University of Asia Pacific
Department of Civil Engineering
Mid Semester Examination Fall 2016
Program: B. Sc. Engineering (Civil)

Course Title: Geotechnical Engineering II (Foundation Engineering) Course Code: CE 441 (A)
Time: 1 hour Full Marks: 40

Answer **any 2 (TWO)** of the following questions.

1. (a) What are the objectives of subsurface exploration? (4)

   (b) In a deposit of normally consolidated dry sand, a cone penetration test was conducted. The results obtained are given in the following table. Assuming the dry unit weight of sand to be 15 kN/m^3, estimate the relative density, D_r, and friction angle, ϕ'. (8)

Depth below EGL (m)	1.5	3.0	4.5	6.0	7.5	9.0
Point resistance, q_c (kN/m^2)	3250	4500	5500	6500	7250	8000

   (c) An individual cast in situ concrete pile in soft saturated clay having a diameter (D) of 500 mm is shown in the following figure (Fig. 1). Calculate the ultimate frictional resistance (Q_s) of the pile by the α method. The groundwater table is located at a greater depth and has no influence on the bearing capacity. (8)

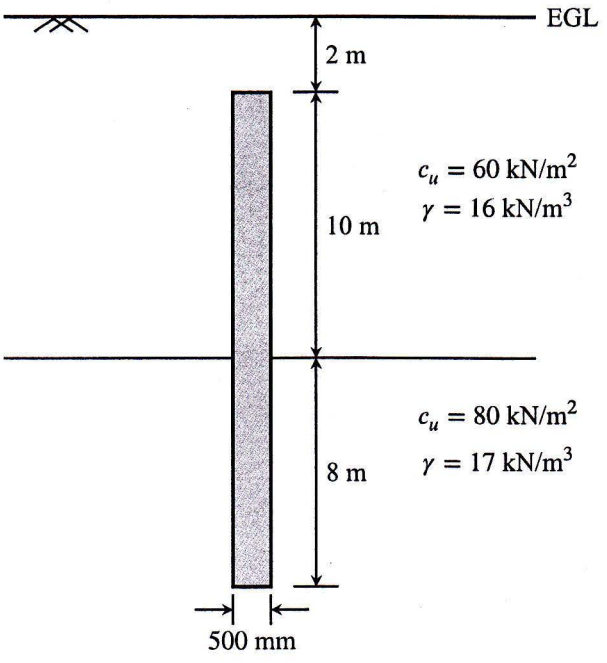


Figure 1

2. (a) What are the assumptions of Terzaghi's bearing capacity theory? (4)

   (b) What do you understand by a fully compensated foundation? A mat foundation on a saturated clay soil deposit has the dimensions of 15 m × 12 m. If the total load, Q, is 5 MN, what should be the depth, D_f, of the mat to be fully compensated foundation? Given that, c =30 kN/m^2, and γ_{sat} = 18 kN/m^3. (2 + 4 = 6)

(c) An individual shallow square foundation as shown in Fig. 2 is required to carry an allowable load of 8 MN. If the factor of safety is 3, what will be the size of the foundation? Use Terzaghi's bearing capacity equation and factors. (10)

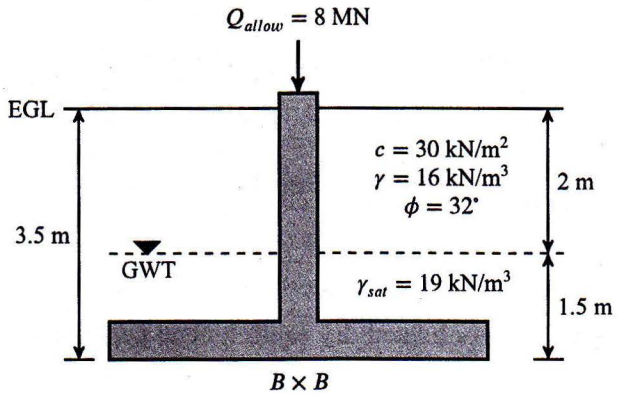


Figure 2

3. (a) What information are required in a soil exploration report? (5)

(b) An individual cast in situ concrete pile in sand having a diameter (D) of 600 mm is shown in Fig. 3. Calculate the Ultimate Bearing Capacity (Q_u) of the pile. Assume $\delta = 0.8\phi$, and $K = 1 - \sin\phi$. Use Meyerhof's method while estimating the point bearing. (15)

