# University of Asia Pacific
# Department of Civil Engineering
# Final Examination Fall 2012
# Program: B.Sc. Engineering (Civil)

Course Title: Environmental Engineering IV — Course No. CE 433
Time: 2 Hours — Full Marks: 135(=45x3)

*[Assume reasonable value for missing data (if any)]*

**Answer ANY THREE of the following Four Questions**

1. **(a)** What are the sources of thermal effluents (heat waste) in rivers? What is the effect of thermal effluents on the Dissolved Oxygen sag curve? Explain with diagrams. **10**

   **(b)** What are the factors that have contributed to the pollution of the Buriganga river in Bangladesh? **5**

   **(c)** How can the Streeter-Phelps DO sag equation help you in water quality management in rivers? **6**

   **(d)** A city of 200,000 people deposits 37 $ft^3$/sec of sewage having a BOD of 28 mg/L and 1.8 mg/L of DO into a river that has a flow rate of 250 $ft^3$/sec and flow speed of 1.2 ft/sec. Just upstream of the release point, the river has a BOD of 3.6 mg/L and a DO of 7.6 mg/L. The saturation value of DO is 8.5 mg/L. Deoxygenation coefficient, $k_d$ is 0.61/day and the reaeration coefficient $k_r$ is 0.76/day. Assuming complete and instantaneous mixing of the sewage and river, find **24**

   (i) The initial oxygen deficit and ultimate BOD just downstream of the outfall.
   (ii) The time and distance to reach the minimum DO.
   (iii) The minimum DO.
   (iv) The DO that could be expected 10 miles downstream.

2. **(a)** What do you understand by eutrophication? What is cultural eutrophication? Which nutrients are primarily responsible for eutrophication? Why is phosphorus typically the limiting nutrient in lakes? **12**

   **(b)** How does thermal stratification affect the water quality in lakes both in summer and winter? Explain with diagrams. **11**

   **(c)** Suppose there are 0.10 mg of N and 0.04 mg of P available for algal production per liter of water. Assuming adequate amounts of the other nutrients, which is the limiting nutrient? **6**

   **(d)** Consider a lake with $100\times10^6$ $m^2$ of surface area for which the only source of phosphorus is the effluent from a wastewater treatment plant. The effluent flow rate is 0.4 $m^3$/s and its phosphorus concentration is 10 mg/L. The lake is also fed by a stream having 20 $m^3$/s of flow with no phosphorus. If the phosphorus settling rate is estimated to be 10 m/year, **16**

   (i) Estimate the average phosphorus concentration in the lake.
   (ii) What level of phosphorus removal at the treatment plant would be required to keep the average lake concentration below 0.010 mg/L?

3. (a) What do you understand by BOD? For a particular wastewater, draw BOD rate equation (i.e., $BOD_t$ vs. time curve) for two different temperatures, $T_1$ and $T_2$; where $T_1 > T_2$. 7

(b) List the common options for control of vehicular air pollution. Briefly explain the working principles of (i) Thermal Reactor, and (ii) Exhaust Gas Recirculation. 10

(c) Discuss the effects of air/fuel ratio on emissions of CO, hydrocarbon, and $NO_x$ from four-stroke engines with diagrams. Also explain the effects of air/fuel ratio on the efficiency of a 3-way catalytic converter. 12

(d) A road has 10 cars passing a given point per minute, and each car on an average emits 9.5 g/km of carbon monoxide (CO). Wind is blowing at 2.0 m/sec perpendicular to the road and the atmosphere is "neutral". A building of 20 m height is located 200 m down-wind of the road. Estimate CO concentration at the ground floor and the roof of the building. (Table is provided for calculation of dispersion coefficient). 16

4. (a) What are the different options of managing (improving) lake water quality? 10

(b) How does suspended solid affect the water quality of lakes and rivers? 7

(c) List the principal assumptions of the "point source Gaussian plume model". 6

(d) Carbon monoxide (CO) is emitted from a stack at the rate of 5.0 g/s. The effective stack height is 30 m and The wind velocity at a height of 10 m is 4.0 m/sec. The atmosphere is adiabatic. Estimate concentration of CO 22

(i) At 0.5 km downwind along the centerline of the plume.

(ii) At 0.5 km downwind and 100 m off the centerline of the plume. (Given: p = 0.15; Table is provided for calculation of dispersion coefficient).

Table : Values of the constants a, c, d, and f for use in ~~(7.44) and (7.45)~~ expressions for $\sigma_y$ and $\sigma_z$

| | | $x \le 1$ km | | | $x \ge 1$ km | | |
|---|---|---|---|---|---|---|---|
| Stability | a | c | d | f | c | d | f |
| A | 213 | 440.8 | 1.941 | 9.27 | 459.7 | 2.094 | −9.6 |
| B | 156 | 106.6 | 1.149 | 3.3 | 108.2 | 1.098 | 2.0 |
| C | 104 | 61.0 | 0.911 | 0 | 61.0 | 0.911 | 0 |
| D | 68 | 33.2 | 0.725 | −1.7 | 44.5 | 0.516 | −13.0 |
| E | 50.5 | 22.8 | 0.678 | −1.3 | 55.4 | 0.305 | −34.0 |
| F | 34 | 14.35 | 0.740 | −0.35 | 62.6 | 0.180 | −48.6 |

*Note:* The computed values of $\sigma$ will be in meters when $x$ is given in kilometers.
*Source:* Martin (1976).

$\sigma_y = a \cdot x^{0.894}$ ; $\sigma_z = c x^d + f$