

Time allowed: $2\frac{1}{4}$ Hours

Maximum Marks: 100

NOTE: ATTEMPT ALL QUESTIONS. ALL QUESTIONS CARRY EQUAL MARKS. PROGRAMMABLE CALCULATORS ARE NOT ALLOWED. ASSUME ANY MISSING DATA.

1. (a) List the *constituents* of wastewater management. List also the *performance criteria* of wastewater management systems. (05)
- (b) Define the term *conventional wastewater treatment*. Draw the *basic flow diagram* for conventional sewage treatment showing different stages of treatment. (05)
- (c) Evaluate the following primary sedimentation tank design with respect to *detention time, overflow rate, and weir loading*.
Design data:
Flow = $0.150 \text{ m}^3/\text{s}$
Influent SS = 280 mg/l
Sludge concentration = 6.0%
Length = 40 m (effective)
Width = 10.0 m
Liquid depth = 2.0 m
Weir length = 75.0 m (10)
2. (a) Write/List the *objectives* of biological treatment processes and also list the *five types of aerobic biological treatment processes* used to treat municipal sewage. (05)
- (b) Differentiate between low rate and high rate trickling filters with respect to *filter media, hydraulic loading rate, organic loading rate, recirculation ratio and sloughing*. (05)
- (c) Design a *single stage trickling filter* to yield an effluent BOD_5 of 30 mg/l . The influent BOD_5 following primary clarification is 160 mg/l and the flow is $1,000 \text{ m}^3/\text{day}$. Maintain a hydraulic loading rate of $20 \text{ m}^3/\text{m}^2 - \text{day}$ and a filter depth of 2 m . (10)
3. (a) Define *activated sludge*. With the help of a neat sketch briefly explain the *working* of a standard activated sludge process. (05)
- (b) List the *different methods* of anaerobic biological treatment processes. (05)
- (c) Design an *aeration tank* for an activated sludge process to treat a flow of $18,925 \text{ m}^3/\text{d}$. BOD_5 is 200 mg/l , F/M ratio = 0.4 d^{-1} , MLSS = $2,000 \text{ mg/l}$ and air supply is $10 \text{ m}^3/\text{m}^3$ of sewage treated. If SVI of 100 ml/gm is required, how much sludge should be returned? (10)
4. (a) Differentiate between an *oxidation pond* and *aerated lagoon*. List the *different types* of waste stabilization ponds used to treat sewage. (05)
- (b) Briefly explain the *symbiotic relationship of bacteria and algae* in a waste stabilization pond. (05)
- (c) An aerated lagoon 50 m square at the water surface and 3 m deep (with banks sloped at 2 horizontal to 1 vertical) receives a wastewater flow of 2.5 ML/d with 600 mg/l of BOD_5 . Draw the sketch and calculate the *detention time, volumetric organic loading* and *F/M ratio*, assuming MLSS concentration in the lagoon is 400 mg/l . (10)
5. (a) Define *solid waste*. List its *types* and *sources*. (05)
- (b) List the classification of the *different forms bacteria* depending on their action towards *free oxygen* for the survival of optimum growth. Also list the classification of the *different forms bacteria* by their *preferred temperature* for the survival of optimum growth. (05)
- (c) Design a *septic tank* for a family of 12. The per capita daily water consumption is 100 liters . Assume a detention time of 3 days, a wastewater flow of 80% of the daily water consumption, and a rate of sludge accumulation of $0.04 \text{ m}^3/\text{head}/\text{day}$. Find also the *desludging interval*. (10)

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