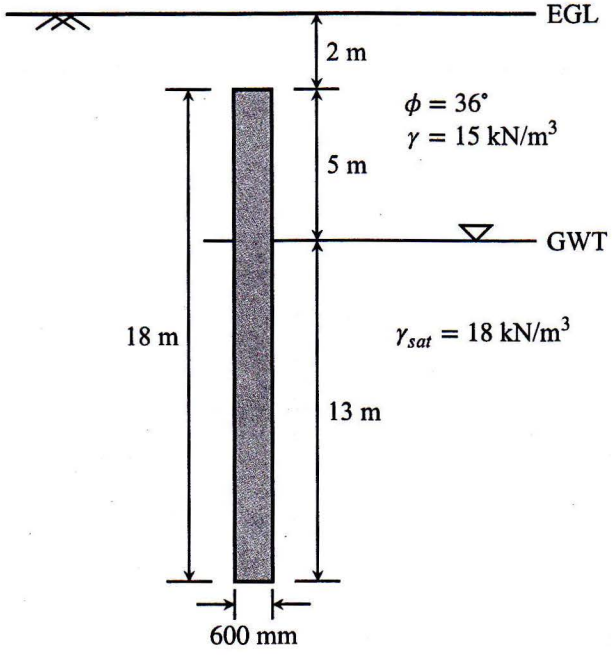


Figure 3

Necessary Equations and Tables

Table 1: Terzaghi's bearing capacity factors for general shear failure

ϕ	N_c	N_q	N_γ	ϕ	N_c	N_q	N_γ	ϕ	N_c	N_q	N_γ
0°	5.70	1.00	0.00	17°	14.56	5.45	3.63	34°	52.64	36.50	35.23
1°	6.00	1.10	0.08	18°	15.52	6.04	4.13	35°	57.75	41.44	41.08
2°	6.30	1.22	0.18	19°	16.56	6.70	4.70	36°	63.53	47.16	48.11
3°	6.62	1.35	0.28	20°	17.69	7.44	5.34	37°	70.07	53.80	56.62
4°	6.97	1.49	0.39	21°	18.92	8.26	6.07	38°	77.50	61.55	67.00
5°	7.34	1.64	0.51	22°	20.27	9.19	6.89	39°	85.97	70.61	79.77
6°	7.73	1.81	0.65	23°	21.75	10.23	7.83	40°	95.66	81.27	95.61
7°	8.15	2.00	0.80	24°	23.36	11.40	8.90	41°	106.81	93.85	115.47
8°	8.60	2.21	0.96	25°	25.13	12.72	10.12	42°	119.67	108.75	140.65
9°	9.09	2.44	1.15	26°	27.09	14.21	11.53	43°	134.58	126.50	172.99
10°	9.60	2.69	1.35	27°	29.24	15.90	13.15	44°	151.95	147.74	215.16
11°	10.16	2.98	1.58	28°	31.61	17.81	15.03	45°	172.29	173.29	271.07
12°	10.76	3.29	1.84	29°	34.24	19.98	17.21	46°	196.22	204.19	346.67
13°	11.41	3.63	2.12	30°	37.16	22.46	19.75	47°	224.55	241.80	451.29
14°	12.11	4.02	2.43	31°	40.41	25.28	22.72	48°	258.29	287.86	600.15
15°	12.86	4.45	2.79	32°	44.04	28.52	26.21	49°	298.72	344.64	819.32
16°	13.68	4.92	3.19	33°	48.09	32.23	30.33				

Table 2: Interpolated values of N_q^* for various friction angles

ϕ	N_q^*	ϕ	N_q^*	ϕ	N_q^*
0°	1.0	26°	29.5	36°	168.0
5°	1.8	27°	34.0	37°	194.0
10°	3.5	28°	39.7	38°	231.0
15°	6.1	29°	46.5	39°	276.0
20°	12.4	30°	56.7	40°	346.0
21°	13.8	31°	68.2	41°	420.0
22°	15.5	32°	81.0	42°	525.0
23°	17.9	33°	96.0	43°	650.0
24°	21.4	34°	115.0	44°	780.0
25°	26.0	35°	143.0	45°	930.0

Table 3: Variation of α (interpolated values based on Terzaghi, Peck and Mesri, 1996)

c_u/p_a	α	c_u/p_a	α
≤ 0.1	1.00	1.2	0.42
0.2	0.92	1.4	0.40
0.3	0.82	1.6	0.38
0.4	0.74	1.8	0.36
0.6	0.62	2.0	0.35
0.8	0.54	2.4	0.34
1.0	0.48	2.8	0.34

$$D_r(\%) = 68\left[\log\left(\frac{q_c}{\sqrt{p_a\,\sigma_0'}}\right) - 1\right]$$

$$\phi' = \tan^{-1}\left[0.1 + 0.38\log\left(\frac{q_c}{\sigma_0'}\right)\right]$$

