B. Sc. Engg (CEE)/7th Semester 09 December, 2023 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Semester Final Examination **Winter Semester: 2022 - 2023**
Course Number: CEE 4735 **Full Marks: 150**
Course Title: Environmental Pollution and Its Control **Time: 03 Hours**

There are **06 (six)** questions. Answer **all** questions. Programmable calculators are not allowed. Do not write on this questions paper. The symbols have their usual meaning. **Assume reasonable data if needed.**

			CO	PO	Marks
1	a)	Select appropriate mechanism for the following situations: i. In an industrial area with a previous record of chemical spills and improper waste handling, the soil of the adjacent area is contaminated with volatile compounds. Suggest a viable control mechanism for soil remediation in this scenario. ii. A manufacturing factory located near a stream utilizes steam turbines as part of its production activities and thus generates heat wastes. The environmentalists are concern about thermal shock on aquatic life and it is required to set up a control mechanism with minimum maintenance.	CO1	PO1	5
	b)	A lake with surface area equal to 80×10^6 m^2 is fed by a stream having an average flow of 15.0 m^3/s and an average total phosphorus concentration of 0.010 mg/L. The phosphorus settling rate is estimated at an average of 9 to 12 m/year. In addition, treated effluent from a wastewater treatment plant adds 0.20 m^3/s of flow having 5.0 mg/L total phosphorus. The temperature of the lake was 16°C whereas the effluent had a temperature twice of that. BOD_5 for the lake and the effluent are 50 mg/L and 3.5 mg/L respectively. At 20°C, the deoxygenation rate constant is 0.23d^{-1}. Based on the above scenario, answer the following questions (i), (ii) and (iii) i. Estimate the average total phosphorus concentration and predict the productivity of the lake. ii. What rate of phosphorus removal at the wastewater treatment plant would be required to keep the concentration of phosphorus in the lake at an acceptable level of 0.010 mg/L? iii. Find out the amount of BOD remaining after 1 day of mixing of the effluent with lake.	CO2	PO2	18

2	a)	Answer the following questions (i), (ii) and (iii) in brief:	CO1	PO1	9
		i. Describe why persistent organic pollutants are considered chemicals of global concern.			
		ii. State the factors upon which the self-purification of pathogens depends on.			
		iii. Describe the benefits of lake turnovers on aquatic environment.			
	b)	A municipal wastewater treatment plant discharges 18925 m^3/d of secondary effluent to a surface stream. The wastewater has a BOD_5 of 30 mg/L, dissolved oxygen (DO) concentration of 2.0 mg/L, and a temperature of 24°C. The stream just above the point of discharge flows at 5.6 m^3/s, has a BOD_5 of 4.0 mg/L, a DO concentration of 8.0 mg/L, and a temperature of 16°C. Complete mixture of the wastewater and stream is almost instantaneous, and the velocity of the mixture is 0.3 m/s. From the flow regime, the reaeration rate constant k_r is estimated to be 0.3 d^{-1} and the deoxygenation rate constant k_d is found to be 0.23 d^{-1} at 20°C Based on the above scenario, answer questions (i), (ii) and (iii).	CO3	PO2	30
		i. Compare the DO after 2 days of mixing of effluent into the stream with that of the saturated DO of the stream.			
		ii. Analyze mathematically if the stream will be suitable for aquatic life considering the presence of effluent discharge. Mention the distance of the zone of maximum pollution.			
		iii. Compute the rate of reoxygenation and the rate of deoxygenation after 2 days of the mixing of effluent into the stream.			
		iv. Illustrate the DO profile of the above scenario up to 100 km reach.			
3	a)	List the control mechanisms for noise level at the following zones	CO1	PO1	4
		i. machine manufacturing industry			
		ii. commercial areas			
	b)	If one noise source produces 56 dB at a given distance, what would be the noise level of 10 of the same sources combined at the same distance? What would be the percentage of change in noise level if the number of vehicles is reduced to half?	CO2	PO2	6
	c)	The average noise level from a two-lane highway is 55 dBA at a receiver located 40 m from the centerline. The ground between the highway and receiver is a grassy field.	CO2	PO2	11
		i. Estimate the noise level that can be expected for a receiver 15 m from the centerline of the same highway.			
		ii. Demonstrate the changes of sound with a diagram when a barrier is placed on a transmission path.			
		iii. Compute the loss of noise level due to the presence of a barrier in the transmission path if only one-third of the noise striking the barrier is transmitted.			

