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

Course Title: Geotechnical Engineering II — Course Code: CE 441
Time: 3 hours — Full Marks: 150

Answer the following questions.

1. (a) What is subsurface exploration in terms of geotechnical engineering? Give two reasons as to why subsurface exploration is required in geotechnical engineering. 3+2=5

   (b) Write down the preliminary information that would be important to execute geotechnical subsurface exploration for a building and for a bridge project. 4

   (c) Write down any two general guidelines used for the selection of depth and location of boreholes for typical civil engineering project. 4

   (d) Write the names of any five in-situ testing performed in the field under the field investigation phase of a sub-surface exploration program. Write a very short note on the one frequently used in Bangladesh? 2+5=7

   (e) The outside and inside diameters of a split-spoon sampler are 2 inches and 1.4 inches, respectively and those of a Shelby tube sampler are 3 inches and 2.85 inches, respectively. Estimate the degree of disturbances for two soil samples; one obtained using the split-spoon sampler and the other using the Shelby tube. Also determine whether the samples are disturbed or undisturbed. 5

   (f) A borehole was advanced as a part of a preliminary geotechnical investigation for a site in Bangladesh as in Figure 1 below. Determine cohesion and angle of internal friction at corresponding depths of the clay and sand deposits, respectively, based on the available data (Use empirical correlations as provided in Appendix-A). Use hammer efficiency as 47%. 20

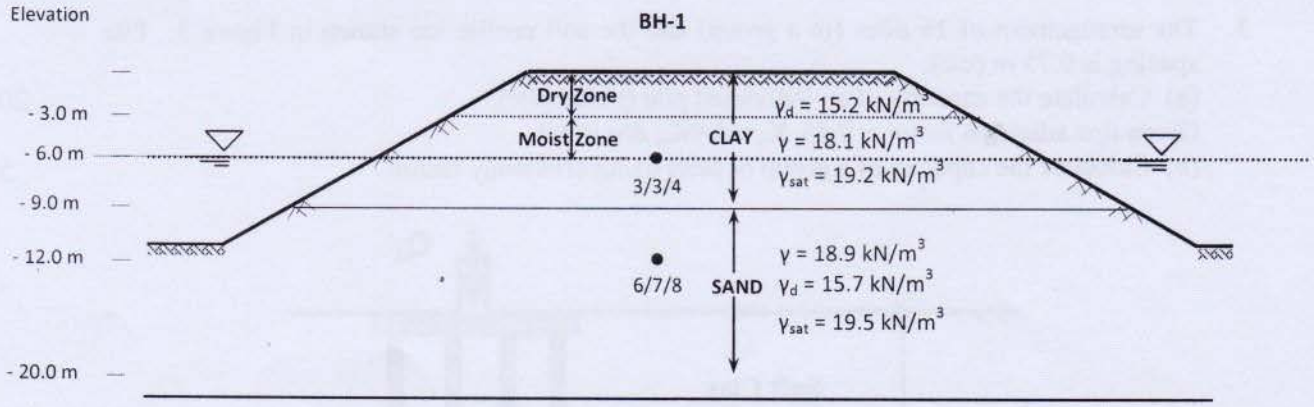


Figure 1. Subsurface Soil

2. (a) Calculate the settlement of the rectangular footing (dimension 2 m x 3 m) in the soil profile shown in Figure 2, due to primary consolidation settlement of the soft clay layer . Use 2:1 pressure distribution. The thickness of clay layer should be 1 m or less in settlement calculation. 15

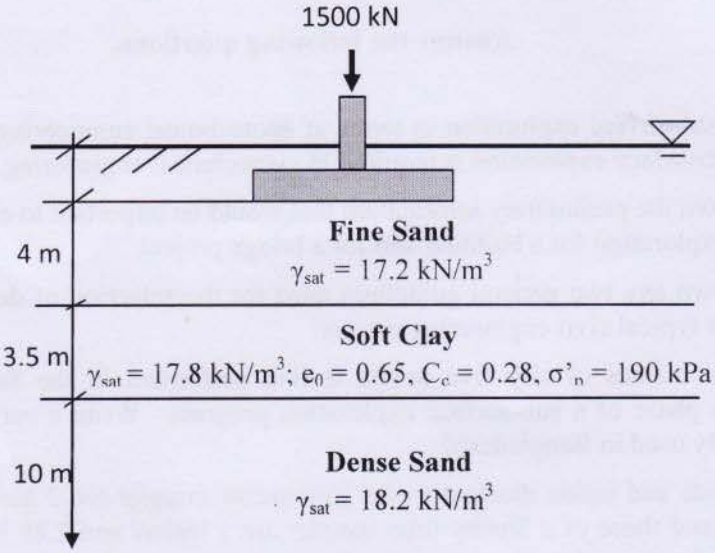


Figure 2

(b) Calculate the immediate settlement of a square footing (2.5 m X 2.5 m) in soil profile shown in Figure 1. 5

Given that Poisson's ratio = 0.28

E_0 = 10,000 kPa , $E_f = 12 * 10^6$ kPa

Modulus of Sub-Grade Reaction = 6000 kPa/m

3. The arrangement of 16 piles (in a group) and the soil profile are shown in Figure 3. Pile spacing is 0.75 m (c/c).

(a) Calculate the capacity of an individual pile (bored pile). 20

Given that adhesion factor = 0.45, $K_s = 0.9K_0$, $\delta/\varphi = 0.7$.

(b) Calculate the capacity of a group of piles using efficiency factor. 5

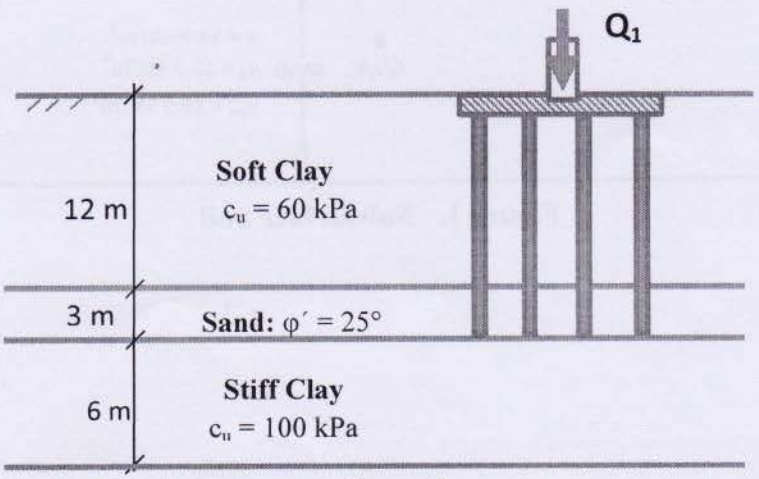


Figure 3

4. According to the soil exploration report, the loose sand layer is overlying medium dense sand as shown in Figure 4 below. The ground water table is located at EGL. The depth of foundation is 1.5 m below the ground level. 10

Estimate the ultimate (gross) bearing capacity for the following case:

2m x 2m square footing; Z = 5 m; column load is 0.2 m eccentric (bothway).

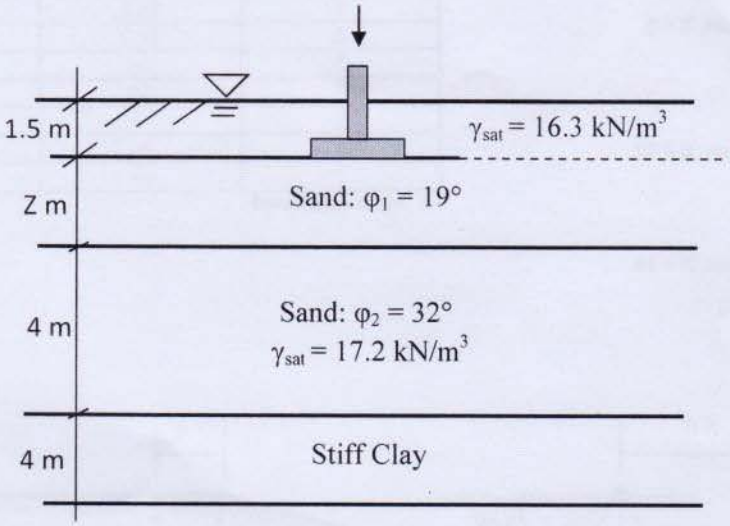


Figure 4

5. According to the soil exploration report, the upper layer is found homogeneous and extends up to 8 m below the ground level. The ground water table is located at GL. 20

Given data: γ_{sat} = 17.8 kN/m^3; c = 15 kPa; φ = 32°

Design a rectangular shallow foundation (placed at a depth 1.8 m below the ground level) to support 580 kN load for the following soil data. Provide a factor of safety equal 2.5.

Use Meyerhof's theory of bearing capacity.

