CET 398	ENVIRONMENTAL POLLUTION MODELLING	CATEGORY	L	T	P	CREDIT	Year of Introduction
		VAC	3	1	0	4	2019

Preamble : This course introduces various approaches for environmental pollution modeling. Students will learn how to develop a verified and validated model. The mathematics behind various environmental pollution models with their uncertainties will be discussed.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able

Course Outcome	Description of Course Outcome	Prescribed learning level
CO1	To appreciate the mathematical modelling approach	Understanding
CO2	To learn how to build a model to represent physical transport of pollutants in environment	Understanding, Applying
CO 3	To simulate pollution transport scenarios in water, air and noise environment	Applying , Analysing
CO 4	To interpret the modelling results for decision support	Analysing

Mapping of course outcomes with program outcomes (Minimum requirement)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	-	-	-	-	-	-	-	-	-	-	-
CO 3	-	2	-	2	-	-	-	-	-	-	-	-
CO4	-	2	-	2	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	15
Understand	10	10	15
Apply	15	15	35
Analyse	15	15	35
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

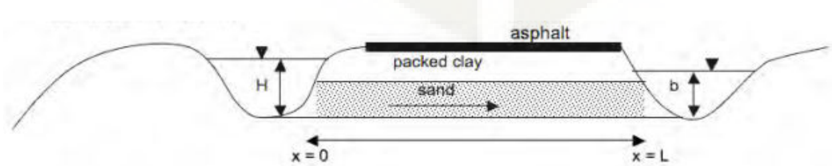
End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question carries 14 marks and can have maximum 2 sub-divisions.

<u>Course Level Assessment Questions</u>

CO1:To appreciate the mathematical modelling approach

1	Discuss the classification of mathematical models
2	Explain how advection-diffusion equation is useful for modelling contaminant transport in ground water
3	How gaussian dispersion model is useful for air pollution modelling of point sources?

CO 2: Tolearn how to build a model to represent physical transport of pollutants in environment

1	Explain model building procedure
2	What is the flow equation for the following situation? 

3	Discuss how salinity intrusion is modeled

CO3: To simulate pollution transport scenarios in water, air and noise environment

1	The SO_2 concentration from 700 MW coal fired power plant has to be estimated. It burns 5% sulphur coal at the rate of 350KG / MW H. Stack height is 150m and plume rise is 50m.The wind speed at stack height is 6 m/s and neutral stability condition exists. Calculate the ground level concentration at 2 km downwind distance, given that σy= 80m and σz= 120m.
2	The initial BOD of a river just below a sewage outfall is 25 mg/L. The oxygen deficit just upstream from the outfall is 2 mg/L. The deoxygenation rate coefficient kd is 0.4/day, and the reaeration rate coefficient kr is 0.7/day. The river is flowing at a speed of 30 km /day. (a) Find the critical distance downstream at which DO is a minimum (b) Find the minimum DO
3	Water levels in two wells far from shoreline are 50 cm and 1.0 m respectively. The wells are separated by a distance of 1 km. Hydraulic conductivity of the aquifer is 10m/d. Thickness of aquifer is 50m. Calculate the length of saltwater wedge and position of interface. Density of salt water can be taken as 1.025 g/cm^3

CO4: To interpret the modelling results for decision support

1	Explain how gaussian dispersion model help in predicting the impact of a proposed coal power plant in a locality
2	A chemical spill occurs above a sloping, shallow unconfined aquifer consisting of medium sand with K=1 m/d and a porosity of 30%. Several monitoring wells are drilled in order to determine the regional hydraulic gradient. The hydraulic head from a well drilled near the spill location yielded a value of 5m. At a distance of 200m down the slope another well yielded a hydraulic head of 1m. Do you need to worry about safe drinking water availability in the well 200 m down the slope?
3	The distance from the base of a pumping well to the freshwater-saltwater interface is 100 m, the pumping rate is 3000 m^3/day, and the hydraulic conductivity is 10 m/d. What's the maximum permitted pumping rate for the well?

