
EN 3Y	Elective VI	DE	4	-	-	4
PRACTICAL						
EN 34	Project Phase- I	P	-	-	12	4
Total			**12**	**-**	**12**	**16**

FOURTH SEMESTER

Subject code	Name of the subject	Category	No. of Hours / Week			credits
			L	T	P	
PRACTICAL						
EN 41	Project Phase- II	P	-	-	36	12
Total			**-**	**-**	**36**	**12**

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

M.Tech DEGREE (Environmental Engineering) PROGRAM

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2011-2012 onwards)

FIRST SEMESTER

S.No.	Sub. code	Name of the subject	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	EN11	Applied Statistics and Optimization	3	50	50	100	25	50
2	EN12	Environmental Chemistry	3	50	50	100	25	50
3	EN13	Environmental Microbiology	3	50	50	100	25	50
4	EN14	Physico - Chemical Treatment Processes	3	50	50	100	25	50
5	EN15	Air Pollution Engineering	3	50	50	100	25	50
6	EN16	Solid and Hazardous Waste Management	3	50	50	100	25	50
PRACTICAL								
7	EN17	Environmental Engineering Laboratory	3	50	50	100	25	50

* CA evaluation pattern will differ from subject to subject and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

** Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 50 marks for the award of terminal examination marks.

Sub Code	Lectures	Tutorial	Practical	Credit
EN11	3	1	-	4

EN11 Applied Statistics and Optimization **3:1**

(Common to IM11)

Preamble:

The correlation refers to the techniques used in measuring the closeness of relationship between the variables. When three or more variables are studied, it is a problem of either multiple or partial correlation. Estimators refer to the problem of determining the functions of sample observations such that the distribution is concentrated as closely as possible near the true value of the parameter. A stastical hypothesis is a quantitative statement about the probability distribution characterizing a population which we want to verify on the basis of information available from a sample. Non-Parametric or distribution free methods that often assume no knowledge whatsoever about the distributions of the underlying populations, except perhaps that they are continuous. In design of experiments we consider some aspects of experimental design briefly and analysis of data from such experiments using analysis of variance techniques.

Prerequisite: Probability and Statistics

Competencies: At the end of the course the student should be able to

1. Calculate the value which relates the dependent variable to one or more independent variables.
2. State a statistical inference from information contained in random samples about the populations from which the samples were obtained.
3. Demonstrate the characteristic of the population with degree of confidence from the random sample.
4. Determine the most reliable results of the population based on all the information available in a sample using non-parametric methods.
5. Calculate the experimental error and hence to control the extraneous variables involved in the experiment.

6. Determine the optimum values of unconstrained optimization problems using search methods.

Assessment Pattern

Sl.No.	Bloom's Category	Test I	Test II	Test III / End semester examination
1.	Remember	10	10	0
2.	Understand	30	30	30
3.	Apply	60	60	70
4.	Analyze	0	0	0
5.	Evaluate	0	0	0
6.	Create	0	0	0

Course Level Learning Objectives

Remember

1. Define Multiple Correlations.
2. What are estimators?
3. Define one tailed and two–tailed tests.
4. Mention the formula to test the hypothesis using Kolmogorov-smirnov test.
5. What is the aim of design of experiments?

Understand

1. In a large city A, 20% of a random sample of 900 school boys had a slight physical defect. In another large city B, 18.5% of a random sample of 1600 school boys had the same defect. Identify whether the difference between the proportions is significant or not.

2. The following information was obtained in a sample of 40 small general shops:

	Shops in areas	
	Urban	Rural
Owned by Men	17	18
Owned by Women	3	12

Discuss is it possible to say that there are more women owners in rural areas than in urban areas? Use Yate's Correction for continuity.

3. The following arrangement indicates whether sixty consecutive care which went by the toll booth of a bridge had local plates,L,or out-of state plates O: L L O L L L L O O L L L L O L O O L L L L O L O O L L L L L O L L L O L O L L L L O O L O O O O L L L L O L O O L L L O. Illustrate whether this arrangement of 's and O's may be regarded as random by using the level of significance $\alpha = 0.05$.
4. Comparing two kinds of emergency flares, a consumer testing service obtained the following burning times(rounded to the nearest tenth of a minute)

   Brand C : 19.4, 21.5, 15.3, 17.4, 16.8, 16.6, 20.3, 22.5, 21.3, 23.4, 19.7, 21.0.

   Brand D : 16.5, 15.8, 24.7, 10.2, 13.5, 15.9, 15.7, 14.0, 12.1, 17.4, 15.6, 15.8 .

   Use the Mann-Whitney test and a level of significance of 0.01 to check whether it is reasonable to say that there is no difference between the true average burning times of the two kinds of flares.
5. The following table shows the lives in hours of four brands of electric lamps brand.

   A: 1610 1610 1650 1680 1700 1720 1720 1800
   B: 1580 1640 1640 1700 1750
   C: 1460 1550 1600 1620 1640 1660 1740 1820
   D: 1510 1520 1530 1570 1600 1680.

   Perform an analysis of variance to test the homogeneity of the mean lives of the four brands of lamps.
6. To determine the effect on taste of three different factors in manufacturing soft-drink cans, an experiment was performed where the taste of one soft drink was rated by a judge on a scale from 1 to 10. The results are as follows:

A Lubricant	B Heat	C Resin	Ratings	
			Rep.1	Rep.2
Fresh	Unheated	A	6	8
Fresh	Unheated	B	8	7
Fresh	Heated	A	9	9
Fresh	Heated	B	1	2

Aged	Unheated	A	6	7
Aged	Unheated	B	6	8
Aged	Heated	A	9	8
Aged	Heated	B	2	3

Perform an analysis of variance and interpret the result.

Apply

1. If x_1, x_2 ,… x_n are random observations on a Bernoulli variable x taking the value 1 with probability θ and the value 0 with probability (1- θ), show that $\frac{\tau(\tau-1)}{n(n-1)}$ is an unbiased estimate of θ^2 where $\tau=\sum_{i=1}^{n} x_i$.

2. Calculate the M.L.E of the parameter α of the population having the density function $f(x,y)=\frac{2}{\alpha^2}(\alpha-x)$,0<x< α for a sample of unit size (single sample) and also Show that the estimate is biased.

3. Examine whether the two samples for which the data are given in the following table could have been drawn from populations with the same SD.

	Size	S.D
Sample 1	100	5
Sample 2	200	7

4. The heights of 10 males of a given locality are found to be 175, 168, 155, 170, 152, 170, 175, 160, and 165 cm. Based on this sample, determine the 95% confidence limits for the height of males in that locality.

5. The following are the number of minutes it took a sample of 15 men and 12 women to complete the application form for a position.

   Men: 16.5, 20.0, 17.0, 19.8, 18.5, 19.2, 19.0, 18.2, 20.8, 18.7, 16.7, 18.1, 17.9, 16.4, 18.9.

   Women: 18.6, 17.8, 18.3, 16.6, 20.5, 16.3, 19.3, 18.4, 19.7, 18.8, 19.9, 17.6.

Apply the Mann-Whitney test at the level of significance $\alpha = 0.05$ to the null hypothesis that the two samples come from identical population.

6. The following are the number of misprints counted on pages selected at random from the Sunday editions of a newspaper:

   April 11: 4, 10, 2, 6, 4, 12
   April 18: 8, 5, 13, 8, 8, 10
   April 25: 7, 9, 11, 2, 14, 7

   Apply Kruskal-Wallis test at the level of significance $\alpha = 0.05$ to test the null hypothesis that the three samples come from identical populations against the alternative that the compositors and/or proofreaders who worked on the three editions are not equally good.

7. To determine optimum conditions for a plating bath, the effects of sulfone concentration and bath temperature on the reflectivity of the plated metal are studied in a 2x5 factorial experiment. The results of three replicates are as follows:

Concentration (grams/liter)	Temperature (degrees F)	Rep.1	Rep.2	Rep.3
5	75	35	39	36
5	100	31	37	36
5	125	30	31	33
5	150	28	20	23
5	175	19	18	22
10	75	38	46	41
10	100	36	44	39
10	125	39	32	38
10	150	35	47	40
10	175	30	38	31

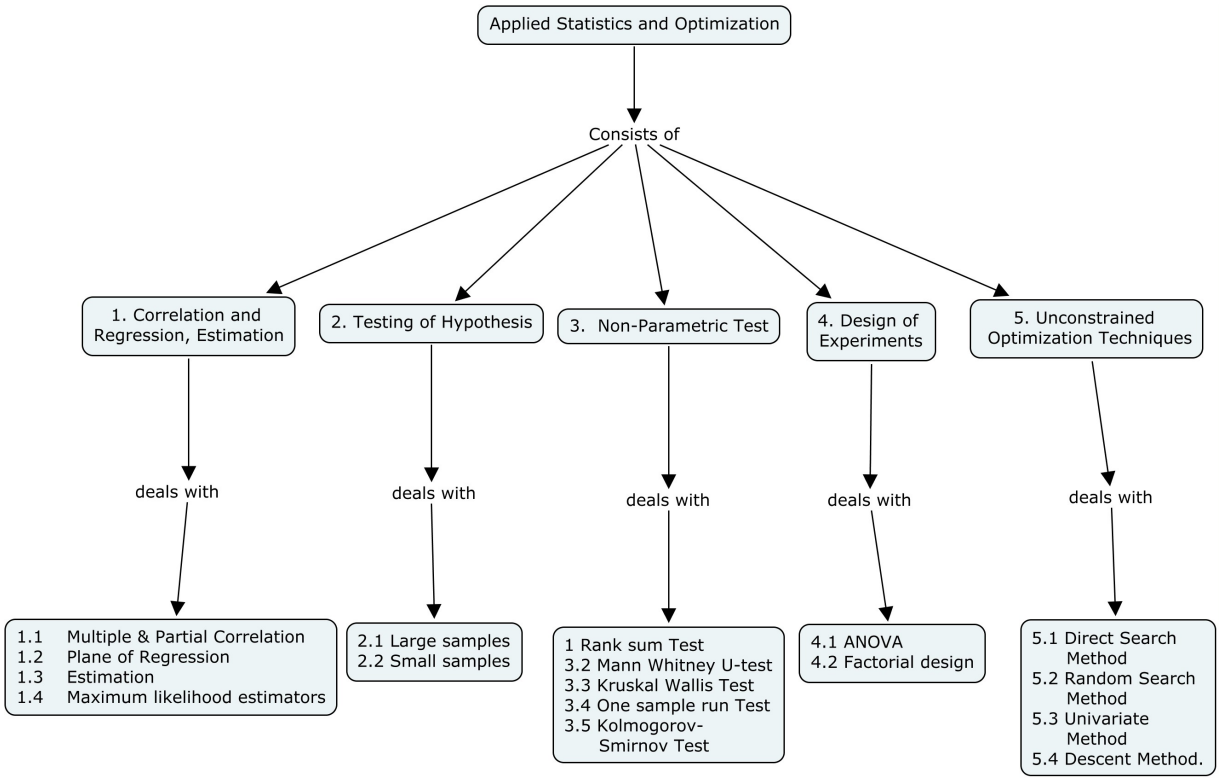
   Determine the bath condition or conditions that produce the highest reflectivity.

8. The following data resulted from an experiment to compare three burners B_1, B_2, B3. A latin square design was used as the tests were made on 3 engines and were spread over 3 days.

	Engine 1	Engine 2	Engine 3
Day 1	B_1-16	B_2-17	B_3-20
Day 2	B_2-16	B_2-21	B_1-15
Day 3	B_2-15	B_1-12	B_2-13

   Test the hypothesis and determine whether there is any difference between the burners.