6. (a) Mention a few features incorporating slope stability issues. 5

(b) Determine the factor of safety (stability) against the failure arcs through the slope for the slope as shown in Figure 5 below. 25

LAYER I:
Sandy Clay
Average SPT Blow Count, N = 6
Unit Weight = 110 pcf

LAYER II:
Clay
Average SPT Blow Count, N = 12
Unit Weight = 115 pcf

LAYER III:
Clay
Average SPT Blow Count, N = 16
Unit Weight = 120 pcf

Segment No.	Area (ft^2)	Arm (ft)
1	10.8	---
2	31.2	---
3	---	7.8
4	15	---
5	---	13.2
6	---	---
7	---	---

--- **to be calculated**

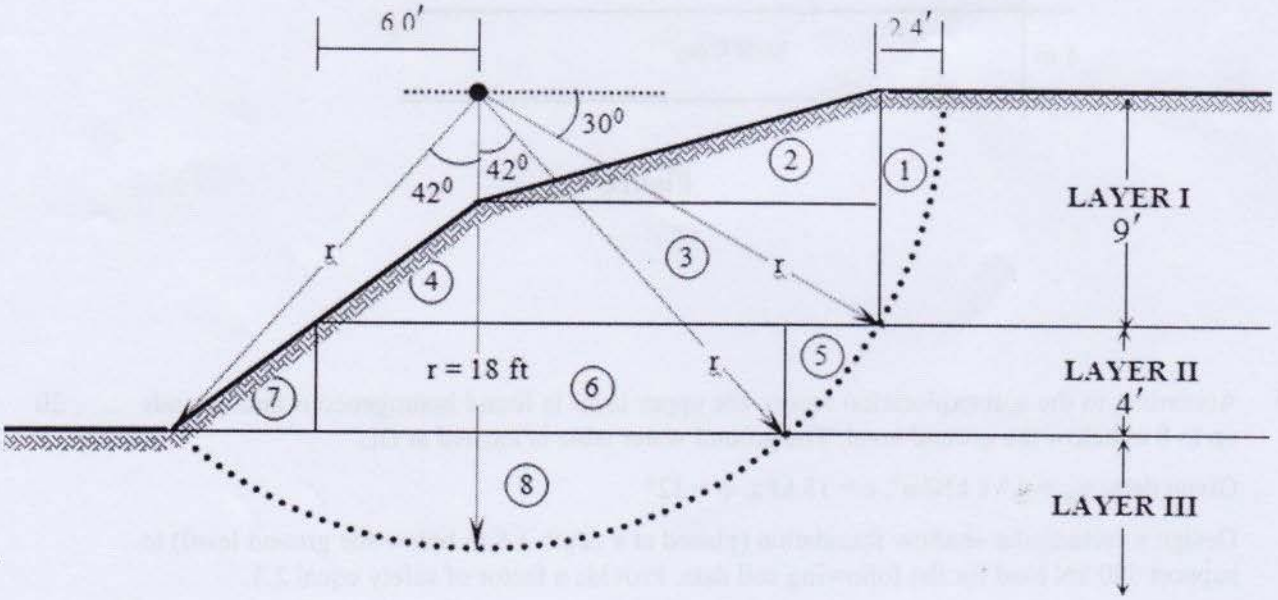


Figure 5

APPENDIX - A

Parameter for 60% Energy Correction For Field SPT

E_m = Hammer Efficiency (Donut + Cathed) = 0.55 to 0.60

C_B = Correction for Borehole Diameter
= 1.0 (For Dia 2.5" – 4.5")
= 1.05 (For Dia of 6")
= 1.15 (For Dia 8")

C_S = Correction for Sampler
= 1.0 Standard Sampler
= 1.2 Sampler Without Liner

C_R = Correction for Rod Length
= 0.75 for L = (3-4) m
= 0.85 for L = (4-6) m
= 0.95 for L = (6-10) m
= 1.0 for L > 10 m

Relevant Empirical Correlations

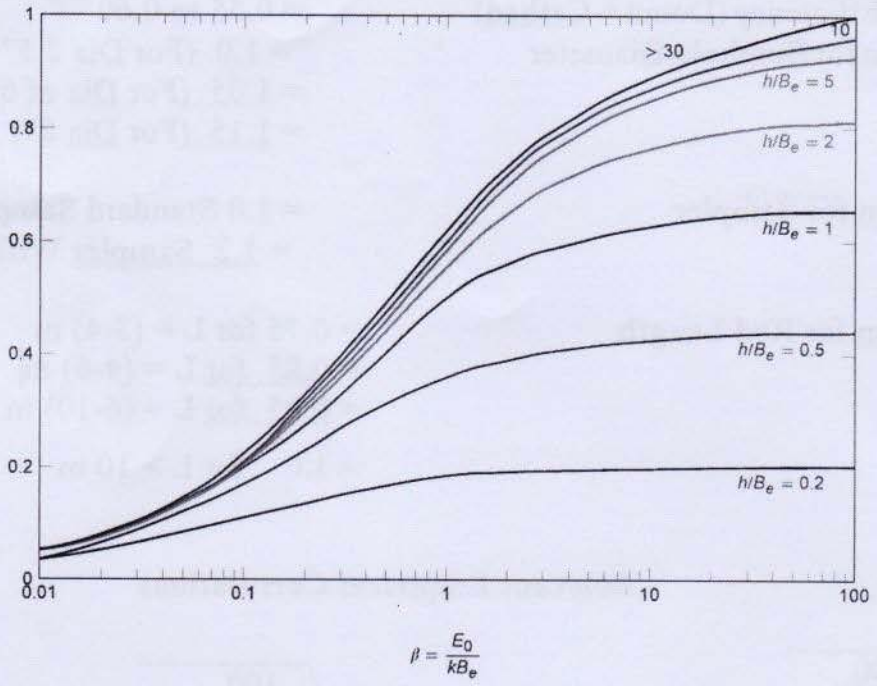
$CF_1 = \sqrt{\frac{2000}{\sigma_{v0}'}}$ (σ_{v0}' is in psf) $CF_1 = \sqrt{\frac{100}{\sigma_{v0}'}}$ (σ_{v0}' is in kPa)

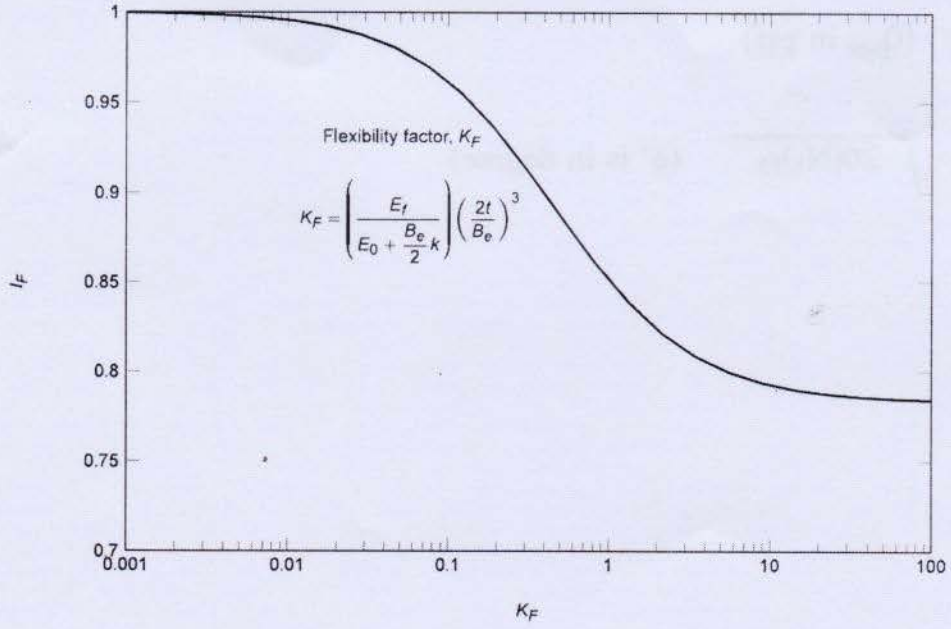
$C_u = (q_{unc}/2)$

$q_{unc} = 300\ N_f$ (q_{unc} in psf)

$\phi' = 15 + \sqrt{20(N_1)_{60}}$ (ϕ' is in degree)

APPENDIX - B


1
0.8
0.6
0.4
0.2
0
0.01
0.1
1
10
100
> 30
10
$h/B_e = 5$
$h/B_e = 2$
$h/B_e = 1$
$h/B_e = 0.5$
$h/B_e = 0.2$
$\beta = \frac{E_0}{kB_e}$


1
0.95
0.9
0.85
0.8
0.75
0.7
0.001
0.01
0.1
1
10
100
I_F
K_F
Flexibility factor, K_F
$K_F = \left(\frac{E_f}{E_0 + \frac{B_e}{2}k}\right)\left(\frac{2t}{B_e}\right)^3$

