B.E. (CIVIL ENGINEERING) –FIFTH YEAR SECOND SEMESTER EXAMINATION 2019
ADVANCED WATER & WASTE WATER TREATMENT
Full Marks : 100 **Time: Three Hours**

Assume any data if necessary. Candidates are required to answer **Any five** question from Group A and Group B, taking at least two from each group.

[Group – A]

1. a. Design a tube settler module of square cross section with following data: [15]
Average design flow: 240 m^3/hr
Cross-section of square tubes: 50 mm × 50 mm
Length of the tubes: 1 m
Thickness of the tube: 1.5 mm
Angle of inclination of the tube with horizontal : 60°
Dia of particle to be removed 100% is 0.04 mm
Specific gravity of particles: 2.65
Kinematic viscosity: 1.035 centistoke. Assume any relevant data if needed.

b. Through a channel of 3 m length, 0.8 m wide, and at a depth of 0.12 m, 0.20 MLD water flows. Calculate the radiation intensity in $\mu watt/cm^2$ at the surface of the water, which is required to destroy 99.9998 % of coliform. Given: *coefficient of absorption at surface water is* 0.06 $cm-1$ and 1 watt= 14.34 calorie/min. Assume any relevant data if needed. [5]

2. a. Design a mechanical rapid mix for a flow of 300 m^3/hr. Assume water temperature to be 20°C. Assume any relevant data if needed. [14]

b. At 20°C the partial pressure (saturated) of chloroform $CHCl_3$ is 18 mm of mercury in a storage tank. Determine the equilibrium concentration of chloroform in water assuming that gas and liquid phases are ideal. Assume that heat absorbed in evaporation of 1 mole of gas from solution at 20°C and a total pressure of 1 atm is 3800 kcal/kmol and empirical constant J is 9.10. Assume any relevant data if needed. [6]

3. a. A settling column analysis of a following suspension is run in. The initial solids concentration is 300 mg/L. At 30 min interval suspended solids samples was collected from each sampling port (spaced at 0.5 m throughout the total settling column depth of 3.0 m) and result obtained from SS concentration was given in the table. What will be the overall removal efficiency of a settling basin which is 2 m deep with a detention time of 1 hr 30 min. Assume any relevant data if needed. [15]

Depth (m)	Time of sampling (min)					
	30	60	90	120	150	180
0.5	132	83	50	38	30	24
1.0	181	124	92	65	55	44
1.5	202	152	117	90	70	57
2.0	212	168	134	112	92	72
2.5	221	181	148	125	105	80
3.0	224	188	157	135	115	97

b. A water with low alkalinity of 12 mg/L as $CaCO_3$ will be treated with the alum lime coagulation (alum as coagulant and lime as coagulant aids). Alum dosage is 52.2 mg/L. [5]

Determine the lime dosage needed to react with alum. Assume any relevant data if needed.

4. a. Find out capacity of storage reservoir to supply a flow of 250 m^3/hr to a city. City power is not available from 6 a.m. to 10 a.m. daily. 8 hrs of pumping is done during 4 am to 6 am and 12 noon to 6 pm. Peak water demand is during i) 6 a.m. to 10 a.m. , ii) 1 p.m. to 2 p.m., 5 p.m. to 6 p.m. Assume a peak factor of 2.25. [12]

Other than peak hours hourly demands are as follows:

i. 17% of average hourly demand : 11 pm to 4 am
ii. 40% of average hourly demand : 4 am to 5 am and 10 pm to 11 pm
iii. 60% of average hourly demand : 12 noon to 1 pm
iv. 70% of average hourly demand : 2 pm to 5 pm and 8 pm to 10 pm
v. 85% of average hourly demand : 5 am to 6am
vi. 95% of average hourly demand : 6 pm to 8 pm
vii. 100% of average hourly demand : 10 am to 12 noon.

Water supply is continuous. Assume any relevant data if needed.

b. Explain how perikinetic flocculation and orthokinetic flocculation depends on particle size. [4]

c. In cascade aeration, efficiency will increase with increase in number of steps"-Explain [4]

[Group – B]

5. Design a bar screen chamber for average sewage flow 40 MLD, minimum sewage flow of 20 MLD and peak flow of 90 MLD. Check the head loss at full clogged and half clogged condition. Also sketch a hydraulic profile through the screen chamber. Velocity in sewer at peak design flow is 1.2 m/sec. Depth of the flow in sewer at peak flow is = 1.2 m. Assume any relevant data if needed. [20]

6. Design a conventional activated sludge process with a flow of 40000 m^3/day, influent BOD_5 = 250 mg/ltr, TSS = 400 mg/ltr, Minimum and maximum temperature is 18°C and 32°C respectively. Primary sedimentation tank BOD and SS removal efficiency is 40% and 70% respectively. Suspended solid concentration in primary and secondary sludge is 40 and 10 kg/m^3. Total BOD_5 and SS in the treated effluent should be ≤ 25 mg/ltr and ≤ 20 mg/ltr respectively. Assume Y = 0.5 and k_d=0.06 day^{-1}. Assume sludge age is 7 days. Assume any relevant data if needed. [20]

7. Design a two stage trickling filter (TF) to treat a domestic sewage of flow 16 MLD having influent BOD_5 is 300 mg/ltr and desired effluent BOD strength is as per Indian standard. Also design the distribution system for the first stage TF. No need of designing under drainage system. Assume any relevant data if needed. [20]

8. a. Determine the value of k, Ks, μmax, Y, K_d using data obtained from a bench scale activated sludge reactor w/o recycling. In each case, Initial BOD is 300 mg/ltr. [14]

	1	2	3	4	5	6
Final BOD	10	20	24	46	39	53
Hydraulic retention time (days)	3.2	2.4	1.7	1.2	1.3	1

b. Derive the Michaelis-Menten equation in connection with enzyme kinetics. [6]