

9210-202

Post Graduate Diploma in Civil Engineering

Environmental engineering

GLA d'Y'DUdYf

**You should have the
following for this examination**

- one answer book
- pen, pencil, ruler
- non-programmable calculator

No additional data is attached

General instructions

- This paper consists of **eight** questions.
- Answer any **five** questions.
- A non-programmable electronic calculator may be used but candidates **must** show sufficient steps to justify their answers.
- Drawings should be clear, in good proportion and in pencil.
- All questions carry equal marks. The maximum marks for each section within a question are shown.

- 1
 - a)
 - i) What is the difference between heterotrophic and autotrophic microorganisms? (2 marks)
 - ii) How can changes in primary productivity of aquatic systems affect the use of aquatic resources? Explain briefly (2 marks)
 - iii) Briefly outline the basic features of the hydrologic cycle. (2 marks)
 - b) Glyphosate is a weedicide extensively used in agriculture. When released to the environment that becomes a very persistent contaminant. How does it impact on human health if Glyphosate is released to inland water sources? *Explain briefly.* (5 marks)
 - c)
 - i) Construction of a dam across a river can cause undesirable environmental impacts on the downstream ecosystem. Discuss highlighting three impacts, suggesting mitigatory measures. (4 marks)
 - ii) What is meant by trace metals? How do they impact on human health if released to the environment? (3 marks)
 - iii) Briefly discuss the difference between the anthropogenic greenhouse effect and the natural greenhouse effect. (2 marks)

- 2
 - a)
 - i) Differentiate between impounding reservoirs and distribution reservoirs. (2 marks)
 - ii) What is meant by 'contaminant plume'? How does it impact on water sources? (2 marks)
 - iii) Calculate the velocity of groundwater flow in soil that has a coefficient of permeability of 0.05 mm/s if the water table drops 0.5 m in elevation over a distance of 200m. (3 marks)
 - b)
 - i) What is the difference between point source and dispersed source of pollutants? Give an example of each. (2 marks)
 - ii) If a sample of stream water had an unusually high chloride ion concentration, what might you conclude about its quality? Briefly describe the difference between chloride and chlorine residual in water. (4 marks)
 - c)
 - i) Pathogens cause communicable diseases. List two modes of transmission of communicable diseases with examples. (2 marks)
 - ii) How do higher concentrations of Mn and Fe impact on drinking water? (2 marks)
 - iii) A 70 kg bag of CuSO_4 is dissolved in a lake to control algal growth. The lake volume is 30 ha-m. If the chemical is completely dispersed throughout the lake volume, what is its concentration in mg/L? (3 marks)

- 3
 - a)
 - i) List the limiting nutrients for eutrophication in surface water. Why does eutrophication rarely occur in a stream? (2 marks)
 - ii) A discharge from a sewage treatment plant enters a stream at a flow rate of 3 mgd. The BOD of the discharge is 50 mg/l. How many kilograms of BOD are entering the stream per day? ($1000 \text{ m}^3/\text{d} = 0.264 \text{ mgd}$) (3 marks)
 - b)
 - i) What is DO? Why it is a significant parameter of water quality? (1 mark)
 - ii) Briefly describe what a 'DO profile' is. Make a sketch of a DO profile for a small, slow moving stream receiving a raw sewage discharge. Why is it important to be able to compute the minimum DO in a stream or river? (4 marks)
 - iii) A 5 ml sample of sewage is diluted to 300 mL in a standard BOD bottle. The initial DO in the bottle is 9.2 mg/L, and after 5 day of incubation the DO is found to be 3.9 mg/L. Determine the 5 day and ultimate BOD values for the sewage assuming that the reaction rate constant is 0.14/day. (4 marks)
 - c)
 - i) It is recorded that a small water stream is getting turbid and gives a bad smell and further, fish have been found dead. Provide the possible causes for such pollution of this stream. (2 marks)
 - ii) If the necessary precautions have not been taken for some period, what conditions do you expect from this river? (2 marks)
 - iii) Suppose the Public Health Inspector (PHI) in the area consults you as an Environmental Engineer, list suggestions that could be given to overcome this problem. (2 marks)