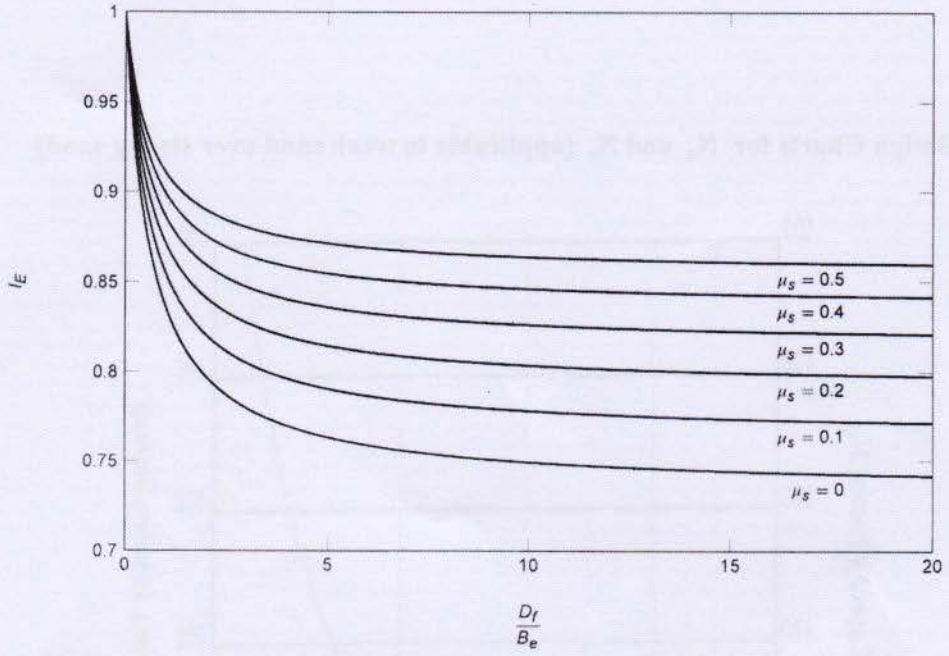
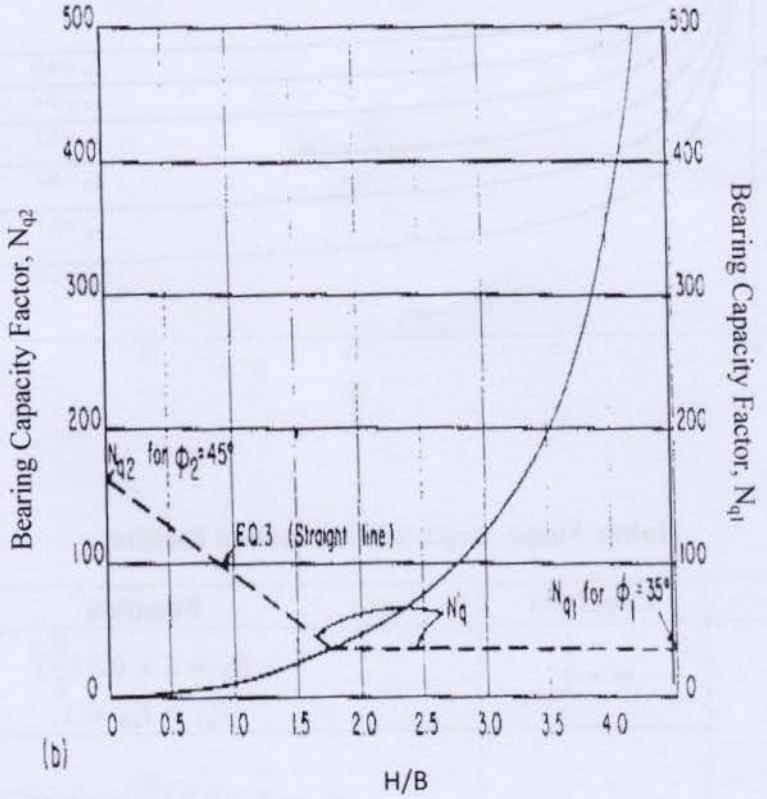


Table: Shape, Depth and Inclination Factors

Factor	Condition	Equation
Shape	$\varphi = 0^\circ$	$F_{cs} = 1 + 0.2\,(\frac{B}{L})$ $F_{qs} = F_{\gamma s} = 1$
	$\varphi \geq 10^\circ$	$F_{cs} = 1 + 0.2\,(\frac{B}{L})tan^2(45^\circ + \frac{\varphi}{2})$ $F_{qs} = F_{\gamma s} = 1 + 0.1\,(\frac{B}{L})tan^2(45^\circ + \frac{\varphi}{2})$
Depth	$\varphi = 0^\circ$	$F_{cd} = 1 + 0.2\,(\frac{D_f}{B})$ $F_{qd} = F_{\gamma d} = 1$
	$\varphi \geq 10^\circ$	$F_{cd} = 1 + 0.2\left(\frac{D_f}{B}\right).tan(45^\circ + \frac{\varphi}{2})$ $F_{qd} = F_{\gamma d} = 1 + 0.1\left(\frac{D_f}{B}\right).tan(45^\circ + \frac{\varphi}{2})$
Inclination	Any φ	$F_{ci} = F_{qi} = (1 - \frac{\alpha^\circ}{90^\circ})^2$
	$\varphi > 0^\circ$	$F_{\gamma i} = (1 - \frac{\alpha^\circ}{\varphi^\circ})^2$
	$\varphi = 0^\circ$	$F_{\gamma i} = 0$

Design Charts for N_q' and N_γ' (applicable to weak sand over strong sand)



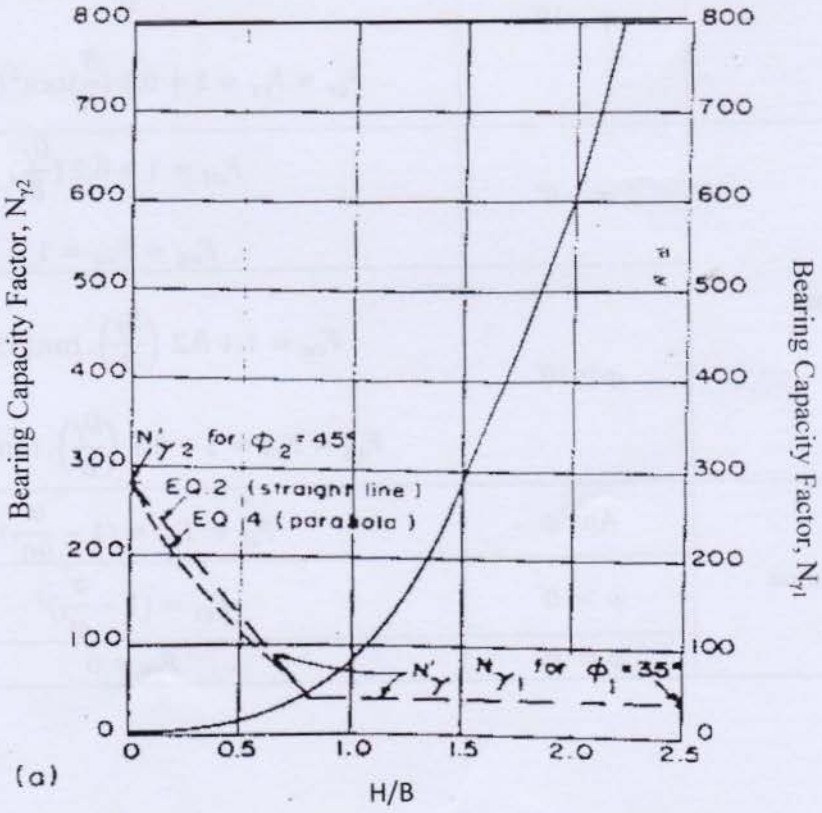
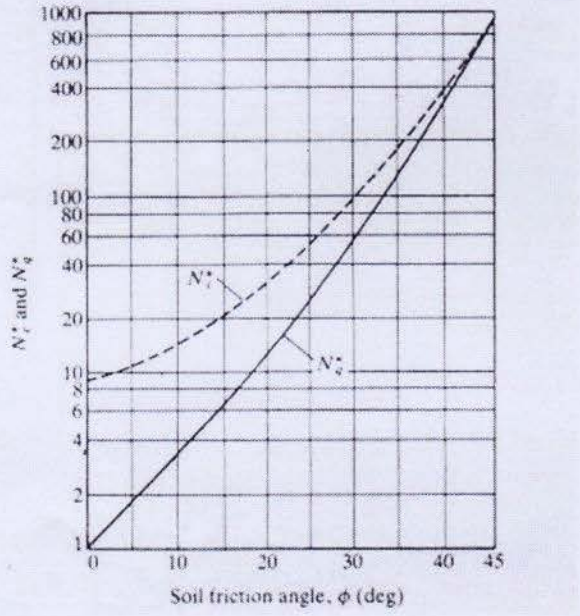