	d)	After conducting a survey for noise level data collection at a classroom for one hour, the following data have been acquired from statistical analysis. L10 = 78 dBA L50= 63 dBA L90=60 dBA Based on the data provided above, answer the following questions (i) and (ii) i. Analyze the significance of the three statistical terms L10, L50 and L90 related to fluctuations of noise level. ii. Compute the equivalent noise level and range of noise fluctuation of the classroom.	**CO2**	**PO2**	**6**
4		A residential area is adjacent to a two-lane road made of moderately absorptive material ($\alpha = 0.75$) with a sidewall measuring 6.1 feet in height. Distance from the center line of the farthest lane to the receiver is 75 ft. Consider receiver height at road level. The information related to the traffic volume and vehicle speed are listed below: Auto = 380 vph/lane; 49 mph Medium Truck (MT) = 318 vph/lane; 43 mph Heavy Truck (HT) = 136 vph/lane; 35 mph Lane width = 22 ft Predict the total equivalent noise level based on above scenario explaining the factors behind the attenuation of noise.	**CO3**	**PO2**	**25**
5	a)	A 15-m-long settling chamber with a height of 2.5 m operates at a horizontal gas velocity of 1 $m.s^{-1}$. The density of particles that are to be removed in the settling chamber is 2100 $kg.m^{-3}$. Assuming plug flow characteristics and a flue gas dynamic viscosity of $1.8x10^{-5}$ $kg.m^{-1}s^{-1}$, Analyze the change of collection efficiency with the change in particle diameters from 10-μ to 100-μ with an interval of 10-μ.	**CO3**	**PO2**	**8**
	b)	Write down the goals of Clean air act.	**CO1**	**PO1**	**4**
	c)	Write down the classification of pollutants.	**CO1**	**PO1**	**5**
6	a)	An environmental pollution management strategy for a power plant first considered using a settling chamber to treat a particulate-filled air stream. The volumetric flow is 1.0 m^3/s. Design a settling chamber to collect particles 10 μm in diameter having a density of 1500 kg/m^3. The chamber is to be 2.5 m in width and 1.5 m in height. Assume dynamic viscosity of $1.8x10^{-5}$ $kg.m^{-1}s^{-1}$ i. Design the settling chamber be to give theoretical perfect collection efficiency? ii. Using the length determine the collection efficiency for 5 μm particles with the same density. iii. Draw the schematic diagram of the settling chamber.	**CO4**	**PO3**	**9**
	b)	What is role of emissions inventory in air pollution?	**CO1**	**PO1**	**5**
	c)	What is good ozone and bad ozone?	**CO1**	**PO1**	**5**

Necessary Formulae

Heavy Trucks:

25-31 mph (40-50 km/h):

REMEL=51.9+19.2Log_{10}(Speed, mph) or 47.9+19.2Log_{10}(Speed, km/h)

35-65 mph: (56-105 km/h):

REMEL=50.4+19.2Log_{10}(Speed, mph) or 46.4+19.2Log_{10}(Speed, km/h)

31-35 mph: (50-56 km/h):

REMELS=Approximately 80 dBA

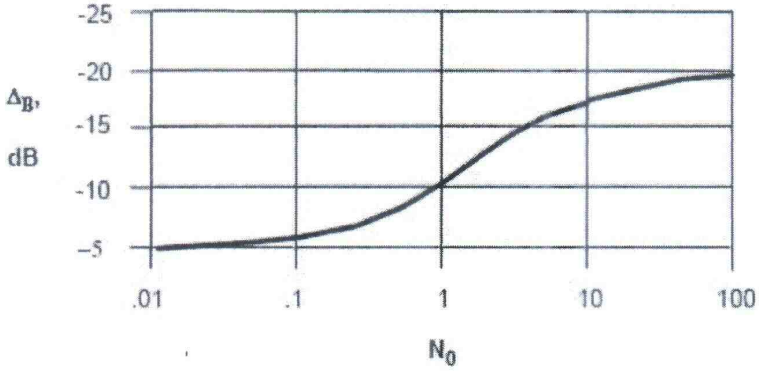
Medium Trucks:

REMEL=35.3+25.6Log_{10}(Speed, mph) or 30.0+25.6Log_{10}(Speed, km/h)

Autos:

REMEL=5.2+38.8Log_{10}(Speed, mph) or -2.8+38.8Log_{10}(Speed, km/h)

REMELS is measured individually for HT, MT and Auto.



$$t_c = \frac{1}{k_2 - k_1} \ln\left\{\frac{k_2}{k_1}\left(1 - D_o \frac{k_2 - k_1}{k_1 L_o}\right)\right\}$$

$$D_t = \frac{k_1 L_o}{k_2 - k_1}\left(e^{-k_1 t} - e^{-k_2 t}\right) + D_o e^{-k_2 t}$$

$DO_{sat} = 14.62 - 0.394T + 0.007714T^2 - 0.0000646T^3$, T in °C