4-2

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2019
Program: B. Sc. Engineering (Civil)

Course Title: Professional Practices & Communication | Course Code: CE 403
Time: 2 hours | Full Marks: 100

[Assume Reasonable Values for Any Missing Data]

PART– A

Answer the following questions.

1. Do you believe the existing procurement practices in Bangladesh are preventing the citizens from getting the best value for their money? Justify your position and suggest ways of improvement. **(10)**
2. Mention the limitations of The Building Construction Act, 1952 in preventing haphazard building construction in Dhaka city. How are these challenges addressed in BNBC 2006 and Dhaka Metropolitan Building Construction Rules, 2008? **(10)**
3. Describe one global environmental problem. In your opinion which environmental issue should be given the utmost priority in Bangladesh's context? Provide reasonable explanation in favor of your answer. **(10)**
4. In Bangladesh there are approximately 35 million construction workers and an average 1200 construction site deaths each year. The table below presents the number of fatalities per 100,000 construction workers in four countries. Why do you think such a high rate of fatality persists in the construction industry in our country compared to others? What measures can be taken to remedy the prevailing condition? **(10)**

Country	***Fatalities per annum** (per 100,000 worker)*
Australia	1.5
United Kingdom	1.6
United States	9.8
Bangladesh	34.2

5. 'Litigation shall only be used as a means of last resort' – do you agree with this statement? Provide justifications for your answer. **(10)**

PART– B

Answer the following questions.

6. 'A' needs to submit a report as a part of his coursework. He chooses 'Padma Multipurpose Bridge' as his topic.
   - **(a)** Classify the type of report A needs to prepare. **(1)**
   - **(b)** Suggest different components of the report. **(2)**

7. In Navana group, a meeting is being arranged by you, where you need to play the role of meeting organizer. The meeting agenda has been prepared and circulated among the participants.

(a) What type of leadership would you choose for the meeting and why? **(1)**

(b) Describe the steps you would follow to conduct the meeting. **(2)**

8. You are a fresh graduate from the Department of Civil Engineering of UAP. You want to be an entrepreneur and need an investor. So, you prepare your business idea and submit it to the investor as a business proposal.

(a) Write down what you should and should not include in the proposal. **(1)**

(b) Describe the 'SMART' process for writing the proposal. **(3)**

9. Mr. A and Mr. B work at the same engineering firm. Mr. A only performs the tasks that are assigned to him and nothing more. On the other hand, Mr. B finishes all of his assigned tasks well ahead of his deadline and then engages himself in activities that can help his colleagues or in long term benefit of the firm.

(a) State which models of responsibility Mr. A and Mr. B exhibit with explanation. **(10)**

(b) Which one do you think is the better approach and why? **(10)**

10. Mr. X is the head of a procuring entity which has published a call for tender notice in the newspaper and his son owns a company that is bidding for the tender.

(a) Name the ethical issue that is prevalent in this case. **(10)**

(b) Give an example of how an engineer can encounter such an issue and what he should do in such a case. **(10)**

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2019
Program: B.Sc. Engineering (Civil)

Course Title: Structural Engineering VI (Design of Steel Structures) Course Code: CE 417
Time: 2 hours Full Marks: 100

[Assume Reasonable Values for Any Missing Data]
Answer all the questions
Draw free-hand sketches where necessary

1. (a) Define limit state. List the classification of limit states with necessary examples. **(5)**
   (b) Draw steel shapes used as 'steel tension members'. **(5)**
   (c) Distinguish between compact, non-compact and slender steel sections. Which of these sections are not recommended in steel structure design and why? **(6)**
   (d) What is lateral torsional buckling? How does lateral torsional buckling differ from bending? Discuss with neat sketches. **(6)**
   (e) What are the advantages of initially tightening a high-strength bolt? Discuss with a neat sketch. **(4)**
   (f) With rough sketches, differentiate between butt joint and lap joint. What are the advantages of lap joint over butt joint? **(5)**
   (g) Briefly discuss the following defects of welded connections: **(9)**
      (i) Slag inclusion
      (ii) Incomplete fusion
      (iii) Undercutting

2. Determine the design moment capacity of the W 14×68 section used as a flexural member of grade 50 steel for the beam loaded as shown in ***Figure 1***. The beam has no lateral bracings in between support points A and C. Use **AISC-LRFD** approach. See **Annexure-1.** **(15)**