Concept map



Course content and Lecture schedule

S.No	Topics	No.of Lectures
	Correlation & Regression Analysis, Sampling Distribution & Estimation	
1.1	Multiple and Partial Correlation	1
1.2	Yules notation, plane of regression	1
1.3	Coefficient of partial and multiple correlation-properties	1
1.4	Sampling-distribution statistics	2
1.5	Standard error, point and interval estimation for population mean, variance	2
1.6	Maximum likelihood estimators	1
	Testing of Hypothesis	
2.1	Testing of hypothesis-inferences concerning to means, variances	2

	and proportions	
2.2	t-test	2
2.3	Chi-Square test	2
2.4	F-test	2
	Non Parametric Tests	
3.1	Sign test of paired data	1
3.2	Rank Sum test	1
3.3	Mann Whitney U-test	1
3.4	Kruskal Wallis test	2
3.5	One sample run test	1
3.6	Kolmogorov-Smirnov test	2
	Design of Experiments	
4.1	Analysis of Variance-One way classification	1
4.2	Two way classification	2
4.3	Block randomized design	1
4.4	Latin Square design	1
4.5	Factorial design	2
4.6	Test of Significance of main and interaction effects	1
	Unconstrained Optimization Techniques	
5.1	Direct Search Method	1
5.2	Random Search Method	1
5.3	Univariate Method	1
5.4	Pattern search Method	2
5.5	Descent Method	1
5.6	Steepest Descent Method	2
	Total	**40**

Syllabus

Correlation & Regression Analysis, Sampling Distribution & Estimation Multiple and Partial Correlation,Yules notation, plane of regression, Coefficient of partial and multiple correlation-properties, Sampling-distribution statistics, Standard error, point and interval estimation for population mean, variance, Maximum likelihood estimators. **Testing of Hypothesis** Testing of hypothesis-inferences concerning to means, variances and proportions, t-test, Chi-Square test, F-test. **Non Parametric Tests** Sign test of paired

data**,** Rank Sum test, Mann Whitney U-test, Kruskal Wallis test, One sample run test, Kolmogorov-Smirnov test. **Design of Experiments** Analysis of Variance-One way classification, Two way classification, Block randomized design, Latin Square design, Factorial design, Test of Significance of main and interaction effects. **Unconstrained Optimization Techniques** Direct Search Method, Random Search Method, Univariate Method, Pattern search Method, Descent Method, Steepest Descent Method.

Reference Books

1. Irwin Miller, John E.Freund "Probability and Statistics for Engineers" Prentice Hall of India Pvt. Ltd.; New Delhi, 1977.
2. S.S Rao "Optimization Techniques". Wiley Eastern Ltd.; 1992.
3. T.Veerarajan "Probability, Statistics and Random Processes" Tata McGraw-Hill, New Delhi, 2003.
4. Ronald E.Walpole, Sharon L.Myers "Probability and Statistics for Engineers and Scientists". Eighth Edition, Pearson education, New Delhi, 2007.

Course Designers:

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Sub Code	Lectures	Tutorial	Practical	credit
EN 12	3	1	-	4

EN12 Environmental Chemistry 3:1

Preamble:

Environmental chemistry is the study of interaction of the chemicals in the environment with the biochemical systems that occur in nature. This course deals with the various aspects of chemical equilibrium and kinetics, pollution in the environment and its effects on the biological systems. This course is defined as the study of the sources, reactions, transport, effects of chemical species in the air, soil, and water environments; and the effect of human activity on these. This course is defined as interdisciplinary science that includes atmospheric, aquatic and soil chemistry, as well as analytical chemistry being related to environmental and other areas of science. This course also deals with control and remedy of various pollutants that affect water, soil and air

Competencies: Students will be able to

1. Understand the basic chemistry on the dissolution of solids, gases and various chemicals laws
2. Understand the importance of clean environment and effect of pollutants on water soil and atmosphere
3. Find out the source of pollution, prevention and control
4. Know the various chemical analysis and instrumentation techniques

Assessment Pattern:

Sl No.	**Bloom's Category**	**Test 1**	**Test II**	**Test III / End Semester**
1	Remember	10	10	20
2	Understand	20	20	40
3	Apply	20	20	40
4	Analyze	0	0	0
5	Evaluate	0	0	0

6	Create	0	0	0

Course level learning objectives under each Bloom's category

Remember

1. Define activity and activity coefficient
2. What do you mean by coagulation?
3. List out some soil pollutants
4. Mention any two functions of soil micro-organisms
5. What is Biochemical Oxygen Demand?
6. Write short notes on ozone layer depletion
7. Define the principle of flame photometry.

Understand

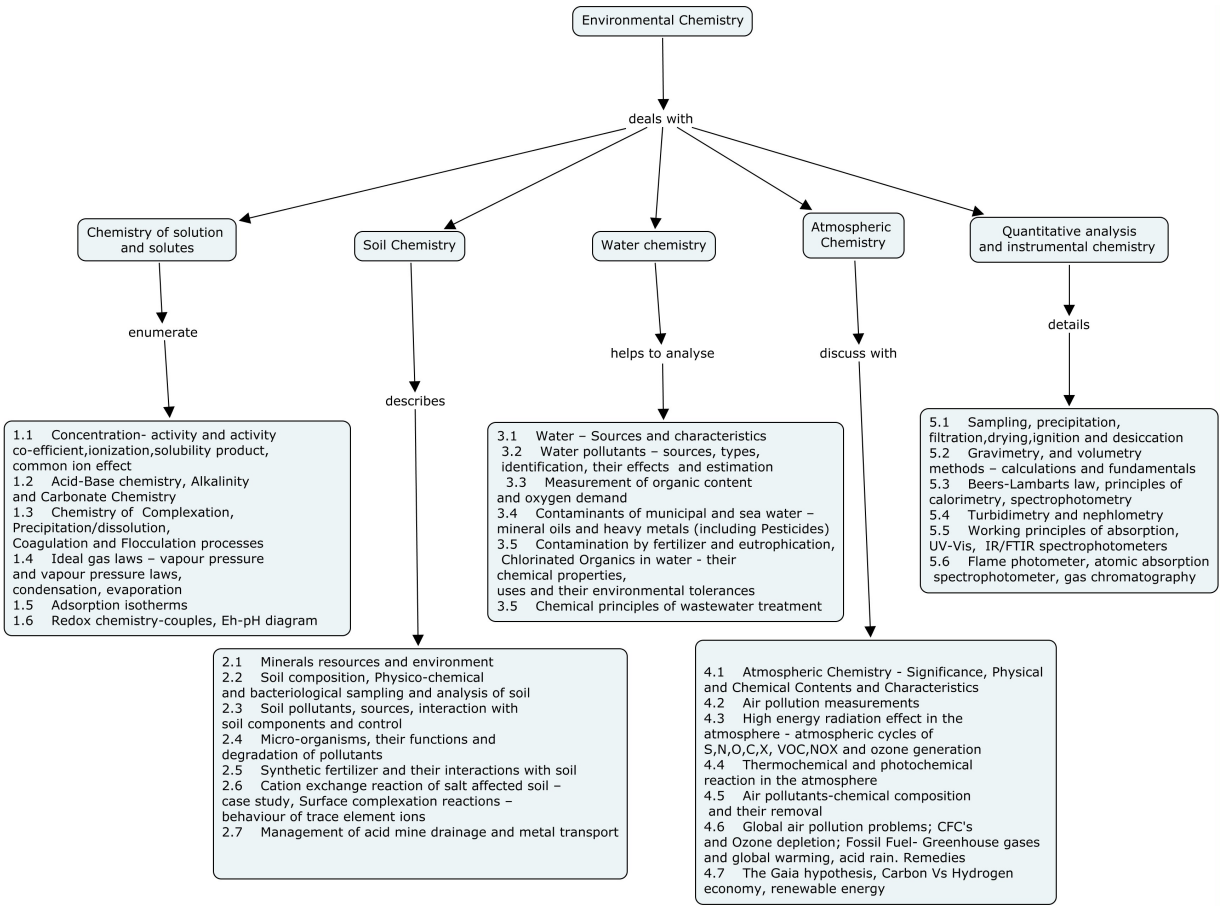
1. How the green house gases play a major role in global warming?
2. Explain the various chemical and photochemical reactions taking place in the atmosphere
3. How does colorimetric analysis differ from volumetric analysis?
4. Explain the various isotherms of adsorption
5. How the constituents of boiled water sample differs from ordinary water?
6. How the ion-exchange phenomena take place in the soil environment?

Apply

1. 100 ml of water sample has hardness equivalent to 15 ml of 0.01N of MgSO4. What is its hardness in ppm?
2. 150ml of sample of hardwater neutralizes exactly 15 ml of 0.15N HCl using methyl orange indicator. What kind of hardness is present? Express the same in terms of CaCO3 equivalent.
3. Calculate the amount of lime and soda required to soften 25,000L of water containing the following ions per litre; Mg^{2+}=5mg; Ca^{2+}=10mg; HCO_3^-=60 mg
4. Calculate the mole fraction of ethanol and water in a sample of rectified spirit which contains 50% of ethanol by mass

5. The Henry constant for oxygen gas content in water is 4.58×10^{-4} atm @ 293K. Calculate the amount of oxygen dissolved in 1L of water @ 293K when the gas pressure is 0.3 atm.
6. Find the molality of a solution containing a non-volatile solute if its vapour pressure is 2% below the vapour pressure of pure water

Concept Map



Course content and lecture schedule

S.No	Topic	No. of lectures
1	**Chemistry of solution and solutes**	
1.1	Concentration- activity and activity co-efficient, ionization, solubility product, common ion effect	2

1.2	Acid-Base chemistry, Alkalinity and Carbonate Chemistry	1
1.3	Chemistry of Complexation, Precipitation/dissolution, Coagulation and Flocculation processes	1
1.4	Ideal gas laws – vapour pressure and vapour pressure laws, condensation, evaporation	2
1.5	Adsorption isotherms	1
1.6	Redox chemistry-couples, Eh-pH diagram	1
2	**Soil Chemistry**	
2.1	Minerals resources and environment	1
2.2	Soil composition, Physico-chemical and bacteriological sampling and analysis of soil	2
2.3	Soil pollutants, sources, interaction with soil components and control	1
2.4	Micro-organisms, their functions and degradation of pollutants	1
2.5	Synthetic fertilizer and their interactions with soil	1
2.6	Cation exchange reaction of salt affected soil – case study, Surface complexation reactions – behaviour of trace element ions	2
2.7	Management of acid mine drainage and metal transport	1
3	**Water Chemistry**	
3.1	Water – Sources and characteristics	1
3.2	Water pollutants – sources, types, identification, their effects and estimation	1
3.3	Measurement of organic content and oxygen demand	1
3.4	Contaminants of municipal and sea water – mineral oils and heavy metals (including Pesticides),	2
3.5	Contamination by fertilizer and eutrophication, Chlorinated Organics in water - their chemical properties, uses and their environmental tolerances,	2
3.5	Chemical principles of wastewater treatment	1
4	**Atmospheric chemistry**	
4.1	Atmospheric Chemistry - Significance, Physical and Chemical Contents and Characteristics	1
4.2	Air pollution measurements	1
4.3	High energy radiation effect in the atmosphere - atmospheric cycles of	1

	S,N,O,C,X, VOC,NO_X and ozone generation,	
4.4	Thermochemical and photochemical reaction in the atmosphere	1
4.5	Air pollutants-chemical composition and their removal	1
4.6	Global air pollution problems; CFC's and Ozone depletion; Fossil Fuel-Greenhouse gases and global warming, acid rain. Remedies	2
4.7	The Gaia hypothesis, Hydrogen vs Carbon economy, renewable energy	1
5	**Quantitative analysis and Instrumental chemistry**	
5.1	Sampling, precipitation, filtration, drying , ignition and desiccation	1
5.2	Gravimetry, and volumetry methods – calculations and fundamentals	1
5.3	Beers-Lambarts law, principles of calorimetry, spectrophotometry	2
5.4	Turbidimetry and nephlometry	1
5.5	Working principles of absorption, UV-Vis, IR/FTIR spectrophotometers	1
5.6	Flame photometer, atomic absorption spectrophotometer, gas chromatography	1
	Total	**40**

Syllabus:

Chemistry of solutions and solutes: Concentration - activity and activity co-efficient, Ionization-solubility product-common ion effect, Acid-Base chemistry, Alkalinity and Carbonate Chemistry, Chemistry of Complexation, Precipitation, Coagulation and Flocculation processes, Ideal gas laws-vapour pressure and vapour pressure laws, condensation and evaporation, Adsorption isotherms - Redox chemistry-couples, Eh-pH diagram. **SOIL CHEMISTRY:** Minerals resources and environment-Soil composition-Physico-chemical and bacteriological sampling and analysis of soil, soil pollutants, sources, interaction with soil components and control, Micro-organism and their functions and degradation of pollutants, Synthetic fertilizer and their interactions with soil, Cation exchange reaction of salt affected soil – case study, Surface complexation reactions – behaviour of trace element ions - management of acid mine drainage and metal transport. **WATER CHEMISTRY:** Water–sources and characteristics, Water pollutants – sources, types, identification and estimation - their effects – Measurement of Organic Content and oxygen demand, contaminants of municipal and sea water – mineral oils and heavy metals (including Pesticides), Contamination by fertilizer and eutrophication, Chlorinated Organics in water - their chemical properties, uses and their environmental tolerances, Chemical principles of wastewater treatment.**ATMOSPHERIC CHEMISTRY:** Atmospheric Chemistry -

Significance, Physical and Chemical Contents and Characteristics, Air pollution measurements, High energy radiation effect in the atmosphere-atmospheric cycles of S,N,O,C,X, VOC,NO_X and ozone generation, Thermochemical and photochemical reaction in the atmosphere-Air pollutants-chemical composition and their removal, Global air pollution problems; CFC's and Ozone depletion; Fossil Fuel, Greenhouse gases and global warming, acid rain. Replacements for (CFCs), The Gaia hypothesis. Hydrogen vs Carbon economy, renewable energy. **QUANTITAIVE ANALYSIS AND INSTRUMENTAL CHEMISTRY:** Quantitative analysis - preparation of standard solution- Sampling, precipitation, filtration, drying-ignition and desiccation- Gravimetry and volumetric – calculations – fundamentals, Beer Lamberts law - Principles of calorimetry – spectrophotometry-– turbidimetry and nephlometry – working principle of absorption, UV-Vis, IR/FTIR spectrophotometers, Flame photometer, atomic absorption spectrophotometer, fluorimeter - gas chromatography.