University of Asia Pacific
Department of Civil Engineering
Mid Term Examination Fall 2016
Program: B.Sc. Engineering (Civil)

Course Title: Geotechnical Engineering II | Course Code: CE 441
Time: 1 hour | Full Marks: 20

Answer all the questions. **(5x4=20 marks)**

1. In a standard penetration test, borehole diameter = 100 mm; sampling method (Standard); γ_{sat} = 16 kN/m^3; rod length = 5 m. Water table is at the ground level.
   (a) Determine the hammer efficiency, if the recorded blow counts are 3/5/5 for three consecutive 150 mm penetrations and $(N)_{60} = 8$. — 2
   (b) At a depth of 7 m, the recorded blow counts are 3/6/6 for three consecutive 150 mm penetrations. Calculate $(N_1)_{60}$. Apply the hammer efficiency determined in (a). — 2
   (c) Determine the missing blow count 'X' if the recorded blow counts are 4/X/7 for three consecutive 150 mm penetrations. The hammer efficiency is 0.55 and $(N)_{60} = 15$. — 1

2. According to the soil exploration report, the upper layer is found homogeneous and extends up to 3 m below the ground level. The ground water table is located at 1.5 m below GL. The data of the soil layers is as follows:

   Given data: γ_{sat} = 18.2 kN/m^3;

   Layer-1: $\varphi_1 = 22°$

   Layer-2: $\varphi_2 = 33°$
   (a) Estimate the allowable bearing capacity of a 2 m wide strip footing, placed at a depth 1.5 m below the ground level. Provide a factor of safety equal 2. Use Terzaghi's bearing capacity equation and apply Hanna's design charts for modified bearing capacity factors. — 2.5
   (b) Recalculate the allowable bearing capacity of the same footing if the foundation is placed at a depth of 2.4 m. — 2
   (c) Compare between the allowable bearing capacities obtained in (a) and (b). — 0.5

3. Design a square (isolated) footing that is placed at a depth 1.5 m below the ground level. The footing has to support 300 kN load for the following soil data. Provide a factor of safety equal 3. — 5

   The data of this soil layer is as follows:

   Given data: γ_{sat} = 17.3 kN/m^3; c = 15 kPa; $\varphi = 20°$

4. (a) Estimate the net bearing capacity of raft foundation (30 m x 40 m) on cohesive soil having cohesion of 20 kPa. 2.5

(b) Determine the primary consolidation settlement of a rectangular footing (3 m X 4 m). 2.5

Given information:

Compression index = 0.02; Initial void ratio = 0.63

Depth of foundation = 1.5 m

The clay layer (6 m) is located at a depth of 3 m. The water table is located at a depth of 1.5 m. Assume the moist unit weight of the soil near the ground is 16 kN/m^3 and the saturated unit weight is 18 kN/m^3.

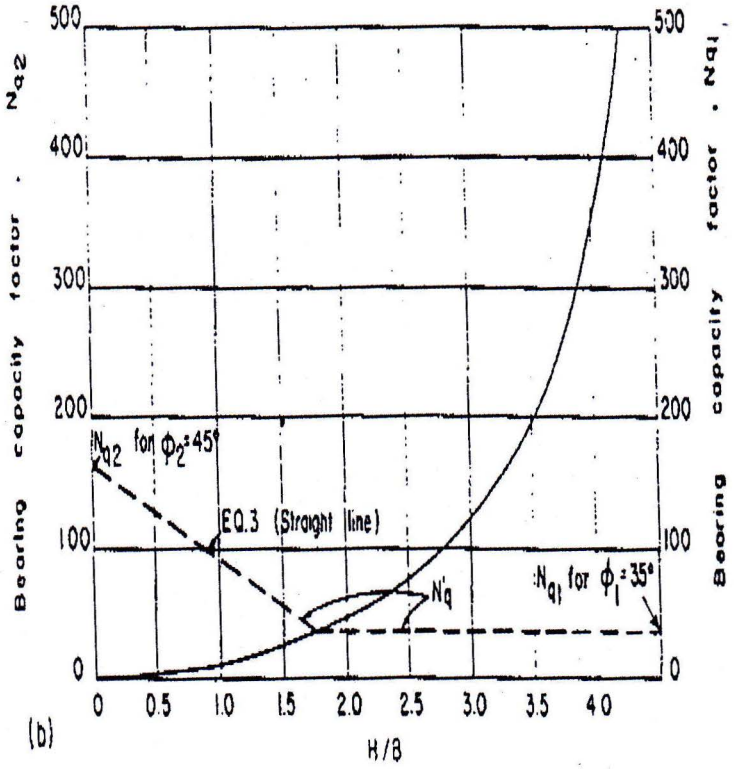
Additional Information:

