BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS : M.Tech./Pre-Ph.D. **SEMESTER: II**
BRANCH : Environmental Science and Engineering **SESSION: SP22**

SUBJECT: CE532 Wastewater Engineering

TIME : 2 HOURS **TOTAL MARKS: 50**

Each question is of 5 marks, attempt any 10.

1. Discuss the sewerage system components and the design requirements.

2. A 30 cm diameter sewer is to flow at 0.3 depth on a grade ensuring a degree of self-cleansing equivalent to that obtained with full depth at a velocity of 0.9 m/sec. Determine the required grade, associated velocity, and discharge rate at this depth. Value of n = 0.013, ignore the variations of n with depth.

Proportionate Depth d/D (1)	*Proportionate area a/A (2)*	*Proportionate Wetted perimeter p/P (3)*	*Proportionate H.M.D. r/R (4)*	*Proportionate Velocity v/V (5)*	*Proportionate Discharge q/Q (6)*
1.00	1.00	1.00	1.000	1.000	1.000
0.90	0.949	0.857	1.192	1.124	1.066
0.80	0.858	0.705	1.217	1.140	0.988
0.70	0.748	0.631	1.185	1.120	0.838
0.60	0.626	0.564	1.110	1.072	0.671
0.50	0.500	0.500	1.000	1.000	0.500
0.40	0.373	0.444	0.857	0.902	0.337
0.30	0.252	0.369	0.684	0.776	0.196
0.20	0.143	0.296	0.482	0.615	0.088
0.10	0.052	0.205	0.254	0.401	0.021
0.00	0.000	0.000	0.000	0.000	0.000

3. With the help of neat sketch describe the unit operations and unit processes involved in a sewage treatment plant.

4. Discuss the essential conditions required for anaerobic treatment of wastewater.

5. Describe any two ASP based configurations with diagram for CBOD and ammonia removal from sewage.

6. Illustrate any two biological based process configurations for nitrogen removal from municipal wastewater.

7. Design a screw pumping station for a wastewater treatment plant which has following characteristics: interceptor sewer - minimum sewage elevation: 514.8 m, maximum sewage elevation: 515 m, discharge elevation to stilling well: 519.2 m, average flow rate at design capacity: 40,000 m^3/d.

Screw diameter, m	Maximum rpm	Maximum capacity at 30° slope, m^3/h			Maximum height at 30° slope, m		
		1-flight	2-flight	3-flight	1-flight	2-flight	3-flight
0.30	110	34	42	52	2.4	2.2	2.1
0.41	91	66	83	103	2.9	2.7	2.5
0.51	79	112	140	175	3.4	3.0	3.0
0.61	70	168	210	262	4.0	3.7	3.7
0.76	60	288	360	451	4.2	3.9	3.7
0.91	53	434	542	678	4.8	4.4	4.2
1.07	48	621	776	970	5.3	5.0	4.6
1.22	44	881	1,101	1,376	4.7	4.3	4.1
1.37	41	1,132	1,415	1,769	5.6	5.2	4.9
1.52	38	1,486	1,858	2,322	5.2	4.7	4.4
1.68	35	1,774	2,216	2,771	5.9	5.5	5.1
1.83	33	2,230	2,788	3,484	5.6	5.1	4.7
2.03	31	2,791	3,488	4,360	5.1	4.6	4.3
2.13	30	3,219	4,023	5,029	5.8	5.3	4.9

8. Estimate the amount of sludge to be wasted each day from an ASP based STP. Given data: Y 0.5 mg VSS/mg BOD_5 removed, SRT 5 d, k_d 0.05 d^{-1}, Q 13000 m^3/sec, S_0 85 mg/L, S 11 mg/L, Q_w 100 m^3/d, X_e 30 g/m^3, MLVSS fraction of MLSS 0.70.

9. For a UASB treating municipal wastewater, determine methane gas production, and energy produced using the following data: total degradable influence COD, S_o 2150 g/m^3, effluent sCOD 200 g/m^3, SO_4 200 g/m^3, 0.67 g COD removed/ g sulfate reduced, temperature 30°C, methane production at 30 °C is 0.4 L CH_4/g COD, gas content 65% methane, methane density at 35°C is 0.6346.

10. Estimate volume and dimensions of SBR based on the following data: Design flow rate 23,000 m^3/d, bCOD 220 mg/L, rbCOD 50 mg/L, TKN 24 mg/L, NH_3-N 19 mg/L, TSS 200 mg/L, VSS 170 mg/L, biodegradable VSS 80 mg/L, temperature 20^0C, pH 7.2, alkalinity 200 mg/L $CaCO_3$; Effluent discharge standards: bCOD ≤20 mg/L, NH_3-N ≤1.0 mg/L, TSS ≤10 mg/L, MLSS 3000 mg/L, MLVSS (0.8) MLSS, NOx 80% of TKN, SRT 20 d, assume settled sludge of 6000 mg/L.

11. Summarize the design procedure of anaerobic suspended growth process

12. Describe the process of solids management in a sewage treatment plant.

********** **06-5-2022**********