Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**ME - SEMESTER–II • EXAMINATION – SUMMER - 2017**

**Subject Code: 2721802** **Date: 25/05/2017**

**Subject Name: Treatment Process Design and Drawing**

**Time: 02:30 PM To 05:00 PM** **Total Marks: 70**

**Instructions:**

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

**Q.1** **(a)** Design a paddle flocculator by determining the basin dimensions, the paddle configuration and the power requirement for the following parameters: **07**

(i) Design Flow Rate= $50 \times 10^3$ $m^3/d$

(ii) t = 22 minutes

(iii) Three flocculator compartments with G= 40, 30, 20 $s^{-1}$

(iv)Water temperature = $15^0$ C Take $\mu = 1.139 \times 10^{-3}$ Pa.s

**(b)** A town has been directed to upgrade its primary WWTP to a secondary plant that can meet an effluent standard of 25.0 mg/L $BOD_5$ and 30 mg/L suspended solids. They have selected a completely mixed activated sludge system for the upgrade. The existing primary treatment plant has a flow rate of 2,506 $m^3/d$. The effluent from the primary tank has a $BOD_5$ of 240 mg/L. Using the following assumptions, estimate the required volume of the aeration tank: **07**

1. $BOD_5$ of the effluent suspended solids is 70% of the allowable suspended solids concentration
2. Growth constant values are estimated to be: Ks = 100 mg/L $BOD_5$; kd = 0.025 $d^{-1}$ $\mu m$= 10 $d^{-1}$ ;Y =0.8 mg VSS/mg $BOD_5$ removed.
3. The design MLVSS is 3,000 mg/L

**Q.2** **(a)** A filter with 1200 $m^2$ of surface area is used to clean 11 $m^3/s$ of air which has a dust loading of 0.0015 $kg/m^3$.The values of Rf and Rp are 22000 $kg/m^2s$. and 25,000 $s^{-1}$ respectively If it is desirable for the overall pressure drop not to exceed 2100 $N/m^2$, determine the maximum allowable cleaning period in hours. **07**

**(b)** An electro static precipitator has six collecting plates 3m tall and 3 m long in the direction of flow. The spacing between the plates is 229 mm. the ESP is to be used to collect particles having a dielectric constant of 4.0 and an effective diameter of 3 mm. The carrier gas (air at $420^0$ K) has a throughput velocity of 7.3 m/s. Calculate the voltage (kV) required for 99.5% collection efficiency. Assume the strength of charge in field and collecting field strength are same, Neglect Cunningham correction factor. Viscosity at $420^0$ K is $2.4 \times 10^{-5}$ kg/m.s **07**

**OR**

**(b)** Design an aerated grit chamber for an average flow of 8 MLD. Check for detention time and surface loading rate. **07**

**Q.3** **(a)** Design following units of Rapid Sand Filter system for the town of 1.2 lakh population. The rate of water supply is 200 L/ capita-day. Take peaking factor of 1.5.Assume necessary data. Design for following: **07**

1. Number of filter beds
2. Depth of sand bed
3. Gravel bed

**(b)** Explain the purpose and location of the following unit operations/processes in water treatment plant **07**

(i) Floculation
(ii) Aeration
(iii) Ion exchange
(iv) RO
(v) softening
(vi) Disinfection
(vii) Recarbonation

**OR**

**Q.3** **(a)** Sludge drying bed length, breadth and depth dimensions are 15m x 6m x 0.45m. The sludge contains 3.8% solids. Calculate how many Kg solids are there in the sludge drying beds. **07**

**(b)** Calculate the amount of sludge to be handled by the sludge drying beds of size 25m x 5m x 4 nos. sludge depth as normal 0.25m .The sludge contains 2.5 % solids and the sludge bed requires 30 days to settle and cleaning for second application. Calculate the amount of sludge applied with the loading rate . Assume specific gravity of sludge as 1.02. **07**

**Q.4** Design a tube module for rectangular cross section with following data: **14**

(i) Design flow=1.5 MLD
(ii) Cross sectional area of tube=50mmx50mm
(iii) Length of tube= 1 m
(iv) Angle of inclination $=60^0$ to horizontal

**OR**

**Q.4** Design a fine screen element with chamber for a peak flow of 50 MLD.Flow conditions in incoming trunk sewer is given by : **14**

(i) Diameter of sewer=1.5 m
(ii) Depth of flow at peak design flow= 1 m
(iii) Velocity at peak design flow= 0.8 m/s
(iv) Drop of screenchamber flow with respect to sewer invert=0.08 m
(v) Screen efficiency factor=0.56

**Q.5** **(a)** A cyclone separator has an inlet width of 0.05 m and Vi= 18m/s. Estimate the cut size diameter for this cyclone and also estimate the collection efficiency of this cyclone separator for particles with 1 μ in diameter . Assume the following : **07**

$\mu = 1.84 \times 10^{-5}$ Kg/m s , Ne =6, Density of particle=2000 kg/$m^3$ and density of gas=1.185 kg/$m^3$

**(b)** Calculate the solids loading rate for 12 m3 sludge filter press operation with following data : **07**

(i) Filter press surface area = 40 m2
(ii) Solids concentration in sludge = 2.5 %
(iii) Filtration time= 110 minutes for 100Kg and feed time is 10 minutes
(iv) Specific gravity of sludge =1.01

**OR**

**Q.5** **(a)** Design a venture scrubber with a flow of $2m^3/s$ along with neat sketch. **07**

**(b)** Define the following terms along with the design equations: (a) Cut size diameter (b) Saltation velocity (c) Number of effective turns (d) A/C Ratio (e) Cane velocity (f) Efficiency with respect to Venturi scrubber (g) Filter drag **07**

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