Reference Books

1. Peter William Atkins and Julio De Paula, Physical Chemistry, W.H.Freeman, 2002
2. Dara.S.S Environmental Chemistry , 3rd Edition, S.Chand & Co, New delhi, 2001
3. Sawyer C.N and McCarty P.L and Parkin G.F. "Chemistry of Environmental Engineering", 4th Edn. McGraw Hill, Newdelhi, 1994.
4. Sharma B.K and Kaur H. "Environmental Chemistry", Goel Publishing House, Meerut, 3rd Ed., 1996-97
5. Environmental Chemistry, A.K. De, New Age International (P) Limited, Publishers, 3rd Ed., 1994
6. Stanley E. Manohar, Environmental Chemistry, Willard Grant Press, Beston Massachusetts,

Course Designer:

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Sub Code	Lectures	Tutorial	Practical	credit
EN 13	3	-	-	3

EN 13 ENVIRONMENTAL MICROBIOLOGY 3:0

Preamble:

Microbiology is the study of living organisms of microscopic size, which include bacteria, fungi, algae, protozoa and the infectious agents. It is concerned with their form, structure, reproduction, physiology, metabolism and classification. It includes the study of their distribution in nature, their relationship to each other and to other organisms, their effects on human beings and on other animals and plants, their abilities to make physical and chemical changes in our environment, and their reactions to physical and chemical agents.

Competencies: At the end of the course, the students will be able to

1. Isolate and identify different microbes present in various sources.
2. Understand the metabolism of microbes and its respiration.
3. Understand the role of microorganisms in various fields like drinking water, wastewater and to control the pollution.
4. To detect disease causing microbes in drinking water by using various methods.
5. Understand the ecological group of microbes.
6. To acquire knowledge in soil, aquatic air microbiology.

Assessment Pattern

S.No.	Bloom's Category	Test 1	Test 2	Test 3/End semester Examination
1	Remember	20	20	20
2	Understand	80	60	60
3	Apply	0	20	20
4	Analyse	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Course Level Learning Objectives

Remember

1. Define DNA and RNA
2. What are the factors which affects the growth of microbes?
3. List some of the water borne diseases caused by microbes.
4. Define indicator microorganism.
5. What are the various methods adopted for isolation of microbes?

6. Define bioconcentration and bioassay.

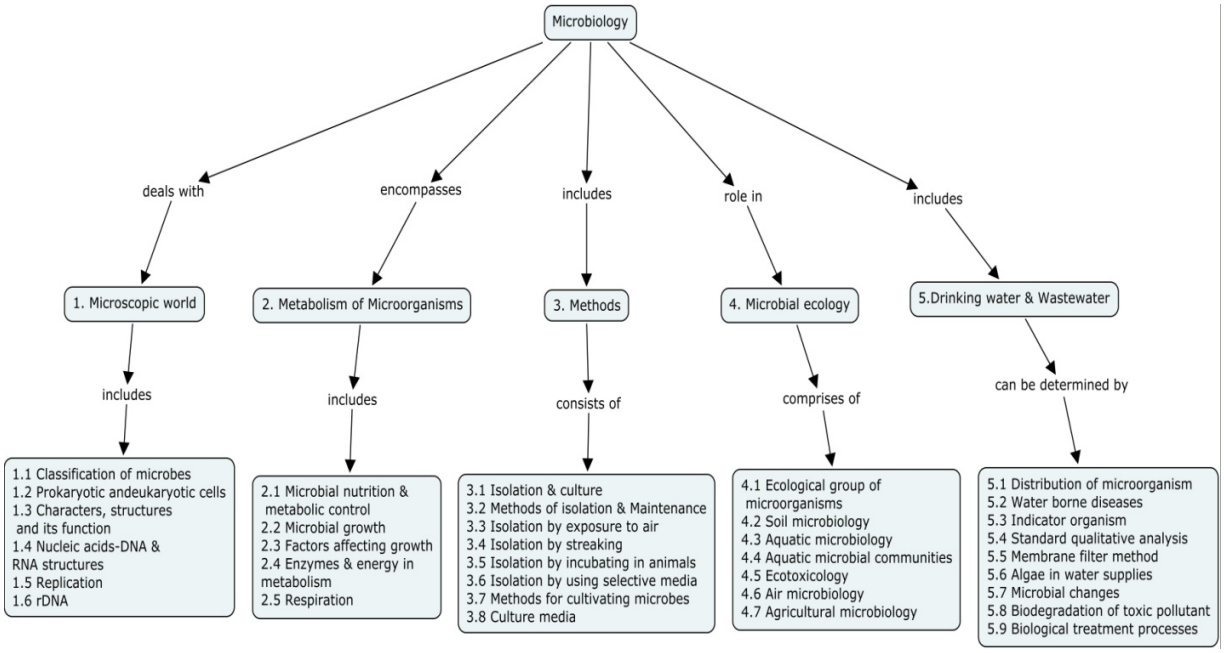
Understand

1. Distinguish between Prokaryotic and eukaryotic cells.
2. Explain rDNA technology.
3. Explain Glycolysis.
4. Compare the structure and chemistry of the cellwalls of gram positive versus gram negative bacteria.
5. Describe biodegradation of toxic pollutants.
6. Discuss the various types of media used for isolating microbes.
7. Discuss the methods for studying aquatic microbes.

Apply

1. Estimate the most probable number with different test.
2. Determine the factors that affect the growth of microbes.
3. Determine an enrichment procedure for an aerobic bacterial species that can use methane gas as a sole carbon and energy source.
4. Determine the three reactions in glycolytic pathway that are not freely reversible by the same specific enzymes.

Concept map



Course content and Lecture schedule

S.No	Topic	No. of Lectures
1.	**MICROSCOPIC WORLD**	
1.1	Microorganisms – classification	1
1.2	Prokaryotic and Eukaryotic cells	1
1.3	Characters, Structure and its functions	1
1.4	Nucleic acids - DNA and RNA Structures	1
1.5	Replication	1
1.6	rDNA technology	1
2.	**METABOLISM OF MICRO – ORGANISMS**	
2.1	Microbial nutrition and metabolic control.	1
2.2	Microbial growth: growth curve – measurement of growth, parameters of growth, growth in batch culture	2
2.3	Factors affecting growth	1
2.4	Enzymes and energy in metabolism, Carbohydrate, protein and lipid metabolism	1
2.5	Respiration – Glycolysis	1
3.	**ISOLATION METHODS**	
3.1	Isolation & culture of microorganisms	1
3.2	Methods of isolation & maintenance of pure culture	1
3.3	Isolation by exposure to air, by streaking	1
3.4	Isolation by incubating in animals	1
3.5	Isolation by using selective or enrichment media	1
3.6	Methods for culturing anaerobes	1
3.7	Culture media – characteristics of a media, types of media, preparation of media. Staining & smearing	2
4.	**MICROBIAL ECOLOGY**	
4.1	Ecological group of microorganism – based on oxygen requirement, carbon source, temperature, habitat, nutrient	2
4.2	Soil microbiology – soil microbes, rhizosphere microorganism, organic matter decomposition, biogeochemical cycle.	2
4.3	Aquatic microbiology – methods of studying aquatic	2

	microorganism – direct & indirect technique.	
4.4	Aquatic microbial communities – Marine environment, Estuarine environment & freshwater environment.	1
4.5	Ecotoxicology – bioconcentration – bioaccumulation – biomagnifications – bioassay – biomonitoring.	1
4.6	Air microbiology – indoor aeromicrobiology.	1
4.7	Agricultural microbiology.	1
5.	**MICROBIOLOGY OF DRINKING WATER & WASTEWATER**	
5.1	Distribution of microorganisms in drinking water	1
5.2	Water borne bacterial diseases	1
5.3	Indicator microorganism	1
5.4	Standard qualitative analysis of water - Presumptive test, Confirmed test and Completed test	1
5.5	Membrane filter method	1
5.6	Algae in water supplies – problems & control	1
5.7	Microbial changes induced by inorganic and organic pollutants..	1
5.8	Biodegradation of toxic pollutants - alpha-oxidation, Beta-oxidation, dehalogenation mechanism	1
5.9	Microbiology of biological treatment processes	1
	Total	**40**

Syllabus

MICROSCOPIC WORLD: Microorganisms – classification, Prokaryotic and Eukaryotic cells - Characters, Structure and its functions. Nucleic acids - DNA and RNA Structures. Replication. rDNA technology. **METABOLISM OF MICRO – ORGANISMS:** Microbial nutrition and metabolic control. Microbial growth: growth curve – measurement of growth, parameters of growth, growth in batch culture and factors affecting growth. Enzymes and energy in metabolism, Carbohydrate, protein and lipid metabolism. Respiration – Glycolysis. **ISOLATION METHODS:** Isolation & culture of microorganisms. Methods of isolation & maintenance of pure culture – Isolation by exposure to air, by streaking, by incubating in animals, by using selective or enrichment media. Methods for culturing anaerobes. Culture media – characteristics of a media, types of media, preparation of media. Staining & smearing. **MICROBIAL ECOLOGY:** Ecological group of microorganism – based on oxygen requirement, carbon source, temperature, habitat, nutrient. Soil microbiology – soil

microbes, rhizosphere microorganism, organic matter decomposition, biogeochemical cycle. Aquatic microbiology – methods of studying aquatic microorganism – direct & indirect technique. Aquatic microbial communities – Marine environment, Estuarine environment & freshwater environment. Ecotoxicology – bioconcentration – bioaccumulation – biomagnifications – bioassay – biomonitoring. Air microbiology – indoor aeromicrobiology. Agricultural microbiology.**MICROBIOLOGY OF DRINKING WATER & WASTEWATER:** Distribution of microorganisms in drinking water . Water borne bacterial diseases. Indicator microorganism. Standard qualitative analysis of water - Presumptive test, Confirmed test and Completed test. Membrane filter method. Algae in water supplies – problems & control. Microbial changes induced by inorganic and organic pollutants. Biodegradation of toxic pollutants - alpha-oxidation, Beta-oxidation, dehalogenation mechanism - Microbiology of biological treatment processes.

Reference Books

1. Stainer R.V and Ingrahum J.L., Wheelis M.C. and Painter P.R. "General Microbiology",MacMillan Edn Ltd., London, 1989.
2. Pelczar, M.I; E.C.Schan and N.R. Kreig, 2000, Microbiology, fifth edition, Tata McGraw Hill Publishing Company Limited, New Delhi.
3. Anthony Gaudy and Elizabeth Gaudy "Micro Biology for Envirorunental Scientists and Engineers ", McGraw Hill international Book Company, New De1hi, 1981.
4. Prescott,L.M., IP.Harley and D.AHelin, 2002, Microbiology, fifth edition, McGraw Hill, New York.
5. Pitchai R.and Govindan V.S.(eds) "Biological Processes in Pollution Control", Anna University, Madras,1988.

Course Designer

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Sub Code	Lectures	Tutorial	Practical	Credit
EN14	3	1	-	4

EN 14 Physico – Chemical Treatment Processes 3:1

Preamble

Wastewater generated from a community must be properly treated to get rid off from its harmfulness before being disposed into any natural system either water bodies or land. Physical operations are needed for the removal of floating, suspended and colloidal matters present in the wastewater. Chemical processes like coagulation, oxidation, and neutralization are required for the conversion of the harmful chemical components amenable for physical removal subsequently.

Competencies: At the end of the course, the student should be able to

1. Characterize the water and wastewater and identify the necessary treatment units in order to remove its harmfulness.
2. Design the sedimentation and filtration treatment units to remove the suspended and finely divided solids present in the water and wastewater.
3. Design chemical treatment system for the conversion of harmful components of water and wastewater into harmless components or change their state amenable for physical removal.
4. Design disinfection and adsorption treatment units required for the removal of pathogens and other undesirable compounds in water and wastewater.