- 4 a) i) Sketch a flow diagram of a typical surface water treatment plant. (2 marks)
- ii) What is meant by a public water system? Write two differences between a community system and a non-community system (2 marks)
- b) i) Raw water inflow rate of a water treatment plant is $0.6 \text{ m}^3/\text{s}$. Assuming that the flocculant slurry can be expected to have a uniform particle size with settling rate of $V_s = 0.004 \text{ m/s}$, if the rectangular settling tank has an effective settling zone of $L = 20 \text{ m}$, $H = 3 \text{ m}$ and $W = 6 \text{ m}$, could 100% removal be expected? If there are any assumptions in your answer, clearly mention them. (5 marks)
- ii) Estimate the fraction of particles to be removed. (2 marks)
- c) i) A 16 million L/day water treatment plant is being designed for an overflow rate of $1.2 \text{ m}^3/\text{hr}/\text{m}^2$. If two circular sedimentation basins are to be used at all times, what would be the diameter of each basin? (5 marks)
- ii) What is the purpose of a jar test? Describe it briefly. (2 marks)
- iii) What is considered to be the most important water treatment process with respect to preventing waterborne diseases? (2 marks)
- 5 a) i) What is the purpose of grit removal at a waste water treatment facility? How is it accomplished? (2 marks)
- ii) What is meant by hydraulic load and organic load in wastewater treatment? How do you estimate hydraulic retention time and solids retention time in wastewater treatment plants? (3 marks)
- iii) Explain the purpose of the F/M ratio and define F and M in terms of BOD_5 and mixed liquor volatile suspended solids. (2 marks)
- b) A completely mixed activated sludge process is to be designed to treat $15,000 \text{ m}^3$ per day of industrial waste containing 1250 mg/L of BOD_5 . Effluent needs to be treated to 30 mg/L . A treatability analysis found that a mean cell residence time of 25 days is sufficient and that the unit could operate at a MLVSS of 6000 mg/L , $y = 0.07 \text{ g/g}$ and the value of $K_d = 0.04$ per day. The underflow concentration is $10,000 \text{ mg/L}$. Calculate the volume of the reactor and the mass and volume of the solids wasted per day. Retention time is given by $\theta = Y \cdot (S_0 - S_e) / X (1 + \theta_c K_d)$ with usual notations. (6 marks)
- c) i) Determine the surface area of a primary settling tank sized to handle a maximum hourly flow of $0.580 \text{ m}^3/\text{s}$ at an overflow rate of 60.0 m/d . If the effective tank depth is 3.0 m what is the effective theoretical detention time? (3 marks)
- ii) If an equalization basin is installed ahead of the primary tank in the above section, the average flow to the tank is reduced to $0.400 \text{ m}^3/\text{s}$. What is the new overflow rate and detention time? (4 marks)

- 6 a) i) Define SVI and explain its use in the design and operation of an activated sludge plant. (2 marks)
- ii) The 500 bed Santa Dora Hospital has a small activated sludge plant to treat its wastewater. The average daily hospital discharge is 1200 litres per bed, and average soluble BOD₅ after primary settling is 500 mg/L. The aeration tank has effective liquid dimensions of 10.0 m width by 10.0 m length by 4.5 m depth. The plant operating parameters are as follows:
 MLVSS = 2000 mg/L
 MLSS = 1.20 (MLVSS)
 Settle sludge volume after 30 min = 200 mL/L
 Determine F/M ratio and SVI (6 marks)
- iii) Estimate solids concentration in return sludge of the problem given in Q6 a) ii) above. (2 marks)
- b) i) Describe with the help of a neat figure, the principles of treatment of trickling filters, bio towers and RBCs. (3 marks)
- ii) How do you improve the efficiency of trickling filters in waste water treatment plants? (1 mark)
- c) i) How do you classify stabilization ponds? List the special features of stabilization ponds in wastewater treatment specially relate to the tropical environment. (2 marks)
- ii) Describe the three basic approaches to land treatment of wastewater. (2 marks)
- iii) What are the objectives of sludge stabilization? (2 marks)
- 7 a) i) Suppose an environmental engineer at a local authority was asked to develop an integrated solid waste management programme for sustainable disposal of solid waste generated in the area. He needs the data of local solid waste generation and composition and not the national averages to develop the said solid waste management plan. Discuss merits and demerits of using locally generated data rather than the regional averages. (4 marks)
- ii) Discuss general characteristics of MSW generated in your area and advantages/disadvantages of incinerating that solid waste. (3 marks)
- b) i) Draw a sketch showing a cross section of a secure landfill. (2 marks)
- iii) In land filling, what does site hydrology refer to? Why is it important with regard to sanitary landfill design? How is land fill leachate controlled? (3 marks)
- c) i) Why is conducting an 'Environmental Impact Assessment' important in national developmental projects? Describe briefly, providing examples. (4 marks)
- ii) In the EIA process, how community awareness and public participation are involved. Explain briefly. (2 marks)
- iii) List the methods of environmental management that can be incorporated for the benefit of the environment and society. (2 marks)

- 8 a) i) Categorize the types of pollutants from automobiles. (1 mark)
- ii) Automobiles are the largest air pollution source in some cities in the world. Name and describe three control devices developed for the control of automotive emissions. (3 marks)
- iii) An air quality standard limits 8-h average carbon monoxide (CO) levels to 9 ppm. Express this concentration in terms of mg/m³ at 25°C and 1 atm pressure? Molecular weights of C and O₂ are 12 and 16 respectively. (3 marks)
- b) i) What is meant by floodplain? What is a flood hazard area? (2 marks)
- ii) Estimate the peak rate runoff on 15 ha watershed from a storm with rainfall intensity of 15 mm/h. Use the runoff coefficient of 0.6. If the runoff of 35% of the above area, having a runoff coefficients of 0.95, is proposed to be collected through rainwater harvesting, estimate the size of collector tanks to be constructed for the same intensity of rainfall. (5 marks)
- c) i) List three general characteristics of a watershed that may affect the runoff volume and rate of runoff. (3 marks)
- ii) Explain the purpose of the unit hydrograph and explain how it might be applied in the analysis of a storm sewer design or a stream flood control project. (3 marks)