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JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATION – December 2017

M.Tech I Semester

COURSE CODE: 14M31CE112 **MAX. MARKS: 35**

COURSE NAME: SIMULATION AND MODELING

COURSE CREDITS: 03 **MAX. TIME: 2.0 Hr**

Note: All questions are compulsory. Carrying of mobile phone during examinations will be treated as case of unfair means. Assume suitable data if required.

Q1.a) How do you estimate the longitudinal dispersion coefficient of a stream reach from concentration-time distribution curves? **[02 Marks]**

b) The following information was obtained from concentration-time distribution curves at two locations (upstream and downstream) in a stream. The variances corresponding to upstream and downstream locations were 10.0 s^2 and 12.6 s^2 respectively. The mean time of passage of tracer cloud was found to be 59s and 97s. The mean velocity of flow between stations is given by 32.5 m/s. Estimate the coefficient of dispersion within the reach. **[02 Marks]**

c) An Industrial wastewater is discharged into a municipal wastewater sewer. The characteristics of the two wastes area as follows: **[02 Marks]**

Characteristics	Wastewater	Stream
Flow	0.3 m^3/s	5.0 m^3/s
BOD_5	100 mg/L	3 mg/L
Temperature	15°C	20.5°C
Phosphate	140mg/L	2.3g/m^3
NH4	30.0mg/L	2.0mg/L
TDS	660 mg/L	100mg/L

Determine the characteristics of the mixture.

Q2.a) Derive Streeter-Phelps model to simulate DO-BOD relationship in streams. **[05 Marks]**

b) Ten kg of a tracer are released instantaneously into a stream at point A. What will be the profile of the tracer cloud 5000 m downstream from point A if the flow velocity of the stream is 0.5 m/s, the dispersion coefficient is 50m^2/s, and the cross-sectional area at point A is 20 m^2? **[05 Marks]**

c) An infinitely long cylinder with a diameter of 10 cm is filled with a stationary fluid. A mass input (M = 0.1 g CO_2) is introduced instantaneously at t = 0 and uniformly at the centre of the tube (x = 0). Find the time for the CO_2 to reach a concentration (mass fraction) of 1 ppm at x = 50 cm for: [05 Marks]

i) Molecular diffusion in air

ii) Molecular diffusion in water.

Assume densities of air and water are 1.23 and 1000 kg/m^3 respectively. Diffusion coefficient of gaseous carbon dioxide is 0.14 cm^2/s in air and 1.71 x 10^{-5} cm^2/s in water

Q3.a) What are the assumptions made in deriving the Gaussian Plume Model?

[02 Marks]

b) A Power plant burns 7.30 tonnes of coal per hour and discharges the combustion products through a stack with an effective stack height of 75 m. The coal has a sulfur content of 4.1 percent, and the wind velocity at the top of the stack is 3.0 m/s. Atmospheric conditions are stable (Class C). Consider Urban Wind Profile Exponent

i. Determine the maximum ground-level concentration of SO_2 and the distance from the stack at which the maximum occurs.

ii. Calculate the centerline concentration for SO_2 at the following distances downwind:
500m, 1km, 3km, 5km, 7.5km, 10km and 15km
Plot these values on a graph and include the maximum concentration

iii. Using the above information, develop the crosswind concentration profiles for SO_2 at 1km, 5 km and 10km. Sketch the profiles. **[02+03+03]**

Q4.a) What do you mean by "Monte Carlo Simulation" and how it is different from a deterministic simulation. **[2.0 Marks]**

b) Mention the several application areas of Monte Carlo Simulation Technique and discuss briefly on any one area **[2.0 Marks]**

Power Law Exponents and Coefficients for σ_z

Atmospheric Stability Class	Downwind Distance, meters $100 < x \leq 500$		Downwind Distance, meters $500 < x \leq 5000$		Downwind Distance, meters $5000 < x$	
	a	b	a	b	a	b
A=1	.0383	1.281	.0002539	2.089	.0002539	2.089
B=2	.1393	.9467	.04936	1.114	.04936	1.114
C=3	.1120	.9100	.1014	.926	.1154	.9109
DD=4	.0856	.8650	.2591	.6869	.7368	.5642
DN=5	.0818	.8155	.2527	.6341	1.297	.4421
E=6	.1094	.7657	.2452	.6358	.9204	.4805
F=7	.05645	.8050	.1930	.6072	1.505	.3662

Power Law Exponents and Coefficients for σ_y

Atmospheric Stability Class	Downwind Distance, meters $x < 10{,}000$		Downwind Distance, meters $x \geq 10{,}000$	
	c	d	c	d
A=1	.495	.873	.606	.851
B=2	.310	.897	.523	.840
C=3	.197	.908	.285	.867
DD=4	.122	.916	.193	.865
DN=5	.122	.916	.193	.865
E=6	.0934	.912	.141	.868
F=7	.0625	.911	.0800	.884

Table 5. Wind Profile exponent as a function of atmospheric stability class

Stability class	rural exponent	urban exponent
A	0.07	0.15
B	0.07	0.15
C	0.10	0.20
D	0.15	0.30
E	0.35	0.30
F	0.55	0.30