Assessment Pattern

S.No	Blooms Category	Test – 1	Test – 2	Test – 3 / End semester examination
1	Remember	-	-	-
2	Understand	60	50	50
3	Apply	40	50	50
4	Analyze	-	-	-
5	Evaluate	-	-	-
6	Create	-	-	-

Course Level Learning Objectives

Understand

1. What are the objectives of water quality standards?

2. What are the needs for mixing and flocculating devices? What are the different types of mixers is use?
3. What is discrete particle settling? Derive an equation for settling velocity.
4. Explain the different removal mechanisms postulated in depth filtration.
5. Explain the theory of coagulation and the factors influencing.
6. What are the factors influencing chlorination process? Explain.
7. What is Ion-exchanging capacity? How could it be determined?

Apply

1. Determine the settling velocity of a sand particle with specific gravity of 2.65 and a diameter of 1.0mm. Take Reynolds number as 275.
2. A rectangular settling tank has an overflow rate of 30 m3/m2d and dimensions of 2.75m deep by 6m wide by 15m long. Determine whether or not particles with diameter of 0.1mm and a specific gravity of 2.50 will be scoured from the bottom. Use f=0.03 and k=0.04
3. The following data were obtained from a test program designed to evaluate a new diffused air aeration system. Using these data, determine the value of Kl.a at 20°C and the equilibrium dissolved oxygen concentration in the test tank. The test program was conducted using tap water at 24°C temp.

Cmg/L	1.5	2.7	3.9	4.8	6.0	7.0	8.2
dc/dt	8.4	7.5	5.3	4.9	4.2	2.8	2.0

4. The chlorine residual measured when various dosages of chlorine were added is given below.Determine the breakpoint dosage and design dosage to obtain a residual of 1.0mg/L free available chlorine.

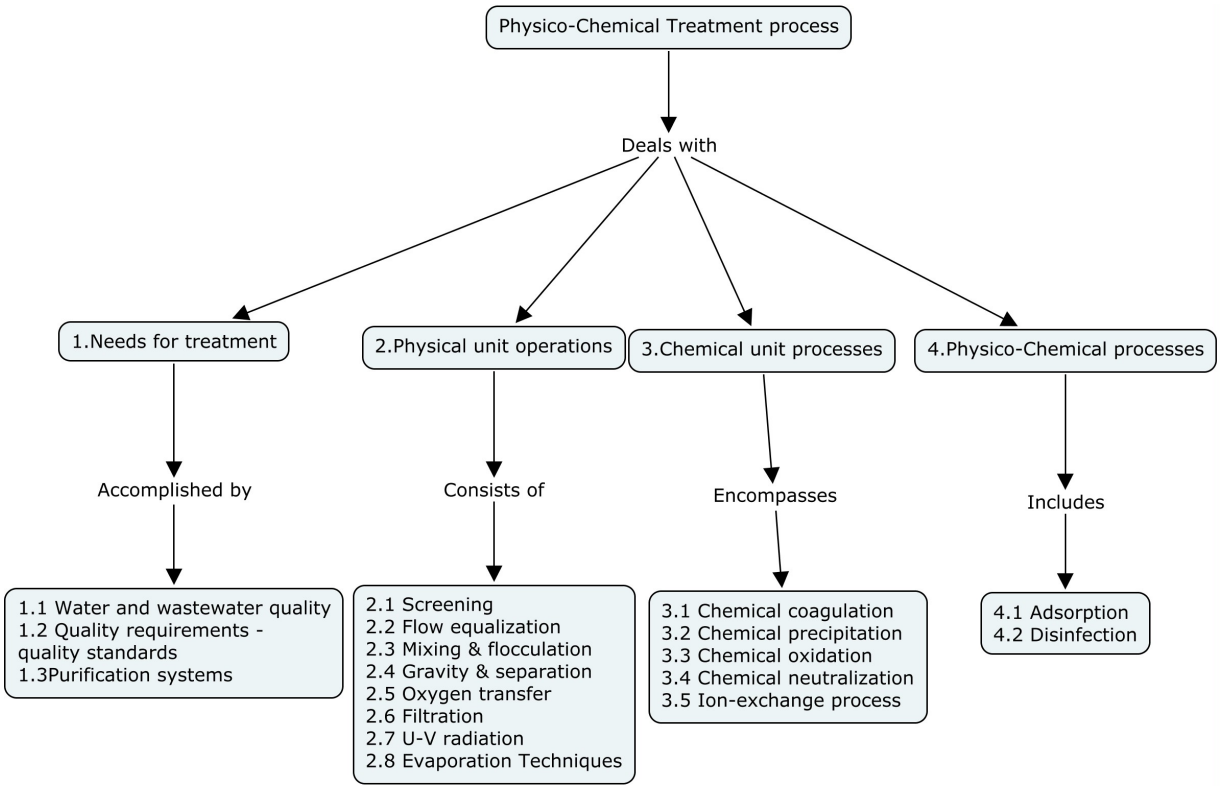
Dosage mg/L	1	2	3	4	5	6	7	8
Residual mg/L	0.95	1.70	2.3	1.9	1.0	1.7	2.7	1.6

5. Using the following carbon adsorption data, determine the Frendlich capacity factor and Frendlich intensity parameters.

Carbon dose mg/L	0	5	10	25	50	100	150	200
Residual Concmg/L	27.5	24.8	24.2	18.9	11.8	2.30	1.10	0.90

6. Determine the headloss through a 750mm sand bed for a filtration rate 240 L/m2 min. The sand bed is composed of spherical unisized sand with a diameter of 0.50mm and a porosity of 0.40. Kinematic viscosity is equal to 1.306×10^-6 m2/s. Use Rose equation.

Concept map



Course content and Lecture schedule

No	Topic	No. of Lectures
1.	**Needs for treatment**	
1.1	Water and wastewater quality – physical, chemical and biological parameters	1
1.2	Quality requirements – Water quality standards – effluent standards	1
1.3	Water purification system – physical processes, chemical processes and biological processes	1
2.	**Physical unit operations**	
2.1	Screening – classification of screens	1
2.2	Flow equalization – Equalization basin – design	1
2.3	Mixing and flocculation – types of mixers for rapid mixing and flocculation	1
2.4	Gravity separation – settling theory – discrete particle settling	2
2.4.1	Flocculant particle settling – tube settling	1
2.4.2	Hindered settling – batch analysis – solid flux analysis.	2
2.4.3	Sedimentation tanks – performances – design criteria and design.	2
2.4.4	Flotation – types	1
2.5	Oxygen transfer – two film theory – aeration systems – types	2
2.6	Filtration – depth filtration – process and physical features	1
2.6.1	filtration process analysis – problems	2
2.6.2	Types of filters – performances	2
2.7	Membrane filtration – process – operation – Applications	2
2.8	Evaporation Techniques	1
3.	**Chemical Unit Processes**	
3.1	Chemical coagulation – theory	1
3.2	Chemical precipitation – chemicals used	2
3.3	Chemical oxidation – applications	2
3.4	Chemical neutralization	1
3.5	Ion –exchange process - Chemistry of ion – exchange –	2

	applications of ion – exchange	
4.	**Physico-Chemical Processes**	
4.1	Adsorption – fundamentals of adsorption	1
4.1.1	adsorption isotherms	1
4.1.2	mass transfer zone – adsorption capacity – breakthrough curves	2
4.1.3	column test	1
4.2	Disinfection – theory – factors influencing	1
4.2.1	Chlorination – breakpoint – process variables – chlorine dosage – dechlorination	2
4.2.2	Disinfection with ozone	1
4.2.3	U-V radiation disinfection	1
	Total	**40**

Syllabus

Water and wastewater quality – physical, chemical and biological parameters. Quality requirements – Water quality standards – effluent standards. Water purification system – physical processes, chemical processes and biological processes. Physical unit operations – screening – classification of screens. Flow equalization – Equalization basin – design. Mixing and flocculation – types of mixers for rapid mixing and flocculation. Gravity separation – settling theory – discrete particle settling – flocculant particle settling – tube settling – Hindered settling – batch analysis – solid flux analysis. Sedimentation tanks – performanmces – design criteria and design. Flotation – types. Oxygen transfer – two film theory – aeration systems – types. Filtration – depth filtration – process and physical features – filtration process analysis – problems – types of filters – performances. Membrane filtration – process – operation – Application, Evaporation Techniques. Chemical unit processes – chemical coagulation – theory – chemical precipitation – chemicals used. Chemical oxidation – applications. Chemical neutralization – Ion –exchange process - Chemistry of ion – exchange – applications of ion – exchange. Adsorption – fundamentals of adsorption – adsorption isotherms – mass transfer zone – adsorption capacity – breakthrough curves – column test. Disinfection – theory – factors influencing – chlorination – breakpoint – process variables – chlorine dosage – dechlorination. Disinfection with ozone – U-V radiation disinfection.

Reference Books

1. Fair, G.M., Geyer J.C. & okun D.A,"Water and waste water Engg.Vol.2. Wiley Eastern Ltd, Newyork 1996.
2. Metcalf & Eddy,"Waste water Engineering treatment, Disposal & Reuse,"Tata-McGraw Hill, 2006.
3. Mackenzie L.Davis, David A.Cornwell, 'Introduction to Environmental Engineering", McGraw Hill, 1998.
4. Manual on Water supply and treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi.
5. Casey, T.J. Unit treatment process in Water and Waste Water Engineering, John Wiley and sons, London 1993.
6. Qasim,S.R.,"Water works Engineering,Planning,Designing&Operation,Prentice Hall(India) Ltd,2006.

Course Designer

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Sub Code	Lectures	Tutorial	Practical	credit
EN 15	3	1	-	4

EN 15 Air Pollution Engineering **3:1**

Preamble:

Atmosphere is the easiest disposal medium for all activities of human being be it household burning or industrial combustion or burning of fuels in the motor vehicles, even particulate and gaseous emissions from natural sources joining hands in the issue. Meteorological factors prevailing either aggrevate or passify the pollution problem. Controlling and reducing the particulate and gaseous contaminants emission into atmosphere by appropriate city planning and enforcement of legal provisions for the upkeeping of the ambient air quality standards alone would lead to the achievement of ambient air quality goals.

Competencies: At the end of the course, the student should be able to

1. Understand the effects of air pollution in local, regional and global level and the sources of such pollutants.
2. Derive a mathematical model for the prediction of dispersion of pollutants concentration.
3. Suggest and design appropriate control devices for the emission of particulate and gaseous pollutants from a particular source.
4. Impress upon the stakeholders in maintaining air quality standards, enforcing laws and adhering to city planning norms.
5. Identify the sources of noise and its possible control measures for the well being of the industrial workers and general public.

Assessment Pattern

S.No	Blooms Category	Test – 1	Test – 2	Test – 3 / End semester examination
1	Remember	20	20	20
2	Understand	60	60	60
3	Apply	20	20	20
4	Analyze	-	-	-
5	Evaluate	-	-	-
6	Create	-	-	-

Course Level Learning Objectives

Remember

1. Define adiabatic lapse rate
2. What is mixing height?
3. What is plume rise?
4. Define stoke's law
5. What are VOCs?
6. Define crankcase emission
7. Define Ambient air quality standards
8. Define Lequ & L50
9. What is atmospheric stability?
10. Define primary and secondary pollutants.

Understand

1. Explain, how do prevailing lapse rate affect the plume behavior from a stack.
2. Explain the Gaussian dispersion model for the pollutants from a point source.
3. How do an ESP work? What are the factors governing its performances?
4. What are the control strategies in automotive pollution? Explain
5. How do scrubbers are classified? Explain them clearly
6. What are the various source reduction methods possible in the control of air pollution?
7. Explain the impacts of noise on human beings. How could it be controlled?