Table: Bearing Capacity Factors (Meyerhof's Chart)

ϕ	N_c	N_q	N_γ (Meyerhof)	ϕ	N_c	N_q	N_γ (Meyerhof)	ϕ	N_c	N_q	N_γ (Meyerhof)
0°	5.10	1.00	0.00	17°	12.34	4.77	1.66	34°	42.16	29.44	31.15
1°	5.38	1.09	0.00	18°	13.10	5.26	2.00	35°	46.12	33.30	37.15
2°	5.63	1.20	0.01	19°	13.93	5.80	2.40	36°	50.59	37.75	44.43
3°	5.90	1.31	0.02	20°	14.83	6.40	2.87	37°	55.63	42.92	53.27
4°	6.19	1.43	0.04	21°	15.81	7.07	3.42	38°	61.35	48.93	64.07
5°	6.49	1.57	0.07	22°	16.88	7.82	4.07	39°	67.87	55.96	77.33
6°	6.81	1.72	0.11	23°	18.05	8.66	4.82	40°	75.31	64.20	93.69
7°	7.16	1.88	0.15	24°	19.32	9.60	5.72	41°	83.86	73.90	113.99
8°	7.53	2.06	0.21	25°	20.72	10.66	6.77	42°	93.71	85.37	139.32
9°	7.92	2.25	0.28	26°	22.25	11.85	8.00	43°	105.11	99.01	171.14
10°	8.34	2.47	0.37	27°	23.94	13.20	9.46	44°	118.37	115.31	211.41
11°	8.80	2.71	0.47	28°	25.80	14.72	11.19	45°	133.87	134.87	262.74
12°	9.28	2.97	0.60	29°	27.86	16.44	13.24	46°	152.10	158.50	328.73
13°	9.81	3.26	0.74	30°	30.14	18.40	15.67	47°	173.64	187.21	414.33
14°	10.37	3.59	0.92	31°	32.67	20.63	18.56	48°	199.26	222.30	526.46
15°	10.98	3.94	1.13	32°	35.49	23.18	22.02	49°	229.93	265.50	674.92
16°	11.63	4.34	1.37	33°	38.64	26.09	26.17				

Design chart: Nc* and Nq* vs ϕ



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

Course Title: Environmental Engineering III | Course Code: CE 431
Time: 2.00 Hours | Credit Hour: 2.00 | Full Marks: 100

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

1. (a) Explain the term "E-waste". What are the challenges of managing E-waste in Bangladesh? [5+10]

   (b) Draw the hierarchy of priorities in Hazardous Waste Management (HWM). [5]

2. (a) Distinguish the following collection systems of Municipal Solid Waste (MSW) with neat sketches: [15]
   i) hauled-container system: Exchange container mode
   ii) hauled-container system: Conventional mode
   iii) stationary-container systems

   (b) With a free hand graph explain the cost comparison with and without transfer station in a MSW management system. [5]

3. (a) Explain the mechanism of anaerobic solid waste digestion (Figure and chemical reaction required). [15]

   OR

   Explain in details the process flow diagram for MSW composting facilities (Figure required).

   (b) Justify the necessity of recycling and reuse in MSW management system from environmental view point. [5]

4. (a) Compare the following solid waste disposal methods in terms of characteristics and environmental impacts: i) open dump ii) controlled dump and iii) sanitary landfill [15]

   (b) Make comments on "After-use of landfill sites". [5]

5. (a) Solid wastes having the composition showed in Table 1 were generated in the cafeteria of University of Asia Pacific. Determine the energy content of the generated solid wastes from 100 Kg sample. [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= $C_{60}H_{80}O_{40}N$.
- Total weight of organic material is 80 kg including moisture in 100 kg of solid waste. Use the equation given below.

OR

Barrels of 75-gal (US) capacity are to be used for a barrel composting plant for a community of 1000 people in Gazipur. The plant will operate throughout the year. The average temperature measured within the waste is 43° C. The composition of solid waste in a 100kg sample is given in following Table 2. The targeted loss of volume is 50 per cent and the average density of the waste is 450 kg/m^3. The waste generation rate of Gazipur is 0.4 kg/capita/day. Compute the number of barrels required in the barrel composting plant.

Equation:

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

Table: 1 (Question No. 5 (a))

Component	Weight (%)	Composition (Kg)					
		C	H	O	N	S	Ash
Food wastes	60	13	0.5	2.5	0.5	0.03	1.47
Paper	25	5.5	1.3	6.4	0.71	0.09	1.0
Plastics	15	3.3	0.35	1.1	--	--	0.15

Table: 2 (Question No. 5 (b) OR)

Component	Wet mass, kg	Dry mass, kg	Composition, Kg					
			C	H	O	N	S	ASH
Food Waste	45	18	13	0.5	2.5	0.5	0.03	1.47
Paper	22	15	5.5	1.3	6.4	0.71	0.09	1.0
Cardboard	8	7.5	3.1	0.31	3.2	0.06	0.03	0.8
Plastics	5	4.9	3.3	0.35	1.1	-	-	0.15
Garden trimming	15	5	1.7	0.65	1.85	0.25	0.01	0.54
Wood	5	4	2.1	0.21	1.35	0.2	-	0.14

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

Course Title: Structural Engineering III | Credit Hours: 3.0 | Course Code: CE 411

Time: 3 hours | Full Marks: 100 (= 10 × 10)

ANSWER ALL THE QUESTIONS

1. Use Stiffness Method (neglecting axial deformations) to calculate rotation at joint ***a*** of the frame loaded as shown in ***Fig.1***, if the joint ***b*** is attached to a circular foundation of radius 3.5 ft on the surface of subsoil (half-space) with shear wave velocity(v_s) equal to 1200 ft/sec
[Given: *EI of the frame members= 80 × 10^3 k-ft^2, Unit weight of soil = 120 pcf, Poisson's ratio of soil material= 0.25*].

2. Calculate the Yield Moment (M_y) and Plastic Moment (M_p) capacity of the section shown in ***Fig. 2*** if the section is made of elastic-fully plastic material [Given: $\sigma_y = \sigma_{yp} = 60$ *ksi*].

3. Use Stiffness Method considering flexural deformations only to calculate the unknown rotations at joint ***b*** and ***c*** of the frame ***abc*** loaded as shown in ***Fig. 3***
[Given: *EI* = 70 × 10^3 k-ft^2].

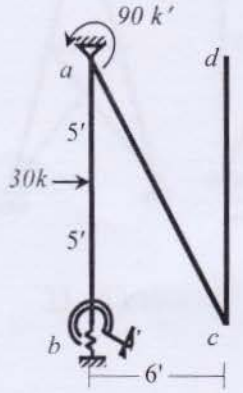


Fig. 1

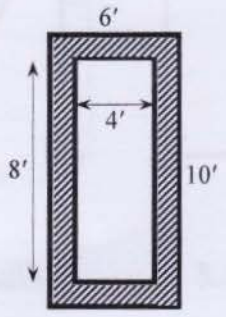


Fig. 2

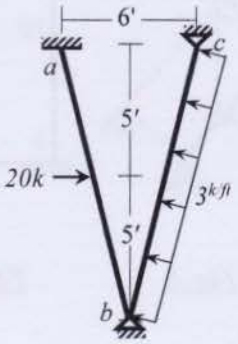


Fig. 3

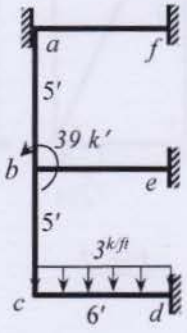


Fig. 4

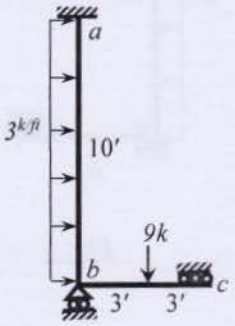


Fig. 5

4. Use Stiffness Method considering geometric nonlinearity and flexural deformations only to calculate the unknown rotation at ***b*** and ***c*** of the frame ***abcdef*** loaded as shown in ***Fig. 4***
[Given: *EI* = 75 × 10^3 k-ft^2].

5. Use the Energy Method to calculate the plastic moment (M_P) capacity of all members to form beam mechanism and side-sway mechanism in the frame ***abc*** loaded as shown in ***Fig. 5.***

6. Use Stiffness Method (neglecting axial deformations) to calculate the value of the applied load w required to cause buckling of the frame ***abcd*** loaded as shown in ***Fig. 6***
[Given: $EI = 39 \times 10^3$ *k-ft*^{2}].

