Municipal Engineering – Engi 8713
Assignment #3
Answers to be Posted

1) The inflow hydrograph of the spillway design flood for a proposed reservoir and the reservoir characteristics are given in the two tables below. The spillway will have a crest elevation of 56.4 m and a crest length, L of 24 m. Reservoir outflow, $Q = 2.0\ L\ h^{1.5}$ where Q is in m^3/s, L is in m, and h is the depth of water above the spillway crest in m. Find the peak outflow and the maximum water surface elevation.

Time (min)	0	30	60	90	120	150	180	210	240	270	300	330
Inflow (m^3/s)	0	7.6	32	101.3	162.2	147.4	119.4	76.4	37.9	16.7	4.2	0

Elevation (m)	56.4	57.9	59.4
Surface area (ha)	28.5	32.7	37.2

2) A settling column test is conducted in a 2.40 m deep column. Sampling ports are located at 60 cm, 120 cm and 180 cm. Samples were collected at the intervals and depths as indicated in the table below. If the initial solids concentration, $C_0 = 430$ mg/L and the surface overflow rate, $V_0 = 0.0475$ m/min, what percentage of solids will be removed? If you want to remove 60% of the solids, what should be the surface overflow rate? Although the column is 2.40 m deep, consider only a settling depth of 1.80 m to allow for sludge collection in the bottom 60 cm.

Time (minutes)	60 cm depth	120 cm depth	180 cm depth
5	357	387	396
10	310	346	366
20	252	299	316
30	198	254	288
40	163	230	252
50	144	196	232
60	116	179	204
75	108	143	181

3) A flocculation basin required to handle 200,000 m^3/d is 30 m long by 30 m wide by 4.5 m deep and it has 6 baffled compartments. Each compartment has a horizontal shaft supporting 6 paddle flocculators with four arms each, for a total of 36 units. A maximum of 5 blades, each 4.6 m by 0.15 m can be attached to each arm at radii of 2.00 m, 1.70 m, 1.40 m, 1.10 m and 0.80 m, from the center of the blades to the centerline of the shaft. The maximum rotation can provide a velocity of 0.80 m/s at the radius of 2.0 m (to center of outer blade). For this paddle flocculator with paddles at multiple radii the equation below can be used where k = the ratio of water velocity to paddle velocity and in this case k = 0.3. The area of paddles A in the equation is the total area for paddles at only one radius. The drag coefficient is 1.8. If the water temperature is 10°C and the velocity gradient is 60 s^{-1}, what is the minimum number of blades that should be installed? Assume that the same blade arrangement should be used for each of the 6 units.

$$P = \frac{C_d A \rho (1-k)^3 (2\pi n)^3 (r_1^3 + r_2^3 + r_3^3 + ...)}{2}$$

4) Design sedimentation basins with 5 m wide chain and flight sludge removal equipment if the maximum daily flow Q_{max} = 3.25 m^3/s, the surface loading rate V_0 = 2.0 m/h and the water temperature T is 5 °C. Using a 90 degree V notch weir, determine the total horizontal weir length required to achieve an acceptable weir overflow rate WOR. Let your design conform to the table in the notes taken from "Water Principles, Treatment and Design". Also check your detention time for the average daily flow assuming that $Q_{avg} \times 1.5 = Q_{max}$.