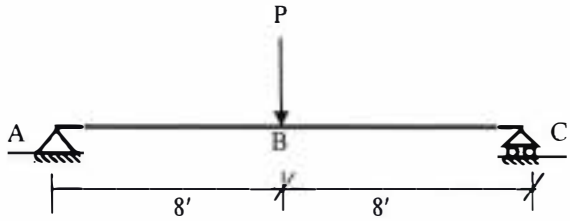

Figure 1

3. Select the lightest W section (from ***Table 1***) of A992 steel (F_y = 50 ksi) to serve as a column of 25 ft length to carry an axial compression of 75 kip dead load and 150 kip live load in a braced frame structure. The column is assumed to be fixed at top and bottom. Use **AISC-LRFD** approach. See **Annexure-2.** **(15)**

Table 1

Shape	A_g (in^2)	r_x (in)	r_y (in)
W 14×68	20.0	6.01	2.46
W 14×61	17.9	5.98	2.45
W 14×53	15.6	5.89	1.92

4. Use the elastic vector method to compute the resultant bolt shear forces at each bolt in the eccentrically loaded bolt group shown in ***Figure 2***. All the bolts are of the same size. **(15)**

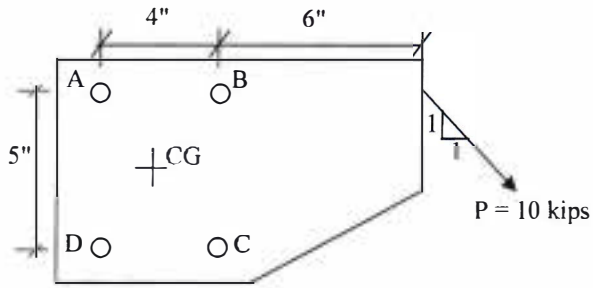

Figure 2

5. Use **AISC-ASD** approach to design the fillet welds to develop the full strength of the angle shown in ***Figure 3*** so that the effects of eccentricity is minimized. Assume the gusset plate does not govern the design. Use A572 Grade 50 steel (F_u = 65 ksi) and a fillet weld size of $\frac{1}{2}$ inch. Neatly sketch the designed connection. **(15)**

Note: Check strength of base metal and shear lag factor U; and thus validate the design.

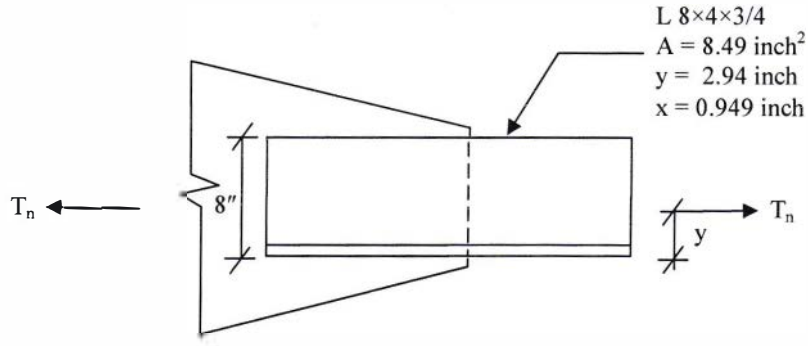

Figure 3

Annexure-1

$$C_b = \frac{12.5M_{max}}{2.5M_{max} + 3M_A + 4M_B + 3M_C} R_m \leq 3.0$$

For compactness of web; $\lambda_p \leq 3.76\sqrt{\frac{E}{F_y}}$

For compactness of flange; $\lambda_p \leq 0.38\sqrt{\frac{E}{F_y}}$

Beam LTB formulae:

$$\frac{L_p}{r_y} = 1.76\sqrt{\frac{E}{F_y}}$$

$$L_r = 1.95 r_{ts} \frac{E}{0.7F_y}\sqrt{\frac{Jc}{S_x h_0}}\sqrt{1+\sqrt{1+6.76\left(\frac{0.7F_y}{E}\frac{S_x h_0}{Jc}\right)^2}} \quad \text{(c=1 for doubly symmetric section)}$$