7. For the 2D truss ***abcd*** loaded as shown in ***Fig. 7***
(i) Identify zero-force members
(ii) Determine the deflections of joint ***c*** and ***d***
(iii) Calculate member forces
[Given: $EA/L = 1400$ *k/ft*].

8. Determine the degree of kinematic indeterminacy (**doki**) and show the corresponding deflections and rotations of the 3D frame (***Fig. 8***) and 2D truss (***Fig. 11***) for the following cases
(i) Not considering boundary conditions
(ii) Considering boundary conditions
(iii) Neglecting axial deformations.

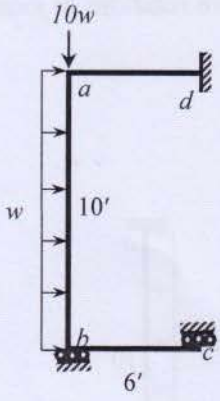


Fig. 6

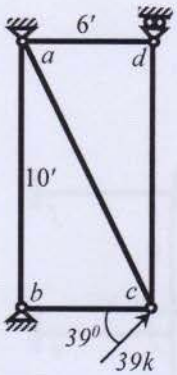


Fig. 7

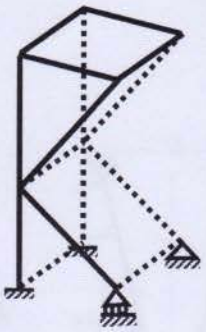


Fig. 8

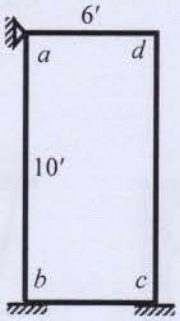


Fig. 9

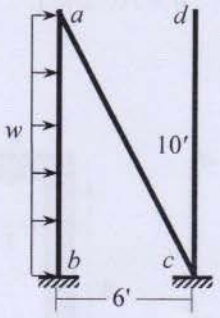


Fig. 10

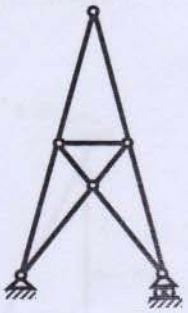


Fig. 11

9. Calculate 1st natural frequency of the frame ***abcd*** shown in ***Fig. 9*** using consistent mass matrices (neglecting axial deformation)
[Given: $EI = 10^4$ *k-ft*^{2}, $\mu = 0.0039$ *k-sec*^{2}*/ft*^{2}].

10. Frame structure ***abcd*** shown in ***Fig. 10*** is subjected to dynamic load, $w = 3e^{9t}$ (*k/ft*).
Use *Constant Average Acceleration* (*CAA*) Method to calculate the rotation of joint ***a*** at time $t = 0.10$ sec
[Given: $EI = 10^4$ *k-ft*^{2}, $\mu = 0.0055$ *k-sec*^{2}*/ft*^{2}, *Damping ratio of the system* = 5%].

List of Useful Formulae for CE 411

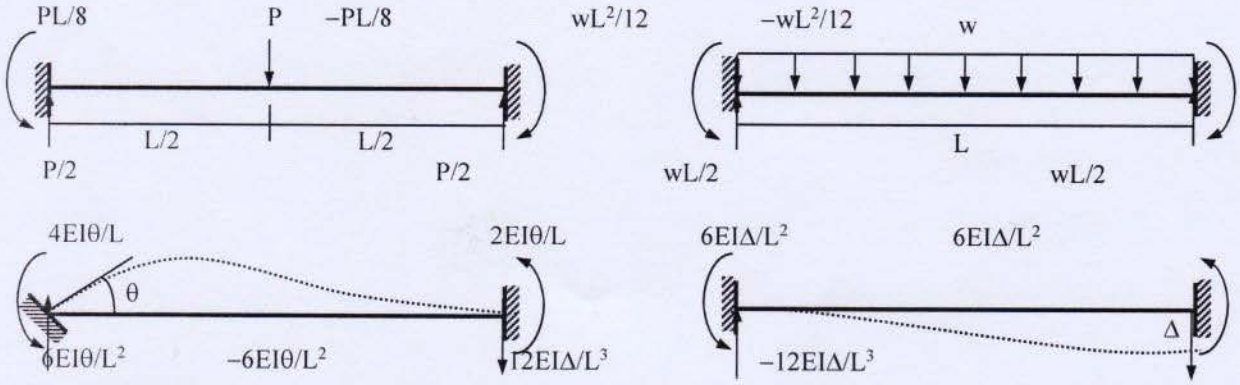
* The stiffness matrix $\mathbf{K_m}^G$ of a 2D truss member in the global axis system is given by

$$\mathbf{K_m}^G = S_x \begin{pmatrix} C^2 & CS & -C^2 & -CS \\ CS & S^2 & -CS & -S^2 \\ -C^2 & -CS & C^2 & CS \\ -CS & -S^2 & CS & S^2 \end{pmatrix}$$

and Truss member force, $P_{AB} = S_x [(u_B - u_A) C + (v_B - v_A) S]$

[where $C = \cos\theta$, $S = \sin\theta$]

Fixed End Reactions for One-dimensional Prismatic Members under Typical Loadings



* The stiffness matrix of a 3D truss member in the global axes system [using $C_x = \cos\alpha$, $C_y = \cos\beta$, $C_z = \cos\gamma$] is

$$\mathbf{K_m}^G = S_x \begin{pmatrix} C_x^2 & C_xC_y & C_xC_z & -C_x^2 & -C_xC_y & -C_xC_z \\ C_yC_x & C_y^2 & C_yC_z & -C_yC_x & -C_y^2 & -C_yC_z \\ C_zC_x & C_zC_y & C_z^2 & -C_zC_x & -C_zC_y & -C_z^2 \\ -C_x^2 & -C_xC_y & -C_xC_z & C_x^2 & C_xC_y & C_xC_z \\ -C_yC_x & -C_y^2 & -C_yC_z & C_yC_x & C_y^2 & C_yC_z \\ -C_zC_x & -C_zC_y & -C_z^2 & C_zC_x & C_zC_y & C_z^2 \end{pmatrix}$$

$C_x = L_x/L$, $C_y = L_y/L$, $C_z = L_z/L$
where $L = \sqrt{[L_x^2 + L_y^2 + L_z^2]}$

* Member force $P_{AB} = S_x [(u_B - u_A) C_x + (v_B - v_A) C_y + (w_B - w_A) C_z]$
* Torsional stiffness $T_1 = GJ/L$
* Ignoring axial deformations, the matrices $\mathbf{K_m}^L$ and $\mathbf{G_m}^L$ of a frame member in the local axis system are

$$\mathbf{K_m}^L = \begin{pmatrix} S_1 & S_2 & -S_1 & S_2 \\ S_2 & S_3 & -S_2 & S_4 \\ -S_1 & -S_2 & S_1 & -S_2 \\ S_2 & S_4 & -S_2 & S_3 \end{pmatrix} \qquad \mathbf{G_m}^L = (P/30L) \begin{pmatrix} 36 & 3L & -36 & 3L \\ 3L & 4L^2 & -3L & -L^2 \\ -36 & -3L & 36 & -3L \\ 3L & -L^2 & -3L & 4L^2 \end{pmatrix}$$

where $S_1 = 12EI/L^3$, $S_2 = 6EI/L^2$, $S_3 = 4EI/L$, $S_4 = 2EI/L$

* $\mathbf{K_{total}} = \mathbf{K} + \mathbf{G}$, buckling occurs (i.e., $P = P_{cr}$) when $|\mathbf{K_{total}}| = 0$

* For sections of Elastic-Fully-Plastic material, $A_t = A_c = A/2$, and $M_p = A_c \bar{y}_c + A_t \bar{y}_t$
* For RC sections, $M_p = A_s f_y (d - a/2)$, where $a = A_s f_y / (0.85 f_c' b)$
* Virtual work done by external forces (δW_E) = Virtual work done by internal forces (δW_I)
* For simply supported beams under (i) concentrated midspan load $P_u = 4 M_p/L$, and (ii) UDL $w_u = 8 M_p/L^2$
* For fixed-ended beams under (i) concentrated midspan load $P_u = 8 M_p/L$, and (ii) UDL $w_u = 16 M_p/L^2$
* For hinged-fixed ended beams under UDL $w_u = 11.66 M_p/L^2$

* Using CAA Method, $(m + c\Delta t/2 + k\Delta t^2/4)a_{i+1} = f_{i+1} - ku_i - (c + k\Delta t)v_i - (c\Delta t/2 + k\Delta t^2/4)a_i$
  [m = Total mass, c = Damping = $2\xi\sqrt{(km)}$, where ξ = Damping Ratio]
  Also $v_{i+1} = v_i + (a_i + a_{i+1})\Delta t/2$, and $u_{i+1} = u_i + v_i\Delta t + (a_i + a_{i+1})\Delta t^2/4$, starting with $a_0 = (f_0 - cv_0 - ku_0)/m$