Apply

1. A dumpsite fire emits 3g/s of NOx, Determine the NOx concentration at 2km downwind if the windspeed U10=5 m/s and the stability is class D. What is the maximum concentration at ground level and also at 50m above ground?
2. A 915 MW power plant with a load factor of 72.5% and efficiency of 40% uses coal as a fuel source. The coal has a 1% sulphur content and a calorific value of 30 MJ/kg. The stack tip is 200m high with a diameter of 7m. If neutral condition prevails, determine the maximum ground level concentration of SO2 at 10km from the plant. U10=4 m/s, Ts=150°C Ta=20°C and Vs=15 m/s.
3. An air conditioner generates a noise level of 75 dB for five minutes every hour. If the background noise level is 55 dB, Compute the Lequ.
4. Determine the effective height of a stack, given the following data:
   Physical stack is 170m tall with a 1.25m inside diameter

Wind velocity is 5.17m/s

Air temperature is 18°C

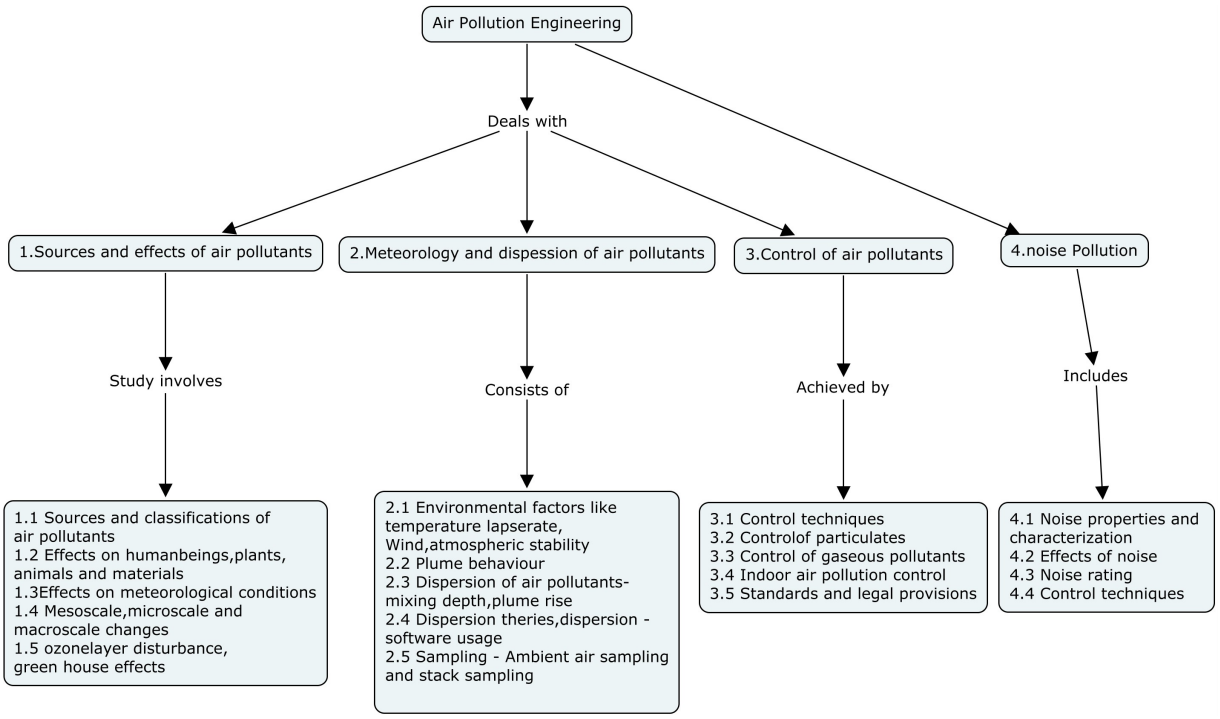
Barometeric pressure is 1.0 bar

Stack gas velocity is 8.75 m/s

Stack gas temperature is 128°C

5. Determine the size of a cyclone that will remove a 15μm particle with 50% efficiency from an air stream of 6.0 m3/min. The temperature of the air is 75°C and the specific gravity of the particle is 1.50. Assume five turns.
6. A cross flow scrubber is collecting 90% of the 3μm particle entering. The water drops are all of the same diameter, 400μm. If a new spray nozzle system is installed that make all the drops to 200μm in diameter. The flow is not changed. What will be the new collection efficiency?

Concept map



Course content and Lecture schedule

S.No	Topic	No. of Lectures
1.	**Sources and effects of air pollutants**	
1.1	Sources and classification of air pollutants	1
1.2	Effects of air pollutants – on human, plants, animals, materials	2
1.3	Effects of air pollutants - On meteorological conditions	1
1.4	Mesoscale,microscale and macroscale changes	2
1.5	Ozone layer disturbance, green house effects	1
2.	**Meteorology and dispersion of air pollutants**	
2.1	Environmental factors – Temperature lapse rate, wind, atmospheric stability	2
2.2	Plume behavior	1
2.3	Dispersion of air pollutants – mixing depth, plume rise	2
2.4	Dispersion theories, dispersion models- Software usage - ISCST3	2
2.5	Sampling – Ambient air sampling, Stack sampling	2
3.	**Control of air pollutants**	
3.1	control techniques – Improved dispersion, source reduction methods, pollution control devices	2
3.2	Control of particulates – Nature of particulate pollutants, stokes law	1
3.2.1	wall collection devices – Gravity settlers, cyclone separators	1
3.2.2	Electrostatic precipitators	2
3.2.3	surface filters	1
3.2.4	scrubbers for particulate control	1
3.3	Control of gaseous pollutants – control of VOCs – control by prevention – control by concentration and recovery – control by oxidation	2
3.3.1	Control of sulphur oxides – recovery of So2 – control of NOx	2
3.3.2	Control of automotive pollution – IC engines – types of pollutants – sources of emission – control methods.	2
3.4	Indoor air pollution control – models for indoor air – control of air quality	2

3.5	Standards and legal provisions – air quality standards – ambient standards, emission standards and trading. Air pollution legislation and regulations.	2
	Industrial plant location and city planning	1
4.	**Noise pollution**	
4.1	Noise properties of sound waves, characterization of noise, noise spectrum	2
4.2	Effects of noise	1
4.3	Noise rating system	1
4.4	Noise control techniques	1
	Total	**40**

Syllabus

Introduction: Sources and classification of air pollutants.Effects of air pollutants – on human, plants, animals, materials - On meteorological conditions-Mesoscale,microscale and macroscale changes-Ozone layer disturbance, green house effects. Meteorology and dispersion – Environmental factors – Temperature lapse rate, wind, atmospheric stability, plume behavior. Dispersion of air pollutants – mixing depth, plume rise, dispersion theories, dispersion models, Software usage - ISCST3. Sampling – Ambient air sampling, Stack sampling. Control techniques – Improved dispersion, source reduction methods, pollution control devices. Control of particulates – Nature of particulate pollutants, stokes law, wall collection devices – Gravity settlers, cyclone separators, Electrostatic precipitators, surface filters, scrubbers for particulate control. Control of gaseous pollutants – control of VOCs – control by prevention – control by concentration and recovery – control by oxidation. Control of sulphur oxides – recovery of So2 – control of NOx. Control of automotive pollution – IC engines – types of pollutants – sources of emission – control methods. Indoor air pollution control – models for indoor air – control of air quality. Standards and legal provisions – air quality standards – ambient standards, emission standards and trading. Air pollution legislation and regulations. Industrial plant location and city planning. Noise pollution and control – Noise properties of sound waves, characterization of noise. Effects of noise – noise rating system – noise control techniques.

Reference Books

1. Lawrence K.Wang, Norman C Pererla, Yung – Tse Hung, "Air Pollution Control Engineering", Tokyo, 2004.

2. Noel de Nevers, Air Pollution Control Engg., McGraw – Hill, New York, 1995.
3. David H.F Liu, Bela G.Liptak "Air Pollution", Lewis Publishers, 2000.
4. Anjaneyalu.Y, "Air Pollution & Control Technologies", Allied Publishers (P) Ltd, India, 2002.
5. Mackenzie L Davis and David A Corwell, "Introduction to Environmental Engineering" McGraw Hill Publishers, 1998.

Course Designers

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Sub Code	Lectures	Tutorial	Practical	credit
EN 16	4	0	0	4

EN 16 SOLID AND HAZARDOUS WASTE MANAGEMENT 4:0

Preamble:

This course work provides an in depth understanding of solid and hazardous waste characteristics and management. The students acquire proficiency in processing technologies and disposal methods for municipal solid waste and hazardous waste generated from a community.

Competencies: At the end of the course, the student should be able to

1. Estimate the waste generated by a community
2. Understand the factors that affect generation of waste
3. Explain the frame work of resource management such as 4R concepts.
4. List the collection methods, collection vehicles & man power requirement.
5. Identify the optimum collection routes.
6. Identify the location of transfer station and disposal site.
7. Explain the engineering and scientific details of processing of solid wastes and resource recovery.
8. Plan the methods of disposal of solid waste.
9. Understand the treatment, storage, and disposal facility for hazardous waste.
10. Identify and classify the hazardous wastes.
11. Describe the physical, chemical and biological methods of treating hazardous waste.
12. Explain the techniques of remediation and contamination discuss the concept of integrated waste management

Assessment Pattern

S.No.	**Blooms Category**	**Test – 1**	**Test – 2**	**Test – 3 / End semester examination**
1	Remember	20	20	10
2	Understand	40	40	40
3	Apply	40	40	30
4	Analyze	0	0	20
5	Evaluate	0	0	0
6	Create	0	0	0

Course Level Learning Objectives

Remember

1. What are the different functional elements in municipal solid waste management?
2. What is the composition of a typical municipal solid waste?
3. List the chemical characteristics of a municipal solid waste?
4. What are the types of containers and collection vehicles used for solid waste management?
5. What are the characteristics of hazardous wastes?
6. What are the responsibilities of Hazardous waste generator?

Understand

1. Based on the source and type, classify the waste generated in your locality.
2. Discuss the factors that contribute to the generation of solid waste in a community?
3. Explain the role of a transfer station in solid waste management?
4. Explain the need for source reduction in waste management?
5. Differentiate recycling and reuse?
6. Explain the advantages of waste minimization in Hazardous waste management?

Apply

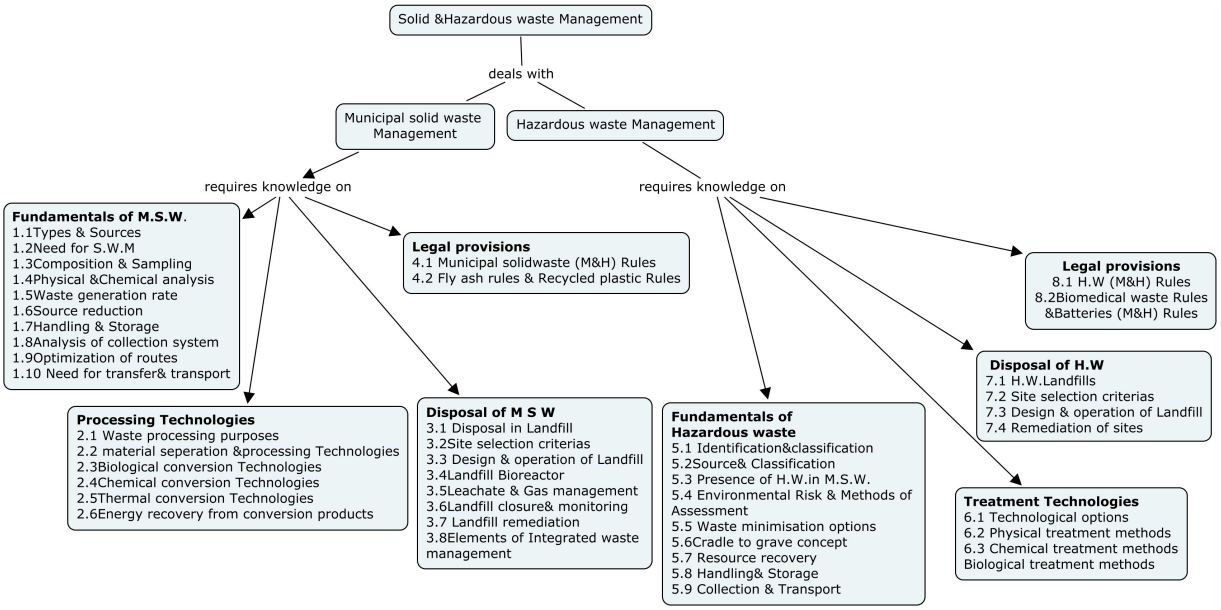
1. Find the current waste collection practice in your locality and state its role in waste management?
2. Discuss the various constraints faced by municipal authorities in identifying a disposal site?
3. Do you think a sanitary landfill is possible to manage wastes in your locality? List at least three reasons to support your answer.
4. How will you control leachate generation from a secured landfill?
5. Suggest the best disposal option for the municipal solid waste generated from your locality.
6. How the packaging wastes in municipal solid waste stream be minimized?

Analyze

1. Analyze the various recovery options and processing technologies for the Municipal solid waste?
2. Analyze the environmental effects of composting and bio-gasification.
3. Assess the technical viability of various processing techniques.
4. Waste generation rate is normally high in bigger cities - why?
5. Analyze the energy generation potential of a MSW.
6. Discuss the issues associated with the present practice of Hazardous waste in India? What are the recommendations for improving the situation?