SYLLABUS

Module1

Role of models in environmental pollution studies- objectives of modelling-modelling principles-types of models-classification of mathematical models-deterministic, stochastic, continuous, discreet, static, dynamic, linear and non-linear-model building framework-model calibration, validation, verification and sensitivity analysis-model scales, error and uncertainty -distributions in modelling data of environmental pollutant concentrations- log-normal, Weibull, and gamma

Module 2

Air pollution modelling: Transport and dispersion of air pollutants- estimating concentrations from point sources –Dispersion Modelling- Gaussian Plume Model – determination of dispersion parameters, atmospheric stability-box models- line source model-area source model-puff model

Module 3

Water quality modeling: historical development of water quality models; rivers and streams water quality modelling– low flow analysis – pollutant transport-advection, diffusion and dispersion––Modelling lake water quality-mass balance for well mixed lakes-models for dissolved oxygen; Streeter Phelps model- sediment transport modelling

Module4

Groundwater modelling: use of ground water models-ground water flow modeling-Darcy's law-ground water flow equations for homogenous, heterogenous, isotropic and anisotropic conditions-mass transport of solutes,advection diffusion equation,favorable conditions for contaminant transport-modelling parameters and boundary conditions, seawater intrusion – basic concepts and modeling-Ghyben–Herzberg formula-popular ground water models

Module5

Environmental noise - noise generation mechanisms- need for noise modelling- modelling inputs-sound propagation factors- Equivalent Continuous Sound Pressure Level (Leq)-noise mapping methodology-modelling traffic noise-CoRTN and RLS90 models

Text Books

1. Gilbert M Masters Wendell P Ela, Introduction to Environmental Engineering & Science, Pearson,2013
2. Steven C.Chapra, Surface Water Quality Modeling, The McGraw-Hill Companies,Inc., New York, 1997.
3. Todd David Keith, Ground water Hydrology, Fourth edition, John Wiley and Sons, New York, 2004..
4. C.P Kumar, Ground water assessment and modelling, Createspace Independent Pub, 2015

References

1. Seinfeld and Pandis, Atmospheric chemistry and physics, Wiley 2016
2. Marcello Benedini, George Tsakiris, Water quality modelling for rivers and streams,Springer 2013
3. Mary Anderson William Woessner Randall Hunt, Applied ground water modelling, Academic Press, 2015
4. Enda Murphy Eoin King, Environmental Noise Pollution, Elsevier, 2014

Lecture Plan- Environmental Impact Assessment

Module	Topic	Course Outcomes addressed	No. of Lectures
1	**Module 1: Total Lecture Hours -9**		
1.1	Role of models in environmental pollution studies-objectives of modelling-modelling principles-	CO1	1
1.2	types of models-classification of mathematical models-deterministic, stochastic, continuous, discreet, static, dynamic, linear and non-linear-	CO1	2
1.3	model building framework-model calibration, validation, verification and sensitivity analysis-model scales, error and uncertainty -	CO2	3
1.4	distributions in modelling data of environmental pollutant concentrations- log-normal, Weibull, and gamma	CO1,CO2	3
2	**Module II: Total Lecture Hours- 9**		
2.1	Air pollution modelling: Transport and dispersion of air pollutants	CO2	1
2.2	estimating concentrations from point sources – dispersion modelling- Gaussian Plume Model – determination of dispersion parameters, atmospheric stability	CO2, CO3, CO4	4
2.3	box models- line source model-area source model-puff model	CO2, CO3, CO4	4
3	**Module III: Total Lecture Hours-9**		
3.1	Water quality modeling: historical development of water quality models	CO1,CO2	1

