

※ 考生請注意：本試題可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. A water treatment plant is processing a flow of 25,000 m³/d. The dimensions of the flocculation basin are 6 m wide by 3.5 m deep by 22 m long. Four horizontal shaft paddle flocculators with blades parallel to flow are evenly distributed along the length of the basin. Each flocculator has two blades with 4 m long and 0.24 m wide, and the distance between the center of the blade and the center of the shaft is 0.80 m. The angular speed of the paddle flocculator is 4.0 r/min. Assume the relative velocity between paddle and water is 70% of the paddle speed (i.e. $k=0.3$), drag coefficient C_D is 1.9, the water temperature is 20°C, the dynamic viscosity (μ) and density (ρ) of the water are 1.002×10^{-3} kg/(m)(sec) and 998.2 kg/m³, respectively. Calculate
- (1) Mean velocity gradient (G) and GT (T: Hydraulic detention time). (15%)
 - (2) The shearing stress (τ) that the floc endure. (5%)

(Hint: $P = C_D A \rho (v^3/2)$)

2. (1) Explain the terms "Effective Size (E.S.)" and "Uniformity Coefficient (U.C.)", which are important parameters to specify the media characteristics of rapid sand filter. (6%)
- (2) Explain the purpose of backwashing and the timing to perform it in the operation of rapid sand filter. (6%)
- (3) Two water treatment plants employ rapid sand filtration. The characteristics of their filter media are shown below. Explain the difference in backwash method that may apply in these two plants, and give your explanation. (8%)

	Effective size (mm)	Uniformity coefficient	Media depth (cm)
Plant A	0.5	1.6	70
Plant B	1.0	1.5	100

3. Explain the principle behind the Phoredox (Anaerobic/Aerobic) process for biological phosphorus removal. (20%)
4. The integrated membrane processes, including UF (ultrafiltration) and RO (reverse osmosis) has been commonly used to treat secondary effluent for municipal wastewater reuse. Answer the following questions:
 - (1) What are the major functions of UF and RO, respectively? (8%)
 - (2) What are "flux" and "permeability (or water mass transfer coefficient)"? (8%)
 - (3) What is "CIP (Clean-In-Place)"? (4%)
5. Answer the following questions related to sanitary sewer system
 - (1) What are "depressed sewers (or inverted siphons)"? What special considerations should be emphasized when design a depressed sewer? (10%)
 - (2) What is "infiltration"? What factors affect the rate of infiltration? (10%)