Bangladesh Army University of Science and Technology

Department of Civil Engineering

Final Examination, Winter 2022

Course Code: CE 3111 **Level-3 Term-I**

Time: 03 (Three) hours **Full Marks: 240**

Course Title: Structural Analysis and Design I

N.B.
- The questions are of equal value.
- Figures in the margin indicate full marks allotted to each question.
- Symbols and abbreviations bear their standard meaning.
- Use separate answer script for each PART.
- The corresponding course outcomes (CLOs) are given in the right most column.

PART- A (Marks: 120)

(Answer any three questions including Q. No. 1)

			Marks	CLOs
1.	a)	Explain determinacy and stability of structures.	(5)	1
	b)	For a three hinged parabolic arch, analyze the equation of central rise and show that	(10)	2

$$y = 4y_c\, x\, (L-x)/L^2$$

Where, the symbols bear their usual meaning.

c) A set of axle load is given in Fig. 1 below. For a simply supported girder of 60 ft. span analyze the effect of the given moving load to determine the position and value of absolute maximum bending moment on it. (25) 3

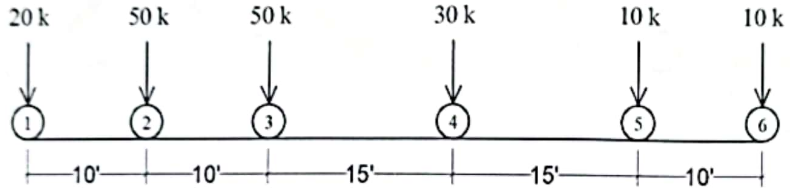


Fig. 1

2. a) For the shear force and bending moment diagram, explain the following terms: (10) 2

   i. Point of inflection
   ii. Point of contra-flexure

b) Solve the frame given in Fig. 2 below and draw the shear force diagram and bending moment diagram of it. (30) 2

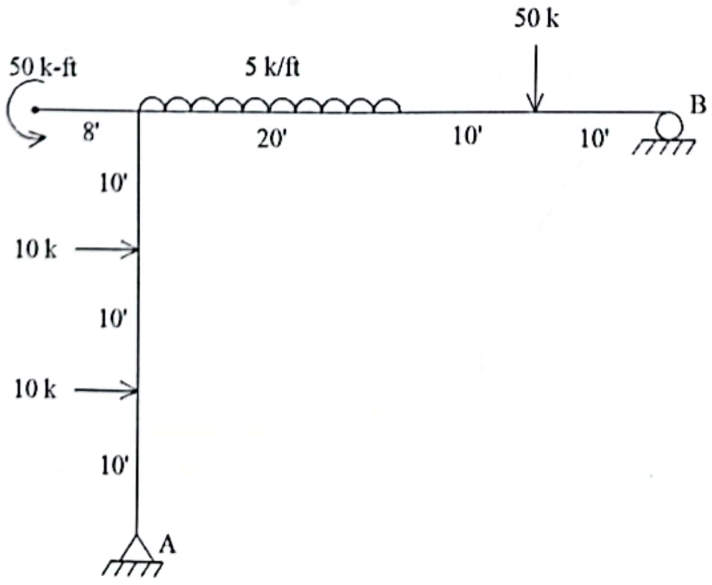


Fig. 2

3. a) Explain shortly why triangular shape is necessary for a structure to be a truss. (10)

b) A parabolic three-pinned arch has a span of 20 ft and central rise of 4 ft. It is loaded with a uniformly distributed load of 2 kip/ft as shown in Fig. 3. Draw the BMD and find the position and magnitude of maximum BM over the arch (30)

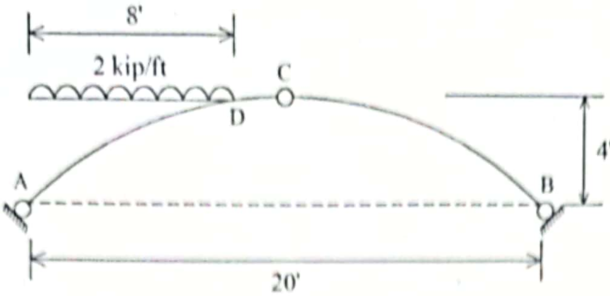


Fig. 3

4. a) For a set of axle load, locate the position of absolute moment and show that the moment load occurs when that load and the CG (Center of Gravity) of total load are at equidistant from the center of the beam. (10) 3

b) For the wheel load arrangement shown in Fig. 4, evaluate the value of any of the followings: (30) 3

i. Maximum Shear at a point 15 ft. from support A.

or,

ii. Maximum moment at a point 15 ft. from support A.

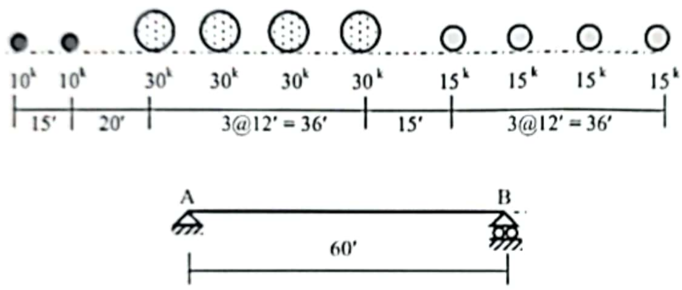


Fig. 4

PART- B (Marks: 120)

(Answer any three questions including Q. No. 5)

Marks CLOs

5. a) Determine the tension in each segment of the cable and dimension h shown in Fig. 5. (20) 4

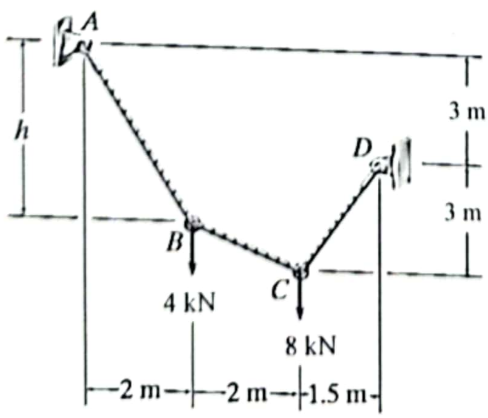


Fig. 5

The suspension bridge in Fig. 6 is constructed using the two stiffening trusses that are pin connected at their ends *C* and supported by a pin at *A* and a rocker at *B*. Determine the maximum tension in the cable *IH*. The cable has a parabolic shape and the bridge is subjected to the single load of 50 kN. (20) 4

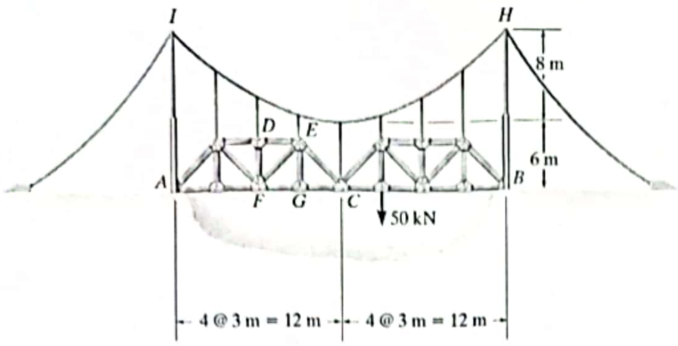


Fig. 6

6. a) State and prove general cable theorem. (16) 4

b) Determine the maximum force developed in member BC, BG, and CG of the truss shown in Fig. 7 due to the wheel loads of the car. Assume the loads are applied directly to the truss. (24) 3

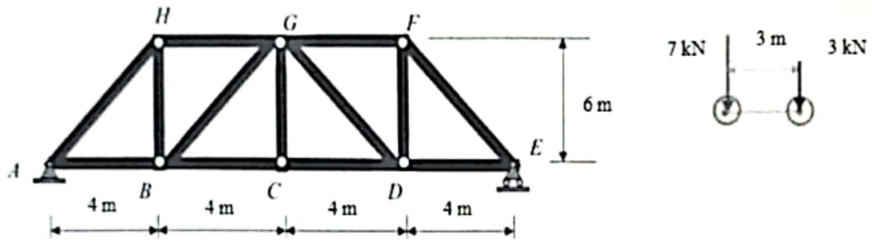


Fig. 7

7. a) Define influence line. Explain its necessity to draw. (10) 3

b) Draw the influence lines with ordinate for the following structure shown in Fig. 8 below: (30) 3

(1) Vertical reactions at A and C. (ii) Shear and moment at B and E. (iii) Shear at just left of support C and G.

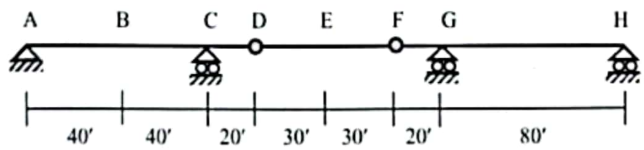


Fig. 8

8. a) Explain H-20 and HS-20 moving load with neat sketches. (10) 3

b) Draw the influence lines with ordinate for the following structure shown in Fig. 9 below and find the maximum values of the parameters due to 60 kN moving load: (30) 3

(1) Vertical reactions at H & G. (ii) Shear at C & C-D panel. (iii) Moment at C-D panel.

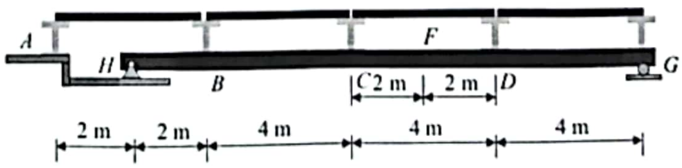


Fig. 9

Bangladesh Army University of Science and Technology

Department of Civil Engineering

Final Examination, Winter 2022

Course Code: CE 3107 | **Level-3 Term-I**

Time: 03 (Three) hours | **Full Marks: 120**

Course Title: Numerical Methods for Engineers

N.B.
- The questions are of equal value.
- Figures in the margin indicate full marks allotted to each question.
- Symbols and abbreviations bear their standard meaning.
- Use separate answer script for each PART.
- The corresponding course outcomes (CLOs) are given in the right most column.

PART- A (Marks: 60)

(Answer any three questions including Q. No. 1)

Marks CLOs

1. a) Explain a convenient criterion used to terminate the computations in numerical analysis. (5) 1

b) In computing the influence line diagram of moment of a cantilever bridge support, it was found that, the moment was varying with the position of moving load by the following equation: (15) 2

$$x^2 - 2x = M$$

Where, x =Distance of load from the support (m), M = Bending moment (N-m)

Determine the value of distance of load from the support for which the bending moment will be 5 N-m at the support by using any numerical methods and correct up to three decimal places.

2. a) Explain iteration method. Explain convergence criteria for iteration method. (5) 1

b) Use the iterative method to find a real root of the following equation (15) 2

$$\sin x = 10(x - 1)$$

Give your answer correct to three decimal places.

3. a) Explain Newton's backward interpolation table. (5) 1

b) In a soil compaction test value of water content was determined for various dry densities and the data is given below: (15) 2

Water content, x (%)	8	11	14	17
Dry density, y (lb/ft^3)	104	108	115	121

Determine the dry density for 16% water content using interpolation method.

4. a) Illustrate least square curve fitting procedures. (5) 1

b) Using the method of least squares, fit a curve of the form (15) 2

$$y = \frac{x}{a + bx}$$

to the following data:

(3, 7.148), (5, 10.231), (8, 13.509), (12, 16.434)

PART- B (Marks: 60)

(Answer any three questions including Q. No. 5)

Marks CLOs

5. Given: $\frac{dy}{dx} = 1 + y^2$ at x=0, y=0, find y(0.2), y(0.4) using fourth order Runge-Kutta method. Assume h = 0.2. (20) 3

6.	a)	Evaluate $I = \int_0^1 \frac{1}{1+x} dx$, use trapezoidal rule take h = 0.25, 0.1.	(10)	2
	b)	Calculate the area bounded by $y = 5x^2 + 2x + 10$, from x= 0 to 5 using Simpson's $\frac{1}{3}$ rule taking h=0.5 and compare it with exact solution.	(10)	2
7.		Evaluate $I = \int_0^1 \int_0^1 e^{x+2y}\, dx\, dy$. Use i. Trapezoidal rule ii. Simpson's rule Assume h = k = 0.5.	(20)	2
8.	a)	Derive the trapezoidal rule for numerical integration with necessary diagrams.	(10)	1
	b)	Differentiate $f(x) = 0.2 + 2x - 2x^2$, using centered, forward differentiation method from x=0 to 4. Assume h=0.5.	(10)	2

Bangladesh Army University of Science and Technology

Department of Civil Engineering

Final Examination, Winter 2022

Course Code: CE 3113 **Level-3 Term-I**

Time: 03 (Three) hours **Full Marks: 180**

Course Title: Reinforced Concrete Structures I

N.B.
- The questions are of equal value.
- Figures in the margin indicate full marks allotted to each question.
- Symbols and abbreviations bear their standard meaning.
- Use separate answer script for each PART.
- The corresponding course outcomes (CLOs) are given in the right most column.

PART- A (Marks: 90)

(Answer any three questions including Q. No. 1)

			Marks	CLOs
1.	a)	State the fundamental assumptions for the design of reinforced concrete structures.	(10)	1
	b)	A floor system as shown in the Fig. 1 below consists of a 4.5″ slab supported by a continuous T beam with a 24 ft span, 45″ on centers. Web dimensions are- b_w = 10″ and d = 16″. Design the tensile steel reinforcement required to resist a factored moment of 6400 kip-in. Given: f_y = 60,000 psi and f_c' = 4,000 psi.	(20)	2

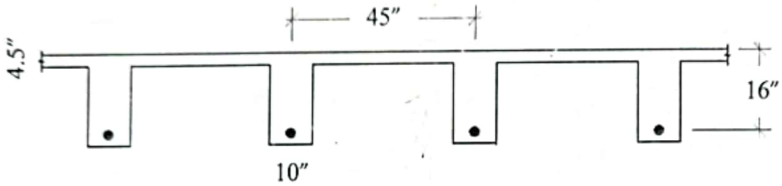


Fig. 1

		Marks	CLOs
2.	A cantilever beam as shown in Fig. 2 has a length of 8′. It is reinforced with 4 #8 bars in tension zone (at top) and 2-#6 bars in compression zone (at bottom). Calculate its ultimate moment carrying capacity and represent it in terms of a UDL on this beam. Given: f_y = 60,000 psi and f_c' = 4,000 psi.	(30)	2

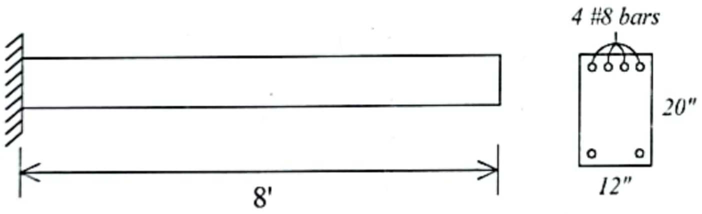


Fig. 2

		Marks	CLOs
3.	A simply supported beam as shown in Fig. 3 is subjected to an unfactored dead load of 1.05 kip/ft (excluding self-weight) and an unfactored live load of 2.47 kip/ft.	(30)	2

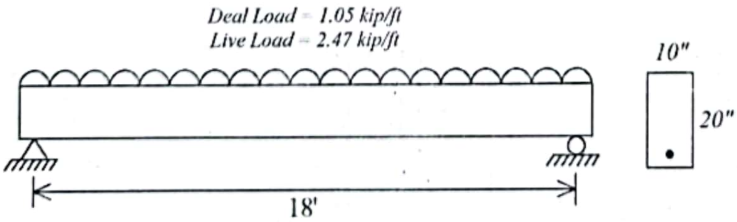


Fig. 3

Calculate the factored moment and check whether it is a singly reinforced or doubly reinforced beam. Finally, calculate the amount of steel area required and draw the reinforcement detailing.

Material properties are f_y = 60,000 psi and f_c' = 4,000 psi.

4. a) State the reasons behind designing a beam as a doubly reinforced one. (10)

b) Explain the design criteria of a T-beam. (10)

c) Illustrate the flexural behavior of RCC beam using figures for following two states: (10)

i. Stress elastic and section uncracked

ii. Stress elastic and section cracked

PART- B (Marks: 90)

(Answer any three questions including Q. No. 5)

			Marks	CLOs
5.	a)	Explain the term 'development length' with neat sketch. Mention the factors which influences the development length.	(8)	3
	b)	A monolithic reinforced concrete floor is to be composed of rectangular bays measuring 21×26 ft, as shown in Fig. 4. Beams of width 12 in and depth 24 in are provided on all column lines. The floor is to be designed to carry a service LL of 137 psf uniformly distributed over its surface, in addition to its own weight. Use f_c'=3 ksi, f_y=60 ksi. Calculate the required slab thickness and reinforcement for the corner panel shown.	(22)	4

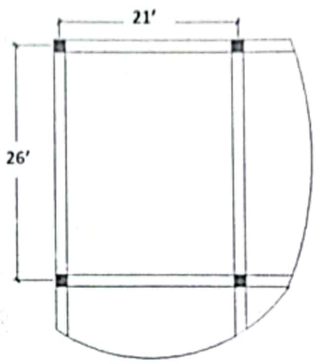


Fig. 4

			Marks	CLOs
6.	a)	Explain-why and how the corner reinforcement is provided in two-way slab.	(5)	4
	b)	A 16 in wide simply supported rectangular beam carries a total factored load of 10 kips/ft on a 20 ft clear span. The effective depth of the beam is 22 in. The beam is reinforced with 7.62 in^2 of tensile steel which continues uninterrupted into the supports. Analyze the beam to locate the position where web reinforcement is required. Consider normal weight concrete with λ=1.0 and f_c'=3 ksi. For simply supported slab minimum thickness may be taken as h=L/20.	(15)	3
	c)	Design web reinforcement for the above beam. Use vertical U stirrups with f_y=60 ksi.	(10)	3
7.	a)	A RCC slab is built integrally with its supports and consists of two equal spans, each with a clear span of 20 ft. The service live load is 100 psf, f f_c'=3 ksi, f_y=60 ksi. Design the slab following the provision of ACI Code.	(22)	4
	b)	Sketch the bar details /drawing with all dimensions in terms of span length L (for both straight bar and bent bar) for above one-way slab (show only main rebars).	(8)	4
8.	a)	State the reason of providing lapping. Explain the ACI Code provision for the required length of laps for tension and compression splices.	(5)	3
	b)	Explain with diagram the ACI Code provision for special anchorage system at the ends of the bar if the desired tensile stress in a bar cannot be developed by bond alone.	(10)	3
	c)	Explain the formation of different types cracks formed in a beam with diagram. Which one is more harmful and why? Show the alternative layouts of web reinforcement.	(15)	3

TABLE A.3
Areas of bars in slabs, in²/ft

Spacing, in.	Bar No. (Inch-Pound: 3 / SI: 10)	4 / 13	5 / 16	6 / 19	7 / 22	8 / 25	9 / 29	10 / 32	11 / 36
3	0.44	0.78	1.23	1.77	2.40	3.14	4.00	5.06	6.25
3½	0.38	0.67	1.05	1.51	2.06	2.69	3.43	4.34	5.36
4	0.33	0.59	0.92	1.32	1.80	2.36	3.00	3.81	4.68
4½	0.29	0.52	0.82	1.18	1.60	2.09	2.67	3.37	4.17
5	0.26	0.47	0.74	1.06	1.44	1.88	2.40	3.04	3.75
5½	0.24	0.43	0.67	0.95	1.31	1.71	2.18	2.76	3.41
6	0.22	0.39	0.61	0.88	1.20	1.57	2.00	2.53	3.12
6½	0.20	0.36	0.57	0.82	1.11	1.45	1.85	2.34	2.89
7	0.19	0.34	0.53	0.76	1.03	1.35	1.71	2.17	2.68
7½	0.18	0.31	0.49	0.71	0.96	1.26	1.60	2.02	2.50
8	0.17	0.29	0.46	0.66	0.90	1.18	1.50	1.89	2.34
9	0.15	0.26	0.41	0.59	0.80	1.05	1.33	1.69	2.08
10	0.13	0.24	0.37	0.53	0.72	0.94	1.20	1.52	1.87
12	0.11	0.20	0.31	0.44	0.60	0.78	1.00	1.27	1.56

Table 1 - Coefficients for Negative Moments in Slabs

$M_a^- = C_{a,neg} w_u l_a^2$

$M_b^- = C_{b,neg} w_u l_b^2$

where w_u = total factored uniform load (DL + LL)

Ratio $m = \frac{l_a}{l_b}$		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{a,neg}$	-	0.045	0.076	0.050	0.075	0.071	0.071	0.033	0.061
	$C_{b,neg}$		0.045		0.050				0.061	0.033
0.95	$C_{a,neg}$	-	0.050	0.072	0.055	0.079	0.075	0.067	0.038	0.065
	$C_{b,neg}$		0.041		0.045				0.056	0.029
0.90	$C_{a,neg}$	-	0.055	0.070	0.060	0.080	0.079	0.062	0.043	0.068
	$C_{b,neg}$		0.037		0.040				0.052	0.025
0.85	$C_{a,neg}$	-	0.060	0.065	0.066	0.082	0.083	0.057	0.049	0.072
	$C_{b,neg}$		0.031		0.034				0.046	0.021
0.80	$C_{a,neg}$	-	0.065	0.061	0.071	0.083	0.086	0.051	0.055	0.075
	$C_{b,neg}$		0.027		0.029				0.041	0.017
0.75	$C_{a,neg}$	-	0.069	0.056	0.076	0.085	0.088	0.044	0.061	0.078
	$C_{b,neg}$		0.022		0.024				0.036	0.014
0.70	$C_{a,neg}$	-	0.074	0.050	0.081	0.086	0.091	0.038	0.068	0.081
	$C_{b,neg}$		0.017		0.019				0.029	0.011
0.65	$C_{a,neg}$	-	0.077	0.043	0.085	0.087	0.093	0.031	0.074	0.083
	$C_{b,neg}$		0.014		0.015				0.024	0.008
0.60	$C_{a,neg}$	-	0.081	0.035	0.089	0.088	0.095	0.024	0.080	0.085
	$C_{b,neg}$		0.010		0.011				0.018	0.006
0.55	$C_{a,neg}$	-	0.084	0.028	0.092	0.089	0.096	0.019	0.085	0.086
	$C_{b,neg}$		0.007		0.008				0.014	0.005
0.50	$C_{a,neg}$	-	0.086	0.022	0.094	0.090	0.097	0.014	0.089	0.088
	$C_{b,neg}$		0.006		0.006				0.010	0.003

Table 2 - Coefficients for Dead Load Positive Moments in Slabs

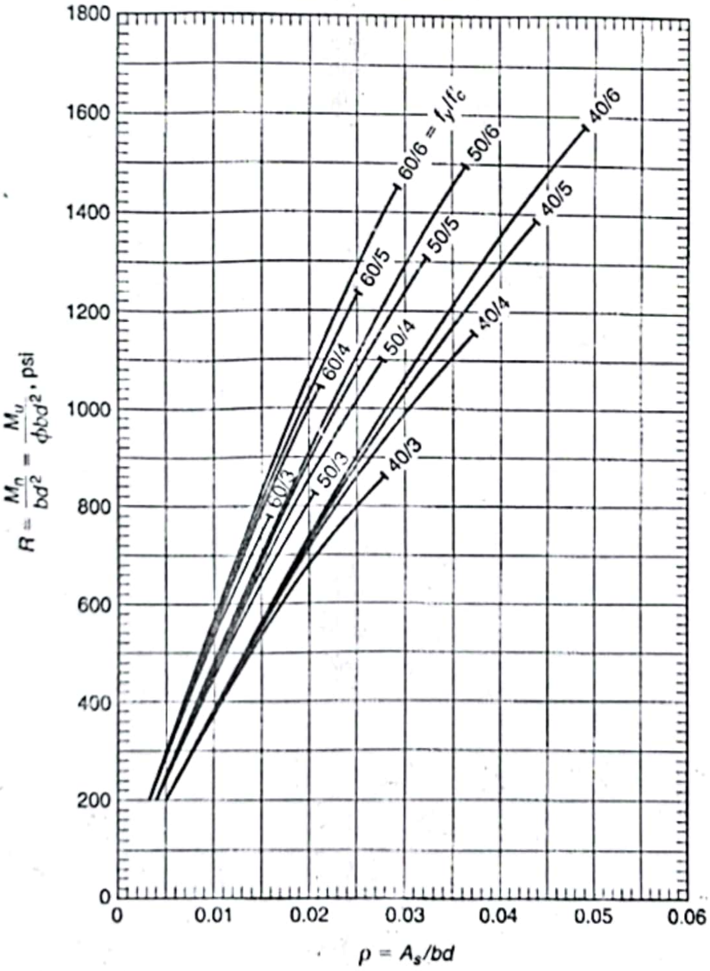
$M_{a,DL}^+ = C_{a,DL} w_{DL} l_a^2$

$M_{b,DL}^+ = C_{b,DL} w_{DL} l_b^2$

where w_{DL} = uniform factored Dead Load (DL)

Ratio $m = \frac{l_a}{l_b}$		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{a,DL}$	0.036	0.018	0.018	0.027	0.027	0.033	0.027	0.020	0.023
	$C_{b,DL}$	0.036	0.018	0.027	0.027	0.018	0.027	0.033	0.023	0.020
0.95	$C_{a,DL}$	0.040	0.020	0.021	0.030	0.028	0.036	0.031	0.022	0.024
	$C_{b,DL}$	0.033	0.016	0.025	0.024	0.015	0.024	0.031	0.021	0.017
0.90	$C_{a,DL}$	0.045	0.022	0.025	0.033	0.029	0.039	0.035	0.025	0.026
	$C_{b,DL}$	0.029	0.014	0.024	0.022	0.013	0.021	0.028	0.019	0.015
0.85	$C_{a,DL}$	0.050	0.024	0.029	0.036	0.031	0.042	0.040	0.029	0.028
	$C_{b,DL}$	0.026	0.012	0.022	0.019	0.011	0.017	0.025	0.017	0.013
0.80	$C_{a,DL}$	0.056	0.026	0.034	0.039	0.032	0.045	0.045	0.032	0.029
	$C_{b,DL}$	0.023	0.011	0.020	0.016	0.009	0.015	0.022	0.015	0.010
0.75	$C_{a,DL}$	0.061	0.028	0.040	0.043	0.033	0.048	0.051	0.036	0.031
	$C_{b,DL}$	0.019	0.009	0.018	0.013	0.007	0.012	0.020	0.013	0.007
0.70	$C_{a,DL}$	0.068	0.030	0.046	0.046	0.035	0.051	0.058	0.040	0.033
	$C_{b,DL}$	0.016	0.007	0.016	0.011	0.005	0.009	0.017	0.011	0.006
0.65	$C_{a,DL}$	0.074	0.032	0.054	0.050	0.036	0.054	0.065	0.044	0.034
	$C_{b,DL}$	0.013	0.006	0.014	0.009	0.004	0.007	0.014	0.009	0.005
0.60	$C_{a,DL}$	0.081	0.034	0.062	0.053	0.037	0.056	0.073	0.048	0.036
	$C_{b,DL}$	0.010	0.004	0.011	0.007	0.003	0.006	0.012	0.007	0.004
0.55	$C_{a,DL}$	0.088	0.035	0.071	0.056	0.038	0.058	0.081	0.052	0.037
	$C_{b,DL}$	0.008	0.003	0.009	0.005	0.002	0.004	0.009	0.005	0.003
0.50	$C_{a,DL}$	0.095	0.037	0.080	0.059	0.039	0.061	0.089	0.056	0.038
	$C_{b,DL}$	0.006	0.002	0.007	0.004	0.001	0.003	0.007	0.004	0.002

Table 3 - Coefficients for Live Load Positive Moments in Slabs										
$M_{a,LL}^{+} = C_{a,LL} w_{LL} l_a^2$ $M_{b,LL}^{+} = C_{b,LL} w_{LL} l_b^2$		where w_{LL} = uniform factored Live Load (LL)								
Ratio $m = \frac{l_a}{l_b}$		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{a,LL}$	0.036	0.027	0.027	0.032	0.032	0.035	0.032	0.028	0.030
	$C_{b,LL}$	0.036	0.027	0.032	0.032	0.027	0.032	0.035	0.030	0.028
0.95	$C_{a,LL}$	0.040	0.030	0.031	0.035	0.034	0.038	0.036	0.031	0.032
	$C_{b,LL}$	0.033	0.025	0.029	0.029	0.024	0.029	0.032	0.027	0.025
0.90	$C_{a,LL}$	0.045	0.034	0.035	0.039	0.037	0.042	0.040	0.035	0.036
	$C_{b,LL}$	0.029	0.022	0.027	0.026	0.021	0.025	0.029	0.024	0.022
0.85	$C_{a,LL}$	0.050	0.037	0.040	0.043	0.041	0.046	0.045	0.040	0.039
	$C_{b,LL}$	0.026	0.019	0.024	0.023	0.019	0.022	0.026	0.022	0.020
0.80	$C_{a,LL}$	0.056	0.041	0.045	0.048	0.044	0.051	0.051	0.044	0.042
	$C_{b,LL}$	0.023	0.017	0.022	0.020	0.016	0.019	0.023	0.019	0.017
0.75	$C_{a,LL}$	0.061	0.045	0.051	0.052	0.047	0.055	0.056	0.049	0.046
	$C_{b,LL}$	0.019	0.014	0.019	0.016	0.013	0.016	0.020	0.016	0.013
0.70	$C_{a,LL}$	0.068	0.049	0.057	0.057	0.051	0.060	0.063	0.054	0.050
	$C_{b,LL}$	0.016	0.012	0.016	0.014	0.011	0.013	0.017	0.014	0.011
0.65	$C_{a,LL}$	0.074	0.053	0.064	0.062	0.055	0.064	0.070	0.059	0.054
	$C_{b,LL}$	0.013	0.010	0.014	0.011	0.009	0.010	0.014	0.011	0.009
0.60	$C_{a,LL}$	0.081	0.058	0.071	0.067	0.059	0.068	0.077	0.065	0.059
	$C_{b,LL}$	0.010	0.007	0.011	0.009	0.007	0.008	0.011	0.009	0.007
0.55	$C_{a,LL}$	0.088	0.062	0.080	0.072	0.063	0.073	0.085	0.070	0.063
	$C_{b,LL}$	0.008	0.006	0.009	0.007	0.005	0.006	0.009	0.007	0.006
0.50	$C_{a,LL}$	0.095	0.066	0.088	0.077	0.067	0.078	0.092	0.076	0.067
	$C_{b,LL}$	0.006	0.004	0.007	0.005	0.004	0.005	0.007	0.005	0.004



Bangladesh Army University of Science and Technology

Department of Civil Engineering

Final Examination, Winter 2022

Course Code: CE 3141 **Level-3 Term-I**

Time: 03 (Three) hours **Full Marks: 180**

Course Title: Environmental Engineering I

N.B.
- The questions are of equal value.
- Figures in the margin indicate full marks allotted to each question.
- Symbols and abbreviations bear their standard meaning.
- Use separate answer script for each PART.
- The corresponding course outcomes (CLOs) are given in the right most column.

PART- A (Marks: 90)

(Answer any three questions including Q. No. 1)

			Marks	CLOs
1.	a)	Briefly explain the challenges that you may face as a Water Supply Engineer while considering groundwater as a source of a Piped Water Supply System Project (PWSSP) in Bangladesh.	(15)	1
	b)	Compare between slow sand filter (SSF) and rapid sand filter (RSF) in terms of: i) filter sand ii) filtration efficiency iii) rate of filtration iv) maintenance v) cost.	(15)	2
2.	a)	Explain different types of pump heads with figure(s).	(15)	1
	b)	Design a suitable set of pumping unit to deliver 450000 gph from an intake well of a river bank to the treatment plant. Total length of rising main from the intake well to the treatment plant is 800 ft and the static hand is 60 ft. Design also the cast iron main. Assume: Velocity of water = 12 fps; Friction factor = 0.0075; Efficiency = 70%	(15)	1
3.	a)	Explain the breakpoint chlorination with a neat sketch.	(15)	2
	b)	Explain confined and unconfined aquifer (Figure required). A tubewell is 460 mm in diameter. The unconfined aquifer is of 18 m depth. After drawdown, depth of water is 12 m in the well. Calculate the discharge of the tubewell if permeability of soil is 24.5 m/d and radius of circle of influence is 275 m.	(7.5+7.5)	2
4.	a)	Using a flow diagram, show the locations of water losses in a piped water supply system.	(15)	3
	b)	Explain shortly the following terms: i) Water demand management ii) Water safety plan	(7.5+7.5)	3

PART- B (Marks: 90)

(Answer any three questions including Q. No. 5)

			Marks	CLOs
5.	a)	Draw a neat sketch of pond sand filter (PSF). "Ponds should be selected carefully for efficient operation of PSF"—justify the statement.	(15)	3
	b)	A family of 8 persons in an arsenic and saline affected area of Bangladesh have planned to install rain water harvesting system (RWHS) as an alternative water supply option. Calculate the minimum capacity of storage tank required for the purpose with the following data: water demand = 10 lpcd of rainwater; yearly rainfall intensity = 2.5 m and the rainfall distribution is such that at least 35% of the rainwater must be stored for uninterrupted water supply throughout the year. What challenges this family may face for choosing this alternative water supply option?	(7.5+7.5)	3

6.	a)	Draw a sedimentation tank and explain its different zones.	(15)	2
	b)	Compare between plain sedimentation and chemical sedimentation (Figure required).	(15)	2
7.		Explain with neat sketches the different methods of water transmission and distribution. In your opinion, among these methods which one is suitable for a city corporation area and why?	(20+10)	3
8.		Calculate the corrected flows in the various pipes of the distribution network as shown in following figure (use Hardy Cross method). The diameters and lengths of the pipes used are given against each pipe. One trial is required.	(30)	3