7. Assess the various options present before implementing a source reduction policy in Hazardous waste management.

Concept Map



Course content and Lecture schedule

S.No	Topics	Periods
1.Municipal solid waste fundamentals		
1.1	Types and sources of solid waste	1
1.2	Need for solid waste management	1
1.3	Composition and sampling of MSW	1
1.4	Physical and chemical analysis of MSW	1
1.5	Waste generation rate	1
1.6	Source reduction of waste-recycling and re use	1
1.7	Handling storage and collection of MSW	1
1.8	Analysis of collection system	1
1.9	Optimization of collection routes	1
1.10	Need for transfer and transport – transfer station	1

2.Processing Technologies		
2.1	Waste processing – purposes of processing	1
2.2	Material separation and processing technologies	1
2.3	Biological conversion technologies	1
2.4	Chemical conversion technologies	1
2.5	Thermal conversion technologies	1
2.6	Energy recovery from conversion products	1
2.7	Co- processing of solid waste	1
3.Disposal of municipal solid waste		
3.1	Disposal in land fills	1
3.2	Site selection criteria's	1
3.3	Design and operation of landfill	2
3.4	Land fill bio reactor	1
3.5	Leachate and landfill gas management	1
3.6	Land fill closure and environmental monitoring	1
3.7	Land fill remediation	1
3.8	Elements of integrated waste management	1
4.Legal provisions on Solid waste Management		
4.1	Municipal Solid waste(Management and handling)rules	1
4.2	Fly ash rules & Recycled plastic rules	1
4.3	Bio degradable plastics & disintegrated plastics	1
5.Hazardous waste fundamentals		
5.1	Identification, classification of Hazardous waste	1
5.2	Source and characterization of hazardous waste – TCLP tests	2
5.3	Presence of hazardous waste in M.S.W.	1
5.4	Defining risk, environmental risk and method of risk	1

	assessment	
5.5	Waste minimization options	1
5.6	Cradle to grave concept	1
5.7	Resource recovery	1
5.8	Handling and storage of hazardous waste	1
5.9	Collection and transport of hazardous waste	1
6.Hazardous waste treatment technologies		
6.1	Hazardous waste technological options	1
6.2	Physical treatment methods	1
6.3	Chemical treatment methods	1
6.4	Biological treatment methods	1
7.Disposal of Hazardous waste		
7.1	Hazardous waste landfills	1
7.2	Site selection Criteria	1
7.3	Design and Operation of Hazardous waste landfills	2
7.4	Remediation of H.W. disposal sites	1
8.Legal provisions on Hazardous waste Management		
8.1	Hazardous waste(Management and handling)rules	1
8.2	Biomedical waste (Management and handling)rules& Batteries (Management and handling)rules	1
	Total	**50**

Syllabus

Types and sources of solid waste- Need for solid waste management- Composition and sampling of MSW- Physical and chemical analysis of MSW- Waste generation rate- Source reduction of waste-recycling and re use- Handling storage and collection of MSW- Analysis of collection system- Optimization of collection rates- Optimization of collection routes- Need for transfer and transport – transfer station. Processing Technologies -Waste processing – purposes of processing- Material separation and processing technologies-

Biological , chemical &Thermal conversion technologies-Energy recovery from conversion products-Co processing of solid waste- Disposal of municipal solid waste- Disposal in land fills- Site selection criteria's- Design and operation of landfill- Land fill bio reactor- Leachate and landfill gas management- Land fill closure and environmental monitoring- Land fill remediation- Elements of integrated waste management- Municipal Solid waste(Management and handling)rules- Fly ash rules & Recycled plastic rules- biodegradable plastic wastes. Hazardous waste- fundamentals- Identification, classification of Hazardous waste- Source and characterization of hazardous waste – TCLP tests- Presence of hazardous waste in M.S.W.- Defining risk, environmental risk and method of risk assessment- Waste minimization options- Cradle to grave concept- Resource recovery- Handling and storage of hazardous waste- Collection and transport of hazardous waste- Hazardous waste technological options- Physical treatment methods- Chemical treatment methods- Biological treatment methods- Disposal of Hazardous waste- Hazardous waste landfills- Site selection Criteria- Design and Operation of Hazardous waste landfills- Remediation of H.W. disposal sites -Hazardous waste(Management and handling) rules- Biomedical waste (Management and handling)rules& Batteries (Management and handling)rules

Reference Books

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil "Integrated Solid Waste Management", McGraw Hill Publishers, New York, 1993.
2. Vesilind P.A., Worrell W and Reinhart, Solid Waste Engineering, Thomson learning Inc., Singapore, 2002.
3. "Manual on Municipal Solid Waste Management", CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2000
4. Bhide A.D and Sundaresan, B.B. "Solid Waste Management Collection, Processing and Disposal", 2001, ISBN 81-7525-282-0
5. Paul T Williams. "Waste Treatment and Disposal", John Willey and Sons.

Course Designer

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Sub Code	Lectures	Tutorial	Practical	Credit
EN17	0	0	3	1

EN17 Environmental Engineering Laboratory **0:1**

Preamble

This laboratory course work is intended to impart hands on training in evaluating the water quality parameters, wastewater characteristics and ambient air quality status measurement. This will form the basic input data for arriving at a solution / treatment system for upkeep of the environment and promoting public health.

List of Experiments

1. Water Softening by Chemical precipitation
2. Optimum Coagulant Dosage
3. Adsorption Kinetics / Isotherms
4. MLSS / MLVSS / SVI of biological reactor content
5. Sodium Absorption Ratio
6. Chlorine Dosage for disinfection of water
7. COD of wastewater
8. Nitrate /Fluoride in water
9. Isolation and Identification of Microbes
10. RSPM and TSPM in ambient air
11. Filter media characteristics – Particle size Distribution
12. Dissolved oxygen in water / wastewater

Demonstration Experiments

1. Atomic Absorption Spectrophotometer – Heavy metal analysis
2. Total Organic Carbon Analyzer – TOC in wastewater
3. Nitrogen Estimation – Composite Fertilizer
4. Noise measurement – Noise addition

Course Designer

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Sub Code	Lectures	Tutorial	Practical	credit
EN 21	3	-	-	3

EN 21 Transport of Water and Wastewater 3:0

Preamble:

Transportation of water from the source / treatment plant to the city premises and distributing it through a net work of pipes to the doorsteps of consumers at adequate pressure is a most important operation to fulfill the various water demands of the general public. Estimation and collection of storm drainage generated from the township / city areas as well as the wastewater generated by the people and conveying through a well planned sewer network to the treatment plant is also equally important to maintain the health and hygienic conditions in the urban areas.

Competencies: At the end of the course, the student should be able to

1. Design water supply mains taking into account all the design parameters.
2. Analyze a water supply pipe distribution network.
3. Select an appropriate pipe material, necessary pipe appurtenances and able to locate the leaking mains for the water distribution system.
4. Estimate the quantity of storm drainage and design a proper storm drainage for speedy draining of storm water from the city area.
5. Design a sewage for the proper disposal of the sewage generated from the city limits to treatment plant.

Assessment Pattern

S.No	**Blooms Category**	**Test – 1**	**Test – 2**	**Test – 3 / End semester examination**
1	Remember	-	-	-
2	Understand	50	30	30
3	Apply	50	50	50
4	Analyze	-	-	-
5	Evaluate	-	-	-
6	Create	-	20	20

Course Level Learning Objectives

Understand

1. Under what circumstances pumping of water becomes necessary? How would you choose a particular pump?
2. What is major loss and minor losses? What do you understand by loss of head?
3. Explain the phenomenon of water hammer. How could it be taken care in water transmission?
4. What are pipe appurtenances? Why it is necessary in water distribution system?
5. Explain the rational method of estimation of storm drainage generated from a catchment area.
6. What are the various functions performed by different sewer appurtenances?

Apply

1. A pipe 50mm diameter is 6m long and the velocity of flow of water in the pipe is 2.40 m/s. What loss of head and the corresponding power would be saved if the central 2m length of pipe was replaced by 75mm diameter pipe, the change of section being sudden? Take f=0.04 for both the pipes.
2. A rectangular notch of crest width 0.40m is used to measure the flow of water in a rectangular channel 0.6m wide and 0.45m deep. If the water level in the channel is 0.225m above the weir crest, find the discharge in the channel. Take Cd=0.63 consider velocity of approach also.
3. Water has to be supplied to a town with one lakh population at the rate of 150 lpcd from a river, 1.8km away. The difference in elevation between the lowest water level in the sump and service reservoir is 36m. Determine the size of the main and power of the pump required. Make suitable assumptions for any needy data.
4. Determine the size of a circular sewer for a discharge of 0.60 m3/s at running half full. Take s=0.0001 and n=0.015.
5. The drainage area of one sector of a town is 12 hectares. The classification of the surface of this area is as follows:

Type of surface	% of total area	Coefficient of runoff
Hard pavement	20	0.85
Roof surface	20	0.80
Unpaved street	15	0.20
Gardens & lawns	30	0.20
Wooded area	15	0.15

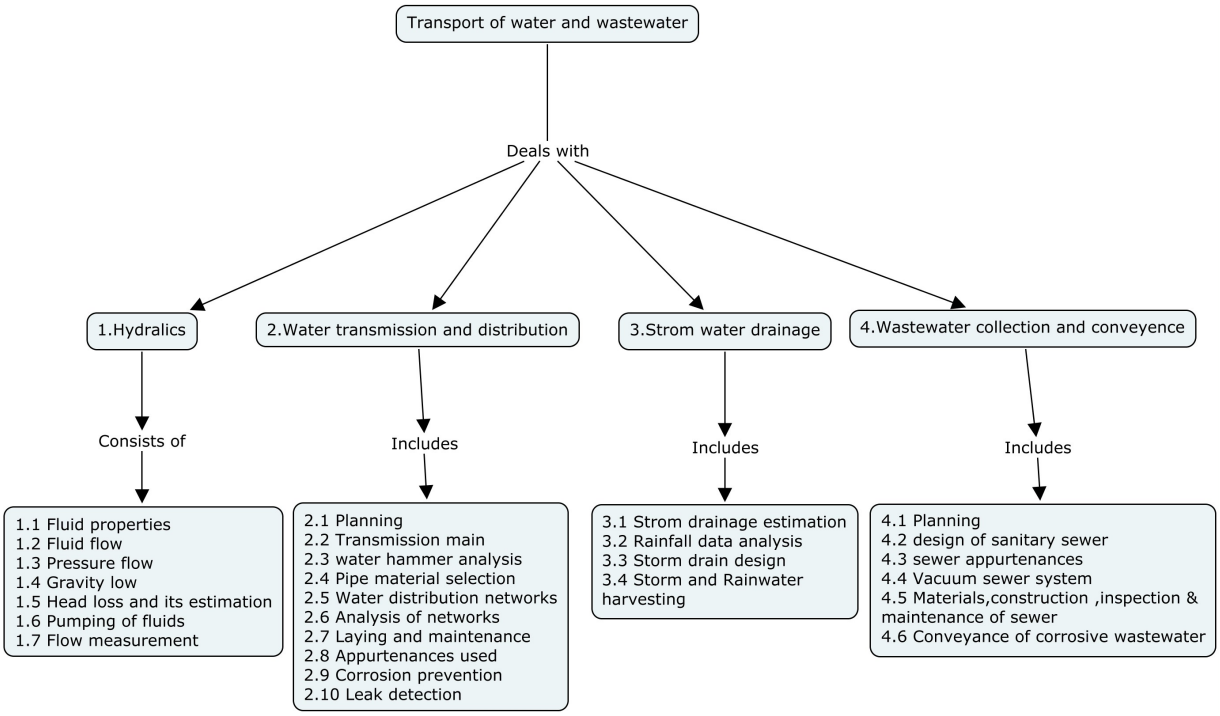
If the time of concentration for the area is 30 minutes, find the maximum run-off.

6. A pump is to deliver water from an underground tank against a static head of 40m. The suction pipe is 50m long and is of 25 cm diameter with f=0.02. The delivery pipe is 20cm diameter 1600m long and has f=0.022. The pump characteristics can be expressed as Hp=100-6000Q2. Calculate the head and discharge of the pump.

Create

1. Design a storm drain for the following data.
   Area of catchment: 50 hectares
   Coefficient of runoff: 0.63
   Critical rainfall intensity: 20 mm/hr
   Bed slope: 1 in 500
2. Design an outfall sewer for the following conditions:
   Population: 1 Lakh people
   Bed slope: 1 in 500
   Sewer is running 0.70 times full during maximum flow.
   Self cleansing velocity to be maintained: 0.60 m/s
3. Design the capacity of a pump which lifts water from a well to the treatment plant. Following are the data
   Quantity to be lifted daily = 40,000m3
   Diameter of suction and delivery pipes=60cm
   Length of suction pipe=30m
   Length of delivery pipe=170m
   Head through which water is to be raised = 25m
   Pump work for two shifts daily, each shift being of 8 hours duration.
4. From a clear water reservoir 3m deep and maximum water level at 30.00, water is to be pumped to an elevated reservoir at 75.00 at a constant rate of 9,00,000 L/hour. The distance is 1500m. Design the economical diameter of the rising main and the capacity of the pump.