* Lumped- and Consistent-Mass matrix for axial rod

$$\mathbf{M_m} = (\mu L/2) \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \qquad \mathbf{M_m} = (\mu L/3) \begin{pmatrix} 1 & 0.5 \\ 0.5 & 1 \end{pmatrix}$$

Consistent-Mass matrix for beam [μ = Mass per unit length]

$$\mathbf{M_m} = (\mu L/420) \begin{pmatrix} 156 & 22L & 54 & -13L \\ 22L & 4L^2 & 13L & -3L^2 \\ 54 & 13L & 156 & -22L \\ -13L & -3L^2 & -22L & 4L^2 \end{pmatrix}$$

* At natural frequency (i.e., $\omega = \omega_n$), $|\mathbf{K} - \omega_n^2 \mathbf{M}| = 0$
* Stiffness of Circular Surface Foundations on Half-Space

Motion	Horizontal	Vertical	Rotational	Torsional
$K_{Halfspace}$	$8G_sR/(2-\nu)$	$4G_sR/(1-\nu)$	$8G_sR^3/(3-3\nu)$	$16G_sR^3/3$

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 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 reasonable value** for any missing data.*

1. (a) A symmetric I-shaped beam as shown in **Figure 1** is prestresssed with A_{ps}= 2350 mm^2 as prestressing steel with an effective stress f_{se} of 1100 MPa. The c.g.s. of the strands is 115 mm above from the bottom of the beam. Determine the ultimate moment of the section using strain compatibility method (moment curvature analysis). (20)
Given that, f'_c = 48 MPa, E_s = 190×10^3 MPa, β_1=0.7 and E_c= 27800 MPa.

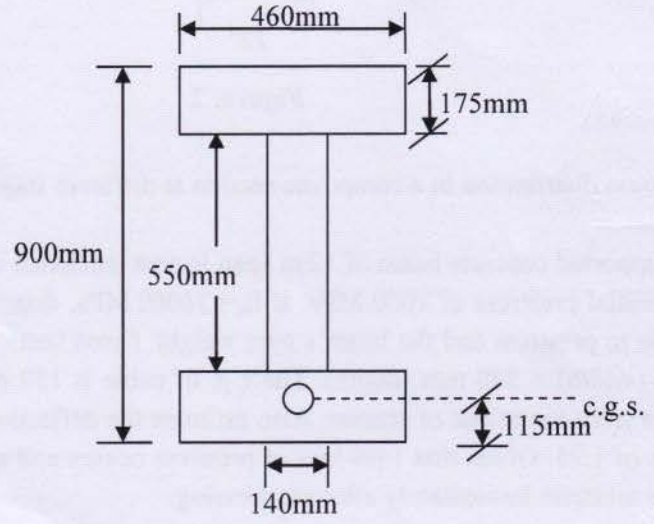


Figure: 1

(b) Briefly explain about the sources of losses of prestress in prestressed concrete member. (5)

2. (a) A section of simply supported composite beam is shown in **Figure 2.** The precast stem is prestressed with an effective force of 400 kips assuming a total loss as 15%. Compute the stresses in the section at different stages of loading and also draw the stress distribution at these stages if the bending moment at the section are as follows: (20)

- Due to precast stem = 150 k-ft
- Due to top slab = 80 k-ft
- Due to live load = 400 k-ft

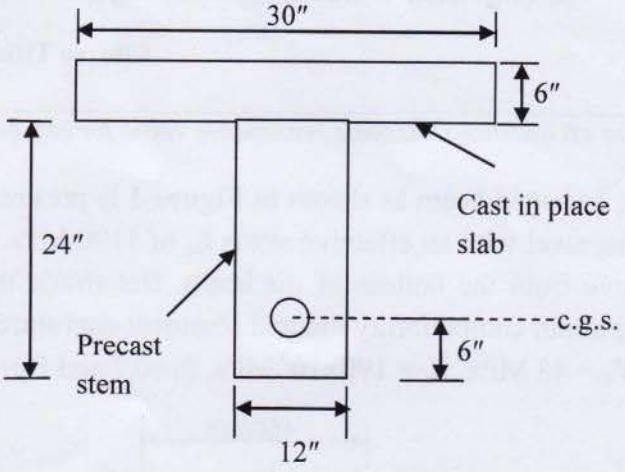


Figure: 2

(b) Show the stress distribution in a composite section at different stages of loading with sketches. (5)

3. A simply supported concrete beam of 12 m span is post tensioned with 860 mm^2 of high-tensile steel to an initial prestress of 1000 MPa. If E_c= 36000 MPa, determine the initial deflection at midspan due to prestress and the beam's own weight. Cross section of the rectangular beam is of 300 mm (width) × 500 mm (depth). The c.g. of cable is 150 mm from bottom at midspan and 300 mm from top at end of section. Also estimate the deflection after 2.5 months assuming creep factor of 1.75. Given that 15% loss of prestress occurs and a concentrated load of 45 kN is applied at midspan immediately after prestressing. (15)

4. Evaluate the shear strength for section a-a for the beam shown in **Figure 3**. The symmetric I-shaped non-composite section spans 20 m and it is adequate for w_u = 85 kN/m. Given, F = 1860 kN, f'_c= 50 MPa, w_d = 6.5 kN/m (beam weight), and e = 340 mm at section a-a. (20)

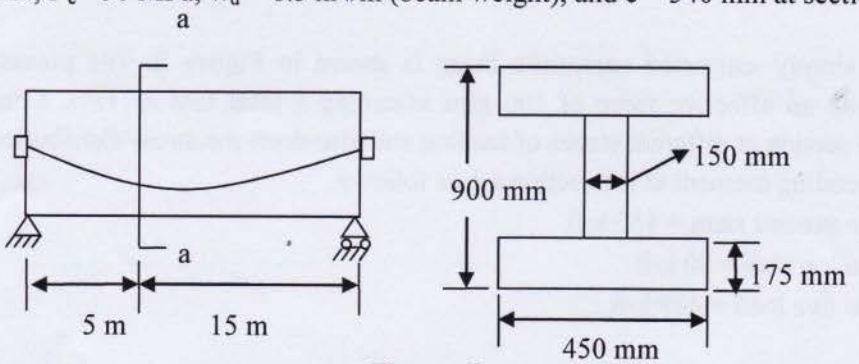


Figure: 3

5. Make final design for the preliminary section shown in **Figure 4** (obtained based on elastic theory) allowing no tension in the concrete both at transfer and under working load. Also make comment on the adequacy of the section considering the given moment. (15)

Given that f_t=-11 MPa, f_b = -12MPa, f_0 = 1035 MPa, f_{se} = 860 MPa, F = 826 kN, M_T= 435kN-m, M_G= 55kN-m, and I= 17.64×10^9 mm^4.

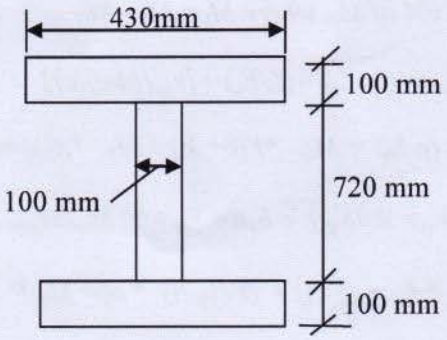


Figure: 4

CE 415 - 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 $M_L = M_T - M_G$

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

*$K = r^2/c$ * $M_1 = f'_b A_c k_t$ * $F_o(e-k_b) = M_G$ *$F(e+k_t) = M_T$ *$A_{c(b)} = (F_o h)/(f_b C_t)$ *$A_{c(t)} = (Fh)/(f_t C_b)$

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

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

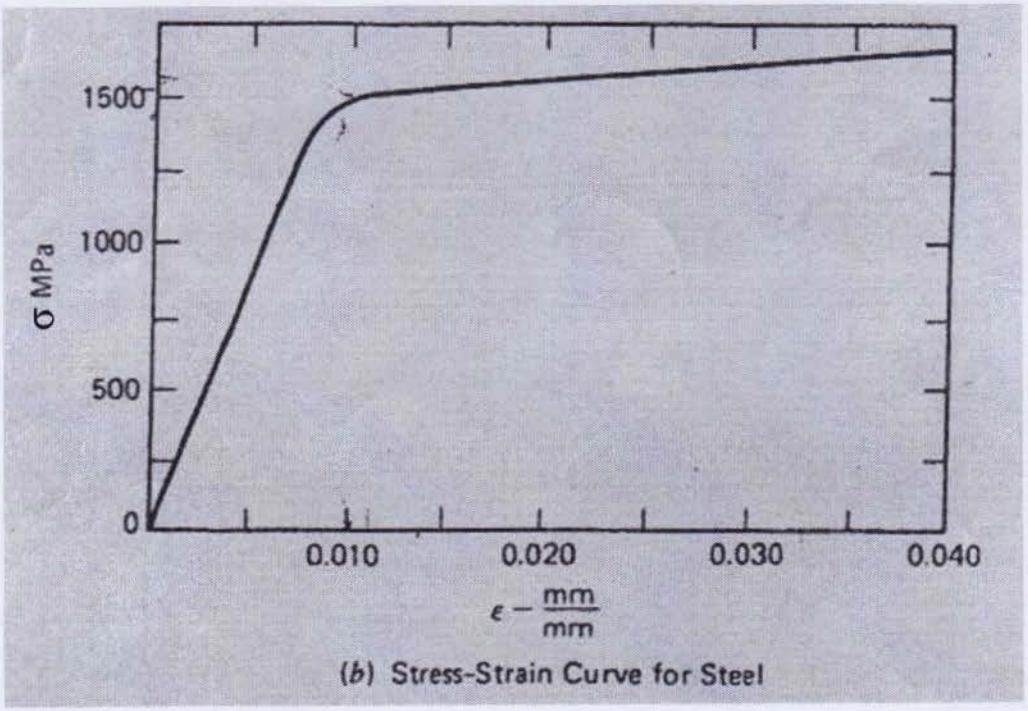
*$e_t = f'_b I/Fc_b$ * $e_b = f'_t I/F_o c_t$

*$\Delta_{prestress}$ 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 = $(Pl^3/48EI)$



(b) Stress-Strain Curve for Steel

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

Course Title: Transportation Engineering II | Course Code: CE 451
Time: 3 hours | Credit Hour: 3.00 | Full Marks: 150

[Assume Reasonable Values for Any Missing Data]

1 You are the pavement engineer of a World Bank project. This project involves constructing a highway from Dhaka to Sylhet with budget of $7 million. Within 20 years' design period, there is option to maintain the pavement after every 5 years. **Explain with diagram the roadway pavement you will consider to construct for this project.** 10

2. a. To construct the pavement in question 1, **name** and **explain tests** that need to be conducted. 10

Or

2. b. The sieve analysis result for the soil on which the pavement will be constructed is: *84%* passing No.10 sieve, *58%* passing No. 40 sieve, and *8%* passing No. 200 sieve, the sample is non-plastic. **Determine the classification and group index of soil sample by AASHTHO method**? Also comment whether that can be used as subbase or base course. 10

3. a. The pavement that need to be constructed is a six-lane divided highway. The present AADT (both directions) of *6000* vehicles is expected to grow at *5%* per annum. The percent of traffic on the design lane is *45%*. **Determine the design ESAL** if the design life is *20* years and the vehicle mix is: 15
Passenger cars (*1000* lb/axle) = *60%*
2-axle single-unit trucks (*5000* lb/axle) = *30%*
3-axle single-unit trucks (*7000* lb/axle) =*10%*

3. b. **Design the pavement** (with the design ESAL calculated in question **3.a.)** consisting of an asphalt mixture surface with an elastic modulus of *250,000* lb/in2, a granular base layer with a structural coefficient of *0.14* on a subgrade having a CBR of 10. Assume all m_i values = *1*, and the percent of traffic on the design lane is *45%*. Use a reliability level of *85%*, a standard deviation of *0.45*, and a design serviceability loss of *2.0*. 20

4. A *6* in. layer of cement-treated granular material is to be used as subbase for a rigid pavement. The monthly values for the roadbed soil resilient modulus and the subbase elastic (resilient) modulus are given in columns 2 and 3 of Table 1. If the rock depth is located *5* ft below the subgrade surface and the projected slab thickness is *9* in., **estimate the effective modulus of subgrade reaction, using the AASHTO method**. 30

Table 1

Month	Roadbed Modulus (lb/in^2)	Subbase Modulus (lb/in^2)
January	20,000	50,000
February	25,000	55,000
March	3000	15,000
April	3500	16,000
May	4000	15000
June	7000	20000

5. A concrete pavement is to be constructed for a four-lane urban expressway on a subgrade with an effective modulus of subgrade reaction k of *100* lb/in^3. The accumulated equivalent axle load for the design period is $3.25X10^6$. The initial and terminal serviceability indices are *4.5* and *2.5*, respectively. **Using the AASHTO design method, determine a suitable thickness of the concrete pavement** if the working stress of the concrete is *600* lb/in^2 and the modulus of elasticity is $5\ X10^6$ lb/in^2. Take the overall standard deviation S_o as *0.30*, the load-transfer coefficient J as *3.2*, the drainage coefficient as *0.9*, and R =*95%*. 10

6. If the sleeper density is M+7 on a broad gauge route and the length of the rail is *13* m and width of sleeper is *25.4* cm, then **estimate ballast depth**. 10

7. Explain check rail and conning of rail. 10

8. Compare flat footed rail over bull headed rail. 5

9. Explain the factors that you will consider for implementing railways in mountain areas. 10

10. In designing an asphalt concrete mixture for a highway pavement to support medium traffic, data in Table 2 showing the aggregate characteristics and Table 3 showing data obtained using the Marshall method were used. Determine the optimum asphalt content for this mix. **Determine the properties of the mix with the optimum asphalt content**. 30

Table 2

Aggregate Type	Percent by Weight of Total Paving Mixture	Bulk Specific Gravity
Coarse	52.3	2.65
Fine	39.6	2.75
Filler	8.1	2.70

Table 3

Asphalt % by weight of total mix	Weight of Specimen (g)		Stability (lb)	Flow (0.01 in.)	Maximum Specific Gravity of Paving Mixture
	in Air	in Water			
5	1325.4	779.8	1465	7	2.54
5.5	1330.9	789.3	1595	10	2.56
6	1338.5	798.6	1550	11	2.58
6.5	1344.0	799.9	1415	13	2.56
7	1349.3	800.1	1210	16	2.54

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

Course title: Irrigation and Flood Control | Course code: CE 461
Time: 3 Hours | Full marks: 100

There are TWO sections in the question paper namely "SECTION A" and "SECTION B". You have to answer from both sections according to the instruction mentioned on each section.

SECTION A

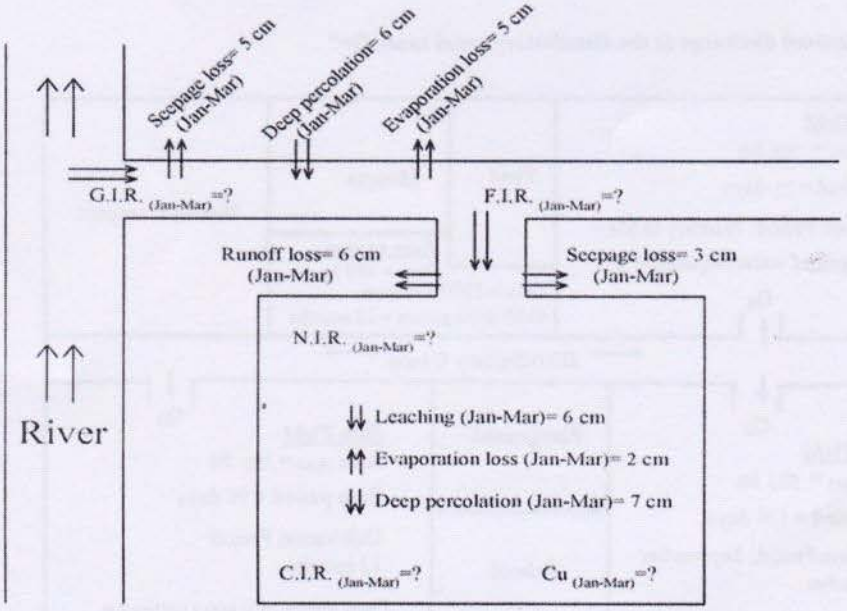
MARKS: 72

There are FOUR (4) questions. Answer <u>questions no. 01 and 02 (COMPULSORY)</u> and any one (1) from the rest (36+ 18 + 18=72). (Assume any missing data.)

1. a) Explain the necessity of irrigation and flood management in Bangladesh. 4

   b) An irrigation project located in Gaibandha district of Bangladesh divert surface water from Teesta river through a canal for irrigating an area of 3900 hectares, Based on the data and information provided in the **<u>figure 1</u>** and **<u>table 1</u>** below, calculate the following for the period from January to March: 14

   - Consumptive Water Use (C_U);
   - Consumptive Irrigation Requirement (C.I.R.);
   - Net Irrigation Requirement (NI.R.);
   - Field Irrigation Requirement (F.I.R.);
   - Gross Irrigation Requirement (G.I.R.);
   - Volume of water required to be diverted from the head works.



