

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 =  $280 \text{ mg/l}$   
Sludge concentration =  $6.0 \%$   
Length =  $40 \text{ m}$  (effective)  
Width =  $10.0 \text{ m}$   
Liquid depth =  $2.0 \text{ m}$   
Weir length =  $75.0 \text{ m}$  (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  $\text{BOD}_5$  of  $30 \text{ mg/l}$ . The influent  $\text{BOD}_5$  following primary clarification is  $160 \text{ mg/l}$  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  $2 \text{ m}$ . (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  $18,925 \text{ m}^3/\text{d}$ .  $\text{BOD}_5$  is  $200 \text{ mg/l}$ , F/M ratio =  $0.4 \text{ d}^{-1}$ , MLSS =  $2,000 \text{ mg/l}$  and air supply is  $10 \text{ m}^3/\text{m}^3$  of sewage treated. If SVI of  $100 \text{ ml/gm}$  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  $50 \text{ m}$  square at the water surface and  $3 \text{ m}$  deep (with banks sloped at 2 horizontal to 1 vertical) receives a wastewater flow of  $2.5 \text{ ML/d}$  with  $600 \text{ mg/l}$  of  $\text{BOD}_5$ . Draw the sketch and calculate the *detention time, volumetric organic loading* and *F/M ratio*, assuming MLSS concentration in the lagoon is  $400 \text{ mg/l}$ . (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  $100 \text{ liters}$ . 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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