Concept map



Course content and Lecture schedule

S.No	Topic	No. of Lectures
1.	**Hydraulics**	
1.1	Principles of hydraulics- fluid properties-	2
1.2	Fluid flow- Pressure flow, continuity principle	2
1.3	Gravity flow- energy principle	1
1.4	Loss of head – major loss-minor losses- estimation of losses	2
1.5	pumping of fluids-types of pumps-selection of pumps	2
1.6	Flow measurement-pipe flow-open channel flow	2
2.	**Water transmission and distribution**	
2.1	Planning factors	1
2.2	Transmission mains – design & Economizing of transmission mains	3
2.3	water hammer analysis – Upsurge and Down surge	1

2.4	pipe materials	1
2.5	water distribution pipe network	2
2.6	Analysis of network-Software's applications- LOOP and BRANCH, EPANET -optimization	3
2.7	Laying and maintenance of pipelines.	1
2.8	Pipe appurtenances	1
2.9	Corrosion prevention- Catholic protection	1
2.10	Minimization of water losses and leak detection	1
3.	**Storm water drainage**	
3.1	Quantity estimation	1
3.2	Rainfall data analysis	1
3.3	storm water drain design	1
3.4	storm water harvesting and roof water harvesting	1
4.	**Wastewater collection and conveyance**	
4.1	Planning factors	2
4.2	Design of sanitary sewer-Software applications - SEWER – economics of sewer design	3
4.3	sewer appurtenances	1
4.4	Vacuum sewer system- Introduction	1
4.5	Material, construction, inspection and maintenance of sewer	2
4.6	Conveyance of corrosion wastewater	1
	Total	**40**

Syllabus

Principles of hydraulics- fluid properties- fluid flow-continuity principle, energy principle. Loss of head – major loss-minor losses- estimation of losses-pumping of fluids-types of pumps-selection of pumps-flow measurement-pipe flow-open channel flow. Water transmission and distribution- planning factors-transmission mains – design & Economizing of transmission mains – water hammer analysis - Upsurge and Down surge – pipe materials-water distribution pipe network-analysis of network - Software's applications-LOOP and BRANCH, EPANET - optimisation. Laying and maintenance of pipelines. Pipe appurtenances – corrosion prevention – minimization of water losses and leak detection.
Storm water drainage – quality estimation – rainfall data analysis – storm water drain design – storm water harvesting and roof water harvesting. Wastewater collection and conveyance – planning factors – design of sanitary sewer – Software applications - SEWER

economics of sewer design – sewer appurtenances - Vacuum sewer system- Introduction – material, construction, inspection and maintenance of sewer – conveyance of corrosive wastewater

Reference Books

1. "Manual on water supply and treatment",CPHEEO,Ministry of urban affairs and Employment GOI,New Delhi,2001.
2. "Manual on sewerage and sewage treatment",CPHEEO,Ministry of urban affairs and employment GOI,New Delhi,2001.
3. P.R.Bhave,"Analysis of flow in water distribution Networks", Technomic publishing co,U.S.A.,1991.
4. Ven Te Chow, David R Maidment, Larry W Mays "Applied hydrology", Mcgraw hill book co. 1988.
5. "Manual on water supply maintenance and management" CPHEEO, Ministry of urban affairs and Employment GOI,New Delhi

Course Designers

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Sub Code	Lectures	Tutorial	Practical	Credit
EN22	3	1	-	4

EN 22 Biological Treatment Process **3:1**

Preamble

Biological treatment process is to remove or reduce the concentration of organic and inorganic compounds. Some of the constituents and compounds found in industrial wastewater are toxic to microorganisms, pretreatment may be required before the wastewater can be discharged to a municipal collection system. The fundamental concepts, kinetics and process parameters of various biological treatment facilities available for the wastewater generated in the environment.

Competencies: At the end of the course, the students will be able to

1. Design the various wastewater treatment systems.
2. Analyze which system can be adopted for certain wastewater characteristic.
3. Determine the biokinetic coefficient for designing treatment units.
4. Identify the various fields of Microbiology that applied in Environmental field.
5. Distinguish between the various treatment units that can be applied during treatment of wastewater.

Assessment Pattern

S.No.	Bloom's Category	Test 1	Test 2	Test 3/End semester Examination
1	Remember	10	10	10
2	Understand	20	20	20
3	Apply	20	20	20
4	Analyze	0	0	0
5	Evaluate	50	50	50
6	Create	0	0	0

Course Level Learning Objectives

Remember

1. What are the classifications of waste stabilization pond?
2. What are the modifications of ASP?
3. What are the types of oxidation ditch and Aerated lagoon?
4. What are enzyme reactions?
5. What are the various fields of Microbiology that applied in Environmental field?

6. Define half velocity constant and F/M ratio.

Understand

1. Write arbitrary flow equation for wastewater.
2. Write Eckenfelder equation adopted for the design of Trickling Filter.
3. Classify the anaerobic contact process.
4. Describe the significance of BOD, COD, and Volatiles Solids?
5. Describe Kraus process?
6. Developing the mass balance relationship for each, describe the reactors used for Wastewater treatment.

Apply

1. The sludge production having 96% moisture content from a wastewater treatment plant is 1000 kg on dry solid basis. The solid contain 70% volatile matter with a specific gravity of 1.02 and 30% mineral matter with a specific gravity of 2.5. Determine the volume of raw and digested sludge if reduction in volatile solids is 55% during digestion and moisture content of digested sludge is 92%.
2. Determine the values of biokinetic constants using the data given in table. Derived from the laboratory experiments carried out on the CFSTR model of an ASP without recycle.

Unit No	Influent substrate concentration S (mg/L)	Reactor substrate concentration S (mg/L)	Detention time (d)	Reactor biomass concentration X (mg/L)
1	250	13	3.5	130
2	250	22	2.5	128
3	250	32	1.9	132
4	250	65	1.2	120
5	250	72	1.0	115

3. Determine the volume of a reactor to carry out 95% removal of a reactant, when the flow
   condition is (a) plug flow and (b) complete mix flow. It is given that
   i. Wastewater flow rate is 300 m^3/d
   ii. First order reaction rate constant is 1.2/h
4. It is proposed to provide a biotower system to treat a wastewater flow of 15 MLD having BOD of 250 mg/L. The depth of modular plastic media to be used is 6m. The

treatability constant determined at 20°C is found to be 0.06 min-1 & the treated effluent is to be discharged into surface water. The desired concentration of effluent BOD is 20 mg/L. Assuming a recirculation ration of 2, Design the biotowers.

5. Discuss the substrate removal when the reactor in series. Calculate & compare the volume of the reactor s required to achieve 95% reduction of a reactant in a flow of 1500m^3/d for the following conditions.
   i. Single CFSTR is used.
   ii. 5 CFSTR are used in series.

   Assume reaction rate constant is 0.6d^{-1}
6. It is proposed to provide an RBC to treat a wastewater flow of a small colony of 1500 persons. The per capita generation of flow has been taken as 200L/d. Assuming that 85% BOD removal can be achieved at an organic loading 0f 25g BOD/m^2.d by 3.0 diameter discs placed at 5cm apart, determine the effective size of tank and the volume of sludge to be wasted each day. The influent BOD size to tank is 200mg/L.

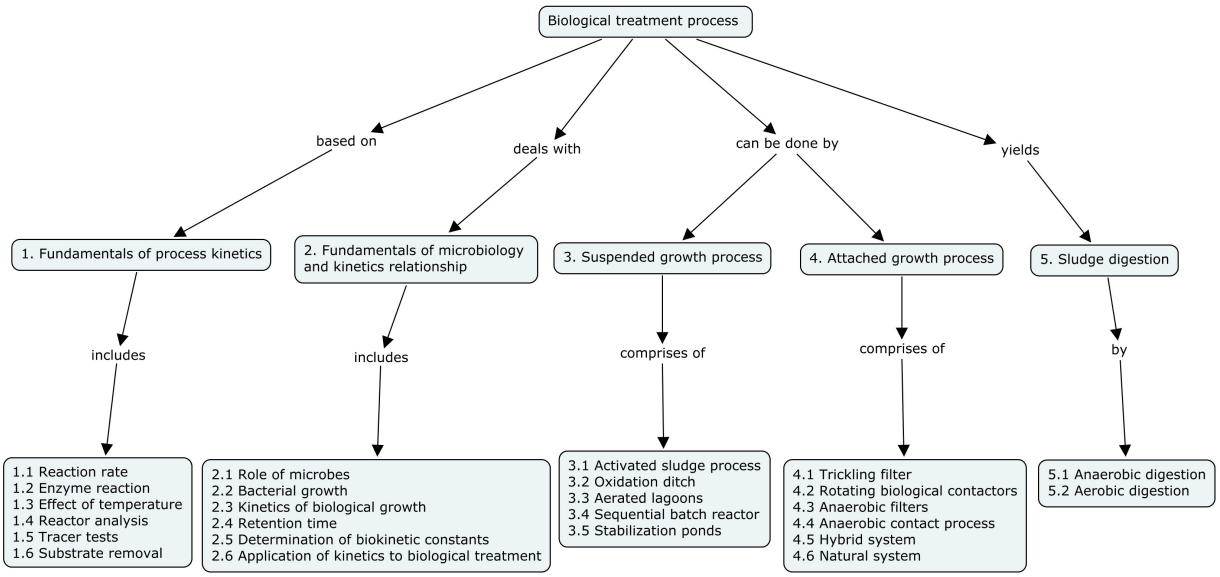
Evaluate

1. Assuming a side water depth of 3.2m, design a flow-through type aerated lagoon proposed to design for following parameters.

   Flow of wastewater = 900 m3/d
   Influent BOD = 175 mg/L
   Desired effluent BOD = 20 mg/L
   Mean cell residence time = 3d
   Effluent suspended solids concentration = 90 mg/L
   MLVSS = 80% MLSS
   Kinetic coefficients: Y=0.6, Kd=0.06 d-1, Ks = 85 mg/L, K=6 d-1
2. Design two- stage TF system to treat 5000m3/d flow of wastewater. Find the efficiency of the treatment & effluent substrate concentration.
   Settled influent BOD = 250 mg/L
   Volume of 1st stage filter = 1000m3
   Volume of 2nd stage filter = 700 m3
   Filter depths = 2m
   Recirculation ratio = 1.5
3. Estimate the final settling tank size required for an extended aeration plant where plant inflow= 9000 m3/d, recycle flow=6000 m3/d. Other data can be assumed.

4. 2000 m3/d of wastewater with BOD=400 mg/L is treated in an activated sludge plant at 90% efficiency. Assuming net VSS production as 0.28 kg/kg of BOD removed at θ_c = 5 days, estimate the phosphorus removal.
5. Design an external aeration unit to operate as an inter-air system serving 5000 persons using parameters suitable for India. Assume that BOD = 50 g/person –day and average flow Q= 200 L/person/day. Neglect nitrification-denitrification. Take F/M=0.15 kg BOD per kg MLSS.

Concept map



Course content and Lecture schedule

No	Topic	No. of Lectures
1.	**Fundamentals Of Process Kinetics**	
1.1	Waste waters – sources, nature and characteristics. Reaction rates	2
1.2	Enzyme reaction	1
1.3	Effect of temperature	1
1.4	Reactor analysis - batch reactor - continuous flow stirred tank reactor, plug flow reactor, arbitrary flow reactor	2
1.5	Tracer tests - estimation of dispersion coefficient	1
1.6	Substrate removal - reactors in parallel - reactors in series	2
2.	**Fundamentals Of Microbiology And Kinetics Relationship**	
2.1	Role of micro-organisms	1

2.2	Bacterial growth and biological oxidation	1
2.3	Kinetics of biological growth, logarithmic growth (batch culture), substrate limited growth cell yield	2
2.4	Biological solids retention time, F/M ratio	1
2.5	Determination of bio-kinetic constants	2
2.6	Application of kinetics to biological treatment	2
3.	**Suspended Growth Treatment Process**	
3.1	Design of activated sludge process - modifications	2
3.2	Oxidation ditch	2
3.3	Aerated lagoons, oxygen requirements, arrangement for transfer of oxygen	2
3.4	Sequential Batch Reactor	1
3.4	Stabilization ponds - classification, applications, process design	1
4.	**Attached Growth Treatment Process**	
4.1	Trickling Filter – Process – design based on popular design equations	2
4.2	rotating biological contactors	1
4.3	anaerobic filters	2
4.4	Anaerobic contact process – anaerobic up flow sludge blanket reactor	2
4.5	Hybrid system – MBR, MBBR and HUASB	2
4.6	Natural system - PGF, Constructed wetlands, Duckweed pond.	2
5.	**Sludge Digestion**	
5.1	Anaerobic digestion – process, kinetic relationship, gas production, design considerations	2
5.2	Aerobic digestion – kinetics, oxygen requirements, design considerations	2
	Total	**40**

Syllabus

Wastewaters – sources, nature and characteristics. **Fundamentals Of Process Kinetics:**Reaction rates - enzyme reaction - effect of temperature. Reactor analysis - batch reactor - continuous flow stirred tank reactor, plug flow reactor, arbitrary flow reactor.