<u>Figure 1</u>

Table 1

Month	Monthly temperature (°C) averaged over the last 5 years	Monthly percent of day time hour of the year computed from the Sun-shine	Useful rainfall in cm averaged over the last 5 years	Crop factor
January	23.0	7.00	1.70	0.69
February	19.7	7.40	1.55	0.72
March	24.5	8.10	3	0.59

c) Find out the following by analyzing the data and information provided in **figure 2** below: 13

- Discharge required at the potato field (Q_1);
- Discharge required at the wheat field (Q_2);
- Discharge required at rice field (Q_3);
- Actual discharge required at the head of the distributary canal (Q);
- Design discharge required at the head if time factor is 0.79;
- Average discharge required at the head of the distributary canal if capacity factor is 0.70.

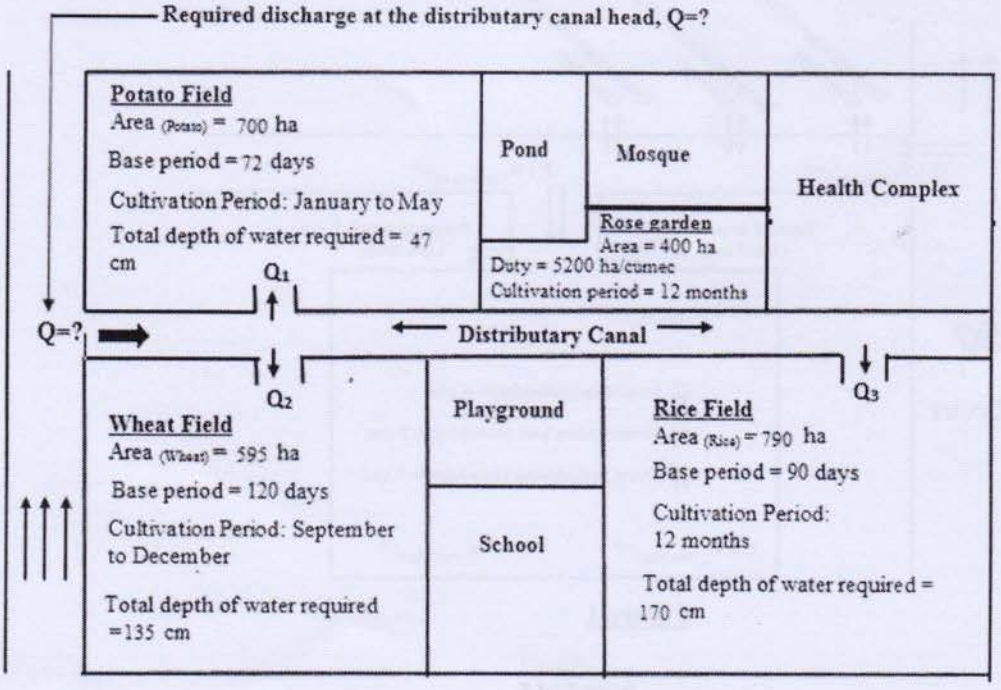


Figure 2

d) Among *basin flooding*, *sprinkler* and *drip irrigation methods*, which one is most appropriate for Bangladesh? Justify your answer. 5

2. a) Explain the following: i) Freeboard; ii) Coefficient of rugosity; iii) Regime channel. 6

b) An irrigation project is located in an area formed by alluvial soil. The responsible engineering department is planning to construct a new irrigation canal to provide sufficient water in the agricultural plots located in the project area. To decrease the cost and keep the options open for possible future changes in the cropping pattern and water distribution requirement in the project area, the engineering department decided to construct an unlined canal. 12

As a newly recruited engineer in the local engineering department, design that canal having the following data (**TWO TRIALS ARE COMPULSORY**):
Full supply discharge = 7 m^3/s
Rugosity coefficient (n) = 0.0224
C.V.R (m) = 1
Side slope = 1:1
Bed slope = 1 in 5100
Assume other reasonable data for the design

3. a) Explain different types of groynes with neat sketch. 6

b) Find out after how many days you should supply water to soil in order to ensure sufficient irrigation of the given crop, if, 8 + 4

- Field capacity of the soil = 29%
- Permanent wilting point = 12%
- Dry density of soil = 1.3 gm/cc
- Effective depth of root zone = 68 cm
- Daily consumptive use of water for the given crop = 11 mm.

If the crop period is 60 days, find out the base period of this particular crop.

4. a) Explain the procedures for determining the required discharge capacity and number of spillways 6

b) By analyzing the data and information provided in **figure 3**, find out the following: 12

- water conveyance efficiency
- water application efficiency
- water storage efficiency
- water distribution efficiency

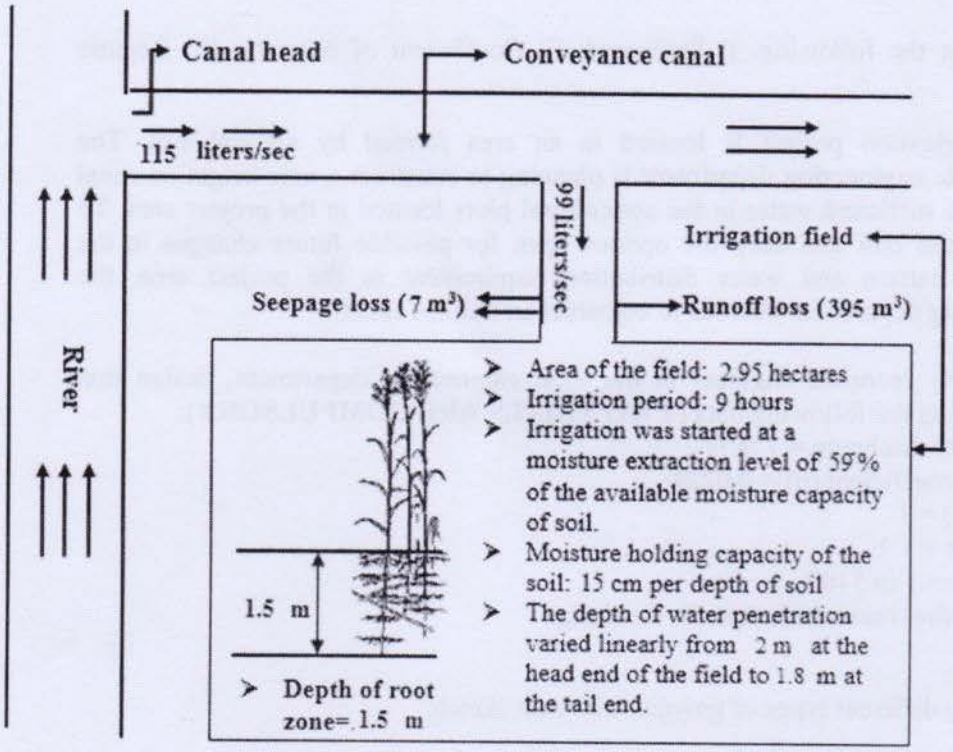


Figure 3

SECTION B
MARKS: 28

There are THREE (3) questions. Answer question no. 05 (COMPULSORY) and any ONE (1) from the rest (16+12=28). (Assume any missing data.)

5. a) United Nations Sustainable Development Goal 6 aims to ensure availability and sustainable management of water and sanitation for all by 2030. Explain the targets and indicators of Sustainable Development Goal 6 that are most relevant to achieve sustainable irrigation and flood management in Bangladesh. 6

   b) During monsoon period, the farmers of Bangladesh are facing flood due to the excessive flow in the major rivers that flow from upstream India to Bangladesh. Bangladesh also claims that due to excessive extraction of water through construction of barrages and dams in upstream India during non-monsoon period, the water availability in downstream Bangladesh is reduced substantially. Bangladesh and India formed a joint rivers commission to solve this conflict related to too little water during non-monsoon period and too much water during monsoon period in Bangladesh. You are representing Bangladesh in the joint rivers commission. 10

   Select three international water resources management principles based on which you can negotiate/cooperate with India to solve this water conflict. Justify why you have selected those three principles.

6. a) You are working as the *Executive Water Resources Engineer* of the *Water Resources Planning Organization* (WARPO) of the Government of Bangladesh and currently posted in its Khulna office. You are responsible for allocating water use license and fixing the water pricing in the area. A large numbers of farmers are using irrigation water supplied by the canal networks constructed by the government for subsistence agriculture to grow crops to meet the basic needs of themselves and their families. 6

Do you think water for irrigation for subsistence agriculture should be considered as an economic good and should be priced in accordance with 1992 Dublin Principle? Justify your answer.

(**Note**: When farmers produce crops to meet the basic needs of themselves and their families, it is called subsistence agriculture.)

b) Explain the following:
   i. Integrated water resources management;
   ii. Flood. 6

7. a) Explain different components of flood risk management. 6

a) Select two structural and two non-structural measures of flood management that you think are most important for flood management in Bangladesh. Justify your answer. 6