3.2	Rivers and streams water quality modelling– low flow analysis – pollutant transport-advection, diffusion and dispersion	CO2, CO3	2
3.3	Modelling lake water quality-mass balance for well mixed lakes	CO2, CO3	2
3.4	models for dissolved oxygen; Streeter Phelps model-	CO2, CO3,CO4	3
3.5	sediment transport modelling	CO2, CO3,CO4	1
4	**Module IV: Total Lecture Hours- 9**		
4.1	Groundwater modelling: use of ground water models-ground water flow modeling-Darcy's law-ground water flow equations for homogenous, heterogenous, isotropic and anisotropic conditions-	CO1,CO2	3
4.2	mass transport of solutes, advection dispersion equation, favorable conditions for contaminant transport-modelling parameters and boundary conditions	CO2,CO3,CO4	3
4.3	seawater intrusion – basic concepts and modeling-Ghyben–Herzberg formula, popular ground water models	CO2,CO3,CO4	3
5	**Module V: Total Lecture Hours- 9**		
5.1	Environmental noise - noise generation mechanisms-need for noise modellingnoise mapping methodology-	CO2	3
5.2	modelling inputs-sound propagation factors - Equivalent Continuous Sound Pressure Level (Leq)-	CO2	3
5.3	modelling traffic noise-CoRTN and RLS90 models	CO3	3

Model Question Paper

Reg No.:_______________ **Name:__________________________**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: CET398

Course Name: ENVIRONMENTAL POLLUTION MODELLING

Max. Marks: 100 Duration: 3 Hours

Part A

(***Answer all questions; each question carries 3 marks***)

1. Why do we need models in environmental studies?
2. A model can never represent the reality. Explain
3. What are the assumptions used in a box model?
4. Explain how atmospheric stability influence dispersion of air pollutants?
5. Explain Streeter-Phelps model
6. How modeling lake water quality is different from modeling river water quality?
7. Explain the role of Darcy's law in ground water modelling
8. Explain Ghyben-Herzberg relation
9. What are the parameters influencing propagation of environmental noise?
10. What you mean by Equivalent Continuous Sound Pressure Level ?

PART B

(Answer one full question from each module, each question carries 14 marks)

11. (a) Why do we need models? Explain with an example (5 Marks)

    (b) Discuss various types of models used in environmental science (9 Marks)

OR

12. (a) Reliability of a model does not necessarily increase with model complexity. Why? (5 Marks)

    (b) Discuss the model building framework (9 Marks)

13. (a) An air sampling station is located at an azimuth of 203^{o} from a cement plant at a distance of 1500 meters. The cement plant releases fine particulate matter at the rate of 94.5 g/s from a 30 meter high stack. What is the contribution from the cement plant to the ambient particulate

matter concentration at the sampling station when the wind is from 30 ^{o} at 3 m/s. Given that σy= 150m and σz= 87m (9 Marks)

(b) What is plume rise? How it influences air quality modelling? (5Marks)

OR

14. (a) How stability parameters used in Gaussian model are determined? (5 Marks)

(b) Discuss in detail various air quality models and their use (9 Marks)

15. (a) Briefly discuss the historical development of water quality models (9 Marks)

(b) What input data are needed for sediment transport modelling (4 Marks)

OR

16. (a) The initial BOD of a river just below a sewage outfall is 25 mg/L. The oxygen deficit just upstream from the outfall is 2 mg/L. The deoxygenation rate coefficient k_d is 0.4/day, and the reaeration rate coefficient k_r is 0.7/day. The river is flowing at a speed of 30 km /day.

(i) Find the critical distance downstream at which DO is a minimum

(ii) Find the minimum DO (9Marks)

(b) Explain low flow analysis (5 Marks)

17. (a) An aquifer has a cross section with a horizontal width of 265m, and a vertical thickness below the water table of 42m. The water table is 36 m below the ground surface. Each day 3340 m3 of water is discharged through the cross section. The aquifer rock has an effective porosity of 27.1%. Find the Seepage velocity through the aquifer (5 Marks)

(b) Discuss the basic mechanisms that drives the contaminant transport in ground water (9 marks)

OR

18. (a) What are the contaminant, soil and site properties and their combinations that are critical in the transport of contaminants to ground water (5 Marks)

(b)The distance from the base of a pumping well to the freshwater-saltwater interface is 100 m, the pumping rate is 3000 m3/day, and the hydraulic conductivity is 10 m/d.

(i) What will be the position of the interface?

(ii) What's the maximum permitted pumping rate for the well? (9 Marks)

19. (a) Discuss the need for environmental noise modelling (5 Marks)

(b) Explain noise mapping methodology (9 Marks)

OR

20. (a) Explain the noise generation mechanisms (5Marks)

(b) Discuss how traffic noise can be modelled? (9 Marks)