Tracer tests - estimation of dispersion coefficient. Substrate removal - reactors in parallel - reactors in series. **Fundamentals Of Microbiology And Kinetics Relationship:** Role of micro-organisms, bacterial growth and biological oxidation. Kinetics of biological growth, logarithmic growth (batch culture), substrate limited growth cell yield, biological solids retention time, F/M ratio. Determination of bio-kinetic constants, application of kinetics to biological treatment. **Suspended Growth Treatment Process:** Design of activated sludge process – modifications. Oxidation ditch, aerated lagoons, oxygen requirements, arrangement for transfer of oxygen, SBR. Stabilization ponds - classification, applications, process design. **Attached Growth Treatment Process:** Trickling Filter – Process – design based on popular design equations – rotating biological contactors, anaerobic filters. Anaerobic contact process – anaerobic up flow sludge blanket reactor. **Hybrid system** – MBR, MBBR and HUASB. **Natural system:** PGF, Constructed wetlands, Duckweed pond. **Sludge digestion –** sources, characteristics, quantities. Anaerobic digestion – process, kinetic relationship, gas production, design considerations. Aerobic digestion – kinetics, oxygen requirements, design considerations.

Reference Books

1. Metcalf and Eddy, "Wastewater Engineering Treatment, disposal and reuse" Tata McGraw-Hill, New Delhi 2003.
2. Arceivala S.J., Shyam R Asolekar., "Wastewater Treatment for Pollution Control and Reuse, 3rd Edition, Tata McGraw Hill Publishers, New Delhi, 2007
3. Manual on Sewerage and sewage treatment, CPHEEO, Ministry of Urban development, GOI, New Delhi, 1993.
4. Qasim, S.R., Wastewater treatment plant, Planning, Design and Operation, Technomic Publications, New York, 1994.

Course Designer

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Sub Code	Lectures	Tutorial	Practical	Credit
EN 31	4	-	-	4

EN31 Environmental and Socio Economic Impact Assessment 4:0

Preamble:

To expose the students to the need, methodology, documentation and application of Environmental Impact Assessment and to develop the skill to prepare Environmental Management Plan.

Competencies: At the end of the course, the student should be able to

1. Identify the impact on environment of the Infrastructural projects
2. Impart the knowledge in legal and regulatory aspect in India according to MoEF.
3. Understand the various components of E I A and its methods.
4. Understand the Methodologies, prediction and Assessment.
5. Prepare Environmental Management plan for Infrastructure engineering project.
6. Prepare a EIA report for a developmental project.

Assessment Pattern

S.No	Blooms Category	Test – 1	Test – 2	Test – 3 / End semester examination
1	Remember	20	20	20
2	Understand	50	50	40
3	Apply	30	30	40
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Course Level Learning Objectives

Remember

1. What is Environmental Impact Assessment?
2. What are the various types of EIA?
3. What are the components of EIA?
4. What are the steps involved in the Mathematical Modeling?
5. What are the tools used in Public Participation?
6. What is an EMP?
7. What is social Impact Assessment?

Understand

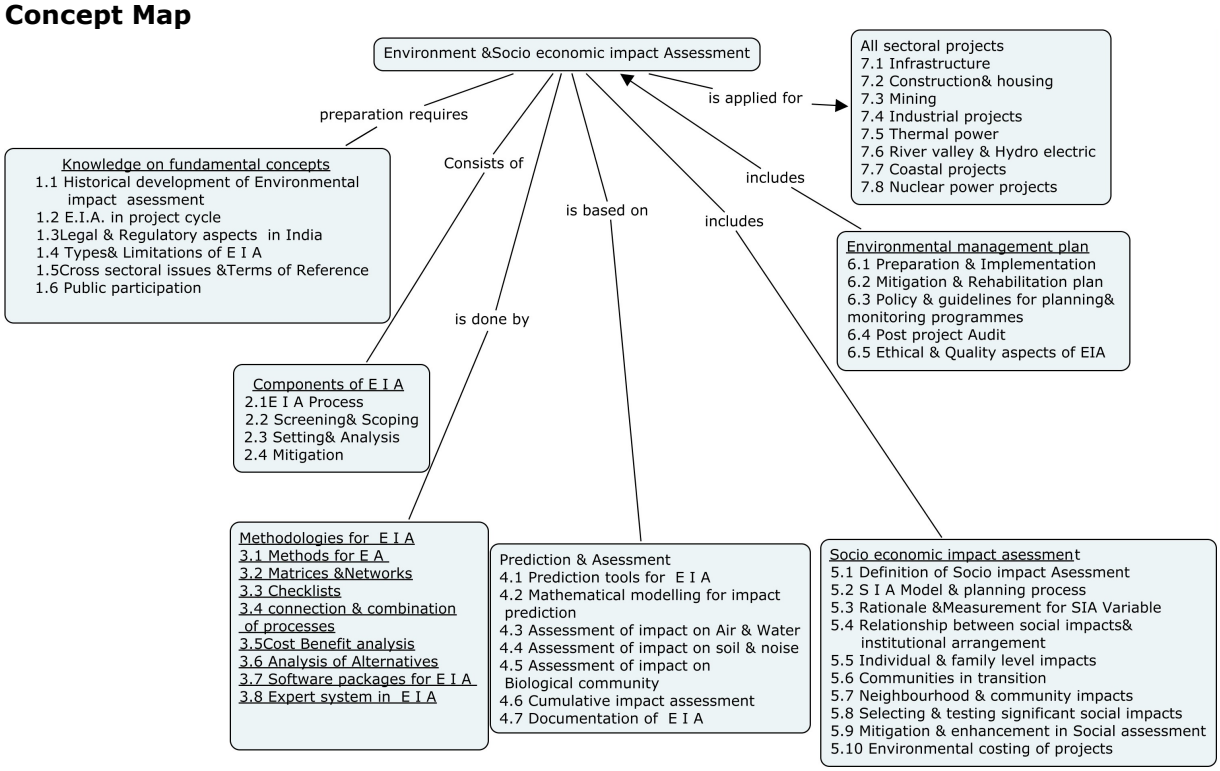
1. What are the main objectives of EIA?
2. Explain the various types of EIA.

3. What is the purpose of screening in EIA process?
4. What is Scoping in the EIA process?
5. Explain the procedure for conducting the public hearing as the part of EIA.
6. How EIA is used as an Evaluation Tool?

Apply

1. Discuss the role of Public Participation in Environmental Decision Making.
2. EIA is an effective management tool : comment
3. Discuss the difficulties generally experienced in implementing EMP in developing countries.
4. Pudur is a town located along the OMR road. It is proposed to construct 6000 No. of residential houses in that area. Identify the potential impacts of the project and suggest a management plan to mitigate them.
5. Sabarimalai is a pilgrimage town located in Kerala state. It is proposed to develop a Greenfield airport project for the capacity to handle six new generation large aircraft. Identify the potential impacts of the project and suggest a management plan to mitigate them.
6. In Madurai it is propose to develop a CETP for 20 Electroplating units. Identify the potential impacts of the project and suggest a management plan to mitigate them.

Concept Map



Course content and Lecture schedule

S.No	Topics	Periods
	1.BASIC FUNDAMENTALS	
1.1	Historical Development of Environmental Impact Assessment	1
1.2	EIA in Project Cycle	1
1.3	Legal and Regulatory Aspects in India	1
1.4	Types and Limitations of EIA	1
1.5	Cross Sectoral Issues and terms of references in EIA	1
1.6	Public Participation in EIA	1
	2.COMPONENTS OF EIA	
2.1	EIA Process	1
2.2	Screening and Scoping	1
2.3	Setting and analysis	1
2.4	Mitigation	1
	3.METHODOLOGY	
3.1	Methods for Environmental assessment	1
3.2	Matrices &Networks	1
3.3	Checklists	1
3.4	Connections and Combinations of Processes	1
3.5	Cost benefit analysis	1
3.6	Analysis of Alternative	1
3.7	Software Packages for EIA	1
3.8	Expert Systems in EIA	1
	4.PREDICTION AND ASSESSMENT	
4.1	Prediction tools for EIA	1

4.2	Mathematical modeling for impact prediction	2
4.3	Assessment of Impacts on Air and Water	1
4.4	Assessment of Impacts on Soil and Noise	1
4.5	Assessment of Impacts on Biological Community	1
4.6	Cumulative Impact Assessment	1
4.7	Documentation of EIA Findings & Report Preparation	1
5.SOCIO-ECONOMIC IMPACT ASSESSMENT		
5.1	Definition of Social Impact Assessment	1
5.2	Social Impact Assessment model and the planning process	1
5.3	Rationale and measurement for SIA variables.	1
5.4	Relationship between social impacts and change in community and institutional arrangements	1
5.5	Individual and family level impacts	1
5.6	Communities in transition	1
5.7	Neighborhood and community impacts	1
5.8	Selecting, testing and understanding significant social impacts	1
5.9	Mitigation and enhancement in social assessment	1
5.10	Environmental costing of projects.	1
6.ENVIRONMENTAL MANAGEMENT PLAN		
6.1	Environmental Management Plan – Preparation and implementation	2
6.2	Mitigation and Rehabilitation plans	1
6.3	Policy and guidelines for planning and monitoring programmes	1
6.4	Post Project Audit	1
6.5	Ethical and Quality aspects of Environmental Impact Assessment	1
7.CASE STUDIES EIA		
7.1	EIA related to infrastructure	1
7.2	EIA related to Construction and Housing	1

7.3	EIA related to Mining	1
7.4	EIA related to Industrial Projects	1
7.5	EIA related to Thermal Power	1
7.6	EIA related to River Valley and Hydroelectric	1
7.7	EIA related to Coastal Projects	1
7.8	EIA related to Nuclear Power	1
	Total	**50**

Syllabus Environmental and Socio Economic Impact Assessment

BASIC FUNDAMENTALS: Historical Development of Environmental Impact Assessment - EIA in Project Cycle - Legal and Regulatory Aspects in India - Types and Limitations of EIA - Cross Sectoral Issues and terms of references in EIA - Public Participation in EIA. **COMPONENTS OF EIA:** EIA Process- Screening and Scoping - Setting - Analysis and Mitigation. **METHODOLOGY:** Matrices – Networks - Checklists - Connections and Combinations of Processes-Cost benefit analysis - Analysis of Alternative - Software Packages for EIA - Expert Systems in EIA. **PREDICTION AND ASSESSMENT:** Prediction tools for EIA - Mathematical modeling for impact prediction - Assessment of Impacts on Air, Water and Soil - Assessment of Impacts on Biological Community - Cumulative Impact Assessment - Documentation of EIA findings -Report Preparation. **SOCIO-ECONOMIC IMPACT ASSESSMENT:** Definition of Social Impact Assessment - Social Impact Assessment model and the planning process. Rationale and measurement for SIA variables - Relationship between social impacts and change in community and institutional arrangements - Individual and family level impacts - Communities in transition - Neighborhood and community impacts - Selecting, testing and understanding significant social impacts - Mitigation and enhancement in social assessment - Environmental costing of projects. **ENVIRONMENTAL MANAGEMENT PLAN:** Environmental Management Plan – Preparation - EMP – Implementation and Review - Mitigation and Rehabilitation plans - Policy and guidelines for planning and monitoring programmes - Post Project Audit - Ethical and Quality aspects of Environmental Impact Assessment. **CASE STUDIES:** EIA related to infrastructure, Construction and Housing, Mining, Industrial Projects, Thermal Power, River Valley and Hydroelectric, Coastal Projects, Nuclear Power.

Reference Books

1. Lawrence, D.P., Environmental Impact Assessment – Practical Solutions to recurrent problems, Wiley-Interscience, New Jersey, 2003.
2. World Bank – Source Book on EIA.
3. Petts, J., Handbook of Environmental Impact Assessment, Vol., I and II, Blackwell science, London, 1999.
4. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York, 1996.

Course Designers

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