$$F_{cr} = \frac{C_b \pi^2 E}{\left(\frac{L_b}{r_{ts}}\right)^2}\sqrt{1+0.078\frac{Jc}{S_x h_0}\left(\frac{L_b}{r_{ts}}\right)^2} \quad \text{(c=1 for this section)}$$

$$M_n = F_y Z_x$$

$$M_n = C_b\left[M_p - (M_p - 0.7F_y S_x)\left(\frac{L_b - L_p}{L_r - L_p}\right)\right]$$

$$M_n = F_{cr} S_x$$

Section properties of W 14×68:

d (in)	t_w (in)	b_f (in)	t_f (in)	S_x (in^3)	Z_x (in^3)	r_y (in)	r_{ts} (in)	h_0 (in)	J (in^4)
14.0	0.415	10.0	0.72	103	115	2.46	2.80	13.3	3.01

Annexure-2

$F_{cr} = [0.658^{F_y/F_e}]F_y$ for $\frac{kL}{r} \leq 4.71\sqrt{\frac{E}{F_y}}$

F_{cr}=0.877 F_e for $\frac{kL}{r} > 4.71\sqrt{\frac{E}{F_y}}$

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2019
Program: B.Sc. Engineering (Civil)

Course No: CE 415 | **Course Title: Structural Engineering V**
Time: 2.0 hours | **Full Marks: 100**

Answer all questions. **Assume** value for any **missing data**.

1. (a) Make a preliminary design for section of a prestressed-concrete beam to resist a total moment of 520 kN-m including girder self-weight moment 95 kN-m. Assume a trial depth of the section 980 mm. The effective prestress (f_{se}) for steel is 850 MPa, and allowable stress for concrete under working load (f_c) is 11 MPa. (6)

(b) Make final design for the preliminary section obtained in **1(a)** allowing no tension in the concrete. (14)
[Given values are f_{se} = 850MPa, f_t = 14MPa, f_b = -12.5 MPa, f_o = 1035 MPa, F_o= 968 kN].

2. (a) Show the stress distributions in a prestressed concrete beam section for different locations of compressive force (C) according to elastic theory. (8)

(b) A pottensioned bonded beam with a transfer prestress of F_t =1560 kN is being wrongly picked up at its mid-span point as shown in **Figure: 1**. Analyze the section to calculate fiber stresses. Check for cracking; Given, $f_r = 0.62\sqrt{f_c'}$, f_c'= 34MPa. (12)

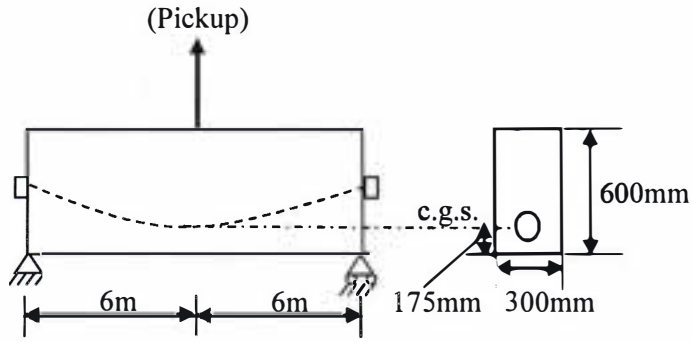

Figure: 1

3. **(a)** Check the shear strength for the beam shown in **Figure: 2** at section 1-1 which is 3 m from the left support. Given that this section is adequate for w_u= 70 kN/m on the basis of its flexural strength. (**Given:** f'_c=*40* MPa, f_{se} = *1100* MPa, A_{ps} = 1760 mm^2) (14)

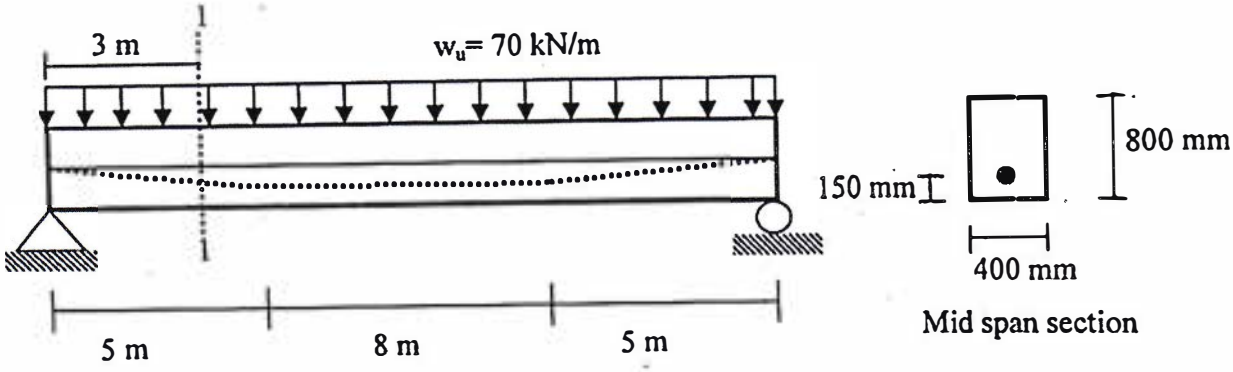

Figure: 2

(b) Define "transfer length" and write down the parameters which affect the length of transfer for prestressing steel of pretensioned member. (3+3=6)

4. **(a)** Evaluate the mid-span deflection of a 16 m span I-beam as shown in **Figure: 3** (14)
(i) Immediately at transfer of prestress
(ii) After 12 years.
The beam carries a superimposed dead load of 4 kN/m and service load of 6 kN/m in addition to its self weight. It has to carry a concentrated live load of 75 kN at midspan.
Assume that, superimposed dead loads are applied soon after prestress trafnsfer.
Given: A_{ps} = 1760 mm^2, A_c= 240000 mm^2, I=2.408×10^{10} mm^4, f_i=1300 MPa, f_{se}= 1120 MPa, E_c=27400 MPa, C_c=2.3, γ_{con}=24 kN/m^3

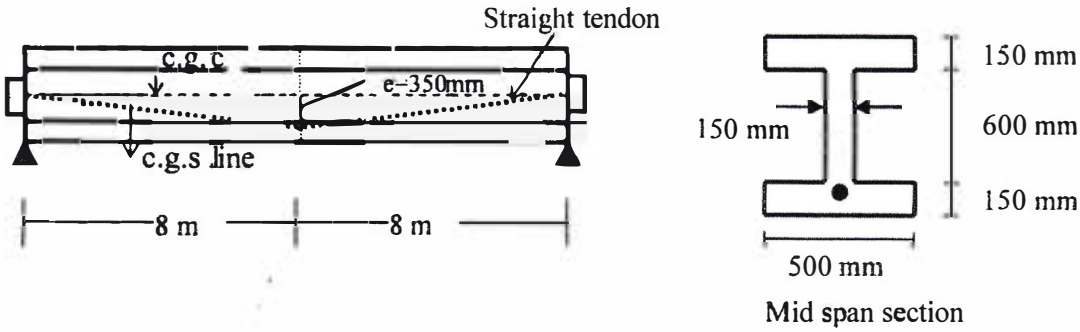

Figure: 3

(b) Draw the load deflection curve of a prestressed beam. (6)

5. **(a)** Fourteen steel wires of 9 mm diameter with anchorages are used for prestressing of a 15m pretensioned beam. The beam has symmetrical I-section shown in **Figure: 4.** [Given, f_o=860MPa, f_{se}= 750 MPa f'_c= 40 MPa, f'_t= 1.58 MPa, f'_b= 3.16 MPa; M_G= 75 kN-m, M_T=270 kN-m at midspan]. Determine the position for the c.g.s. line. (14)

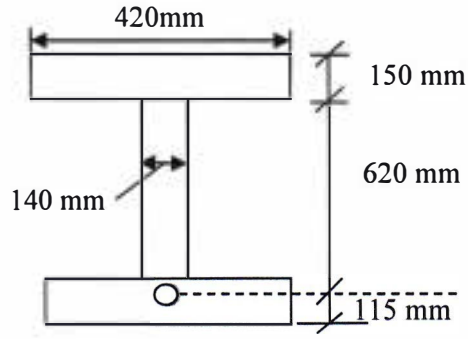

Figure: 4

(b) Draw the typical layouts for pre-tensioned beams. (6)

Formulae Sheet

$F = M_T/(0.65h)$, if M_G is greater than 20% of M_T

$F = M_L/(0.5h)$, if M_G is less than 20% of M_T, where $M_L = M_T - M_G$

$A_c = A_{ps}f_{se}/0.5f_c$ $\varepsilon_{pu} = \varepsilon_{pu} + \varepsilon_{ce} + \varepsilon_{ct} = (f_{se}/E_s) + (f_c/E_c) + [\varepsilon_{pu}\{(d-c)/c\}]$

$K = r^2/c$ $M_I = f'_b A_c k_t$ $F_o(e-k_b) = M_G$ $F(e+k_t) = M_T$ $A_{c(b)} = (F_o h)/(f_b C_t)$ $A_{c(t)} = (Fh)/(f_t C_b)$

$f = -(F/A) \pm (Fey/I) \pm (My/I)$ $V_{ci} = 0.05\sqrt{f'c}\, b_w d + V_d + V_i M_{cr}/M_{max}$ $f_r = 0.62\sqrt{f'c}$

$M_{cr} = (I/y_b)(0.5\sqrt{f'c} + f_{pe} - f_d)$ $f_{pe} = (F/A) + (Fey_b/I)$ $a_1 = M_T/F$ $a_2 = M_G/F_o$

$e_t = f'_b I/Fc_b$ $e_b = f'_t I/F_o c_t$

$\Delta_{prestress}$ in a simply supported beam = $(5wl^4/384EI)$

$\Delta_{self\text{-}weight}$ in a simply supported beam = $(5wl^4/384EI)$

Δ_{moment} in a simply supported beam = $(Ml^2/8EI)$

$\Delta_{point\text{-}load}$ in a simply supported beam = $(Pl^3/48EI)$

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2019
Program: B. Sc. Engineering (Civil)

Course Title: Environmental Engineering IV — Course Code: CE 433
Time- 2 hours — Full marks: 100

There are four questions. Answer all the questions. (4 X 25 = 100)
(Assume any missing data)

1. (a) What is temperature inversion? During temperature inversion, demonstrate and explain with neat sketches how stack height can contribute towards ground level pollution control. (10)

(b) Identify the factors that cause plume rise over a stack. (3+12)

A power plant has a 150 m stack with inside radius of 2 m. The exit velocity of the stack gases is estimated at 10 m/s, at a temperature of 100 °C (373 K). Ambient temperature is 25 °C (298 K) and wind speed at stack height is estimated to be 5.0 m/s. Estimate the effective height of the stack if the atmosphere is slightly unstable (Stability Class C).

The buoyancy flux parameter is given by:

$$F = g\, r^2\, v_s\, (1 - T_a/T_s)$$

where, F = buoyancy flux parameter (m^4/s^3)
g = gravitational acceleration (=9.8 m/s^2)
r = inside radius of stack (m)
v_s = stack gas exit velocity (m/s)
T_s = stack gas temperature (K)
T_a = ambient air temperature (K)

For "neutral" or "unstable" atmosphere (Stability Class A-D), "plume rise" is given by:

$$\Delta h = (1.6\, F^{1/3}\, x_f^{2/3})/u$$

where, u = wind speed at stack height (m/s)
x_f = distance downwind to point of final plume rise, m

The following is used to estimate x_f

$x_f = 120\, F^{0.4}$ if $F \geq 55\ m^4/s^3$
$x_f = 50\, F^{5/8}$ if $F < 55\ m^4/s^3$

2. (a) Sketch the following plume phenomena and discuss each sketch in relation to adiabatic lapse rate: (i) looping, (ii) fanning (iii) coning (iv) fumigating (v) lofting (vi) trapping. (12)

OR

What are some important health effects of particulate matter (PM), particularly, $PM_{2.5}$; carbon monoxide (CO); and sulfur dioxide (SO_2)? What particular health hazards are posed by SO_2 in a dusty atmosphere? What is the mechanism by which H_2SO_4 mist can cause damage to limestone surfaces?

(b) An industrial stack emitting 160 g/s of NO has an effective height of 120 m. The wind speed is 5.8 m/s at effective stack height and it is a clear summer day with the sun nearly overhead meaning that the atmosphere is moderately unstable (Stability Class B). (13)

Estimate the ground level NO concentration:

(a) directly downwind at a distance of 2 km; and
(b) at a point 2 km downwind and 0.2 km off the downwind axis.

Gaussian Plume Equations used under various conditions are as below:

For ground level concentration (z = 0) (with ground reflection): c (x, y, 0)

$$c = \frac{Q}{\pi u \sigma_y \sigma_z} \exp -0.5\left(\frac{y}{\sigma_y}\right)^2 \left[\exp -0.5\left(\frac{H}{\sigma_z}\right)^2\right]$$

For ground level concentration (z = 0) on centerline (y=0) (with ground reflection): c (x, 0, 0)

$$c = \frac{Q}{\pi u \sigma_y \sigma_z}\left[\exp -0.5\left(\frac{H}{\sigma_z}\right)^2\right]$$

The two dispersion coefficients in the above equations, σ_y and σ_z are standard deviations of the horizontal and vertical Gaussian distributions, respectively, and can be reasonably estimated using the following equations:

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

where the constants *a, c, d,* and *f* are given in the following table:

VALUES OF THE CONSTANTS, *a*, *c*, *d*, AND *f*

		$x \leq 1$ km			$x \geq 1$ 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

[a] The computed values of σ will be in meters when x is given in kilometers.

3 (a) Water quality of River Shitalakhya has been analyzed to find out that the **desired quality ≠ actual quality**. Produce a flow diagram for Water Quality Engineering incorporating the steps to address the problem. (15)

OR

River Turag is facing severe pollution due to different sources of pollution surrounding it. Answer the following through:

i) Identify the factors that you will consider while choosing a particular control measure;

ii) As pollution control measures, explain how you will apply the following measures:

Reducing effluent concentration (C_w), Reducing effluent volume (Q_w).

(b) Analyze the factors that affect the "self purification" of "oxygen demanding waste" and "pathogens" in order to formulate sustainable natural solutions for streams and rivers. (10)

OR

Analyzing the sources of groundwater pollution, explain how you will attempt to seek solution and protect groundwater.

4 (a) Demonstrate how a first order BOD rate equation can be developed. Display the changes in nitrogen species in polluted water under aerobic conditions. (10)

OR

Interpret the significance of limiting nutrients and illustrate the effect of temperature on DO sag curve (with figure).

(b) A municipal wastewater treatment plant discharges treated effluent in a stream. The BOD_5 of the mix is 16.8 mg/L, DO concentration of the mix is 6.2 mg/L and the temperature at the mixing point is 25^0C. The deoxygenation and the reaeration constants at 20^0C are 0.23/day and 0.4/day respectively. Analyze the following: (15)

a. The critical distance downstream at which DO is minimum.
b. The minimum DO.

Given Formulae:

$BOD_m \cdot V_m = BOD_w \cdot V_w + BOD_d \cdot V_d$ $\quad BOD_t = L_0 (1- e^{-kt})$ $\quad L_t = L_0 e^{-kt}$

$$D = \frac{k_d L_0}{k_r - k_d}\left(e^{-k_d t} - e^{-k_r t}\right) + D_0 e^{-k_r t}$$

$$t_c = \frac{1}{k_r - k_d} \ln\left[\frac{k_r}{k_d}\left(1 - \frac{D_0[k_r - k_d]}{k_d \cdot L_0}\right)\right]$$

$$D_c = \frac{k_d}{k_r} L_0 e^{-k_r t_c}$$

$DO_{(sat)} = 14.62 – 0.39\ T + 0.007714\ T^2 – 0.0000646\ T^3$

$k_{d\ (at\ T°C)} = k_{20°C} \cdot (1.047)^{T-20}$, $k_{r\ (at\ T°C)} = k_{r20°C} \cdot (1.024)^{T-20}$

$DO_{min} = DO_{sat} – D_c$; $D_0 = DO_{sat} – DO_{mix}$; $DO\ (x) = DO_{sat} – D(x)$

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2019
Program: B.Sc. in Civil Engineering

Course Title: Structural Engineering X (Concrete Technology) Course Code: CE 425
Time: 2 hours Full Marks: 100

Answer all questions

QUESTION 1 [10 MARKS]

"Incorporation of pozzolanic material in Ordinary Portland Cement decrease the amount of Calcium Hydroxide [$Ca(OH)_2$] which enhance the mechanical and durability performances of concrete". Justify this statement with chemical reactions and proper comments.

QUESTION 2 [20 MARKS]

For dam construction, three types of cement (X, Y and Z) have been chosen and technical data sheets are collected to pre-investigate the performance of cement. The dam will be constructed with ultra-high performance concrete to have higher strength and higher durability that ensures the longer service life of the dam. The chemical constituent of cement (X, Y and Z) is given in Table 1.

Table 1: Chemical constituent of cement (X, Y and Z)

Bulk Oxide Content	CaO	SiO_2	Al_2O_3	Fe_2O_3	MgO	SO_3	K_2O	Na_2O	LOI
X	58	21	7	6	1.3	1	0.3	0.3	0.2
Y	49	9	14	3	1.1	2.5	0.2	0.3	2.9
Z	66	20	5	2.5	1.4	2	0.4	0.5	1.6

(i) Calculate the silica modulus, alumina modulus and hydraulic modulus of three types of cement. **[4.5]**

(ii) Using Bogue's equation, calculate the major chemical compounds of those cement (X, Y and Z). If these three types of cement are used in concrete, explain the expected performance of concrete mixes made with those three types of cement with reference to the following: (a) temperature increase in concrete, (b) compressive strength and (c) permeability. **[10]**

(iii) Based on the silica modulus, alumina modulus, hydraulic modulus and Bogue analysis, propose a suitable cement for the dam construction and justify your selection with proper comments. **[5.5]**

QUESTION 3 [10 MARKS]

Explain with neat sketches the effect of specimen height to diameter ratio and loading rate on the compressive strength of concrete cylinder.

QUESTION 4 [10 MARKS]

A circular reinforced concrete column will be constructed inside the mosque. The following necessary data are provided for the circular column.

Given data:
Size of the column: Height = 6 m; Diameter = 1.2 m
Concrete type: Blended cement containing less than 70% slag with any admixture, except a retarder
Density of concrete = 2550 kg/m^3
Concrete temperature at placement = 20 °C
Uniform volume supply rate = One 5 m^3 truck every 20 min

Table 2: Values of coefficients C1 and C2

Walls: C1 = 1.0	
Columns: C1 = 1.5	
Concrete:	**Value of C2**
Ordinary Portland Cement (OPC) without admixture	0.3
OPC with any admixture, except a retarder	0.3
OPC with a retarder	0.45
Blended cement containing less than 70% slag without admixture	0.45
Blended cement containing less than 70% slag with any admixture, except a retarder	0.45
Blended cement containing less than 70% slag with a retarder	0.6
Blended cement containing more than 70% slag	0.6

(i) Calculate the concrete lateral pressure and draw the pressure envelope as a function of height for formwork design. **[8]**

(iii) Provide a list of factors that affect the concrete pressure on formwork. **[2]**

QUESTION 5 [10 MARKS]

What is fire spalling of concrete? Describe with neat sketch the pore pressure mechanism of concrete spalling due to fire.

QUESTION 6 [10 MARKS]

Explain in detail the rebound hammer test to carry out Non-destructive test on concrete structure. Identify what are the main factors that affect the rebound number during assessing the concrete strength via rebound hammer.

QUESTION 7 [10 MARKS]

Using schematic diagram and chemical reaction, explain the mechanisms involved in concrete deterioration by corrosion of embedded steel.

QUESTION 8 [20 MARKS]

The durability of the reinforced concrete (RC) dam is needed to be investigated since it is exposed to seawater which contains chloride, sulfate and magnesium. In order to provide higher corrosion resistance of the RC dam, three types of concrete (A, B and C) has been cast and durability tests such as gas permeability, porosity and water absorption capacity are performed at 7, 14 and 28 days. Part of the test results are given below:

Table 3: Test data for porosity measurement

Concrete	Age of concrete [day]	Mass of dry test specimen [gm]	Apparent mass of immersed test specimen [gm]	Mass of soaked test specimen [gm]
A	7	207	131	221
	14	186	117	196
	28	231	111	240
B	7	210	128	228
	14	213	124	229
	28	240	146	250
C	7	230	208	233
	14	233	208	235
	28	240	209	241

Table 4: Test data for water absorption capacity measurement

Concrete	Age of concrete [day]	Mass of dry test specimen [gm]	Mass of wet specimen [gm]	Dimension of test specimen [mm]
A	7	1550	1615	Diameter = 150 Height = 70
	14	1510	1560	
	28	1480	1520	
B	7	1720	1805	
	14	1650	1725	
	28	1620	1690	
C	7	1585	1635	
	14	1530	1560	
	28	1490	1505	

(i) Calculate the apparent porosity and water absorption capacity of three types of concrete (A, B and C) for all ages. **[10]**

(ii) Draw the evolution of apparent porosity and water absorption capacity on the graph paper as a function of the age of concrete. **[5]**

(iii) Based on the porosity and absorption test results, propose a suitable concrete that will provide higher resistance to corrosion for RC dam and justify your selection with proper comments. **[5]**

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2019
Program: B.Sc. Engineering (Civil)

Course Title: Environmental Engineering III | Course Code: CE 431
Time: 2 hours | Full Marks: 100

Answer all the questions. Please note that all questions are NOT of equal value.
Assume data if not available.

1. (a) Define E-waste. What are the challenges of managing E-waste in Bangladesh? **[5+5]**

   (b) Draw the flow chart showing the functional elements of solid waste management system. What are the risks associated with improper management of solid waste in a municipality? **[5+5]**

2. (a) "Generation rate of solid waste plays a vital role in Municipal Solid Waste Management (MSWM) system" --- justify the statement. What are the common methods to determine the generation rate of solid waste? **[5+5]**

   (b) A cannery (where food/fruits are canned) receives on a given day: **[10]**
   - 18 tons of raw produce
   - 10 tons of cans
   - 0.5 tons of cartons
   - 0.3 tons of miscellaneous materials.

   As a result of internal activity
   - 15 tons of product are produced, remainder discharged to a disposal facility
   - 8 tons of cans are stored, remainder used
   - iii) 3% of cans used are damaged and incinerated, remainder used.
   - iv) 75% of miscellaneous materials become paper waste and incinerated, remainder is disposed of.

   Determine the generation rate of solid wastes.

3. (a) With figure explain the urban solid waste recycling pattern in Bangladesh. **[5]**

   (b) Distinguish the following collection systems with neat sketches: **[15]**
   i) hauled-container system: Exchange container mode
   ii) hauled-container system: Conventional mode
   iii) stationary-container systems

4. (a) With figure explain the mechanism of anaerobic solid waste digestion.
   OR **[10]**
   With process flow diagram explain the basic steps of solid waste composting process.

   (b) Determine the break-even time (using graph paper) for a hauled container system and a stationary container system as compared to a system using transfer and transport operations, when the following data are applicable: **[10]**
   Transportation costs:
   - HCS using a hoist truck with 10-m^3 container = Tk. 8/hr.
   - SCS using 20-m^3 compactor = Tk. 12/hr.
   - Tractor-trailer transport unit 150-m^3 capacity = Tk. 16/hr.

Transfer station costs:

- Amortization and operation Costs = Tk. 0.50/m^3

5. (a) Discuss the characteristics of the following solid waste disposal methods: i) open dump ii) controlled dump and iii) sanitary landfill. **[10]**

(b) Estimate the total gas (theoretical) that could be produced from the organic fraction of MSW under anaerobic conditions using the given data below: **[10]**

- Chemical formula without water= $C_{60}H_{94.3}O_{37.8}N$.
- Total weight of organic material in 100 lb of solid wastes is equal to 75 lb including moisture. Use the following equations.

OR

Determine the amount of oxygen required to compost 1000 kg of solid wastes. Assume that the initial composition of the material to be composted is given by $[C_6H_7O_2(OH)_3]_5$, that the final composition is estimated to be $[C_6H_7O_2(OH)_3]_2$, and that half of materials remain after the composting process. Use the following equations.

Equations:

$$C_aH_bO_cN_d+\left(\frac{4a-b-2c+3d}{4}\right)H_2O \rightarrow \left(\frac{4a+b-2c-3d}{8}\right)CH_4 + \left(\frac{4a-b+2c+3d}{8}\right)CO_2+dNH_3$$

$$C_aH_bO_cN_d + 0.5\,(ny+2s+r-c)\,O_2 \longrightarrow n\,C_wH_xO_yN_z + sCO_2 + rH_2O + (d-nx)\,NH_3.$$

$$r = 0.5[b-nx-3(d-nz)]$$

$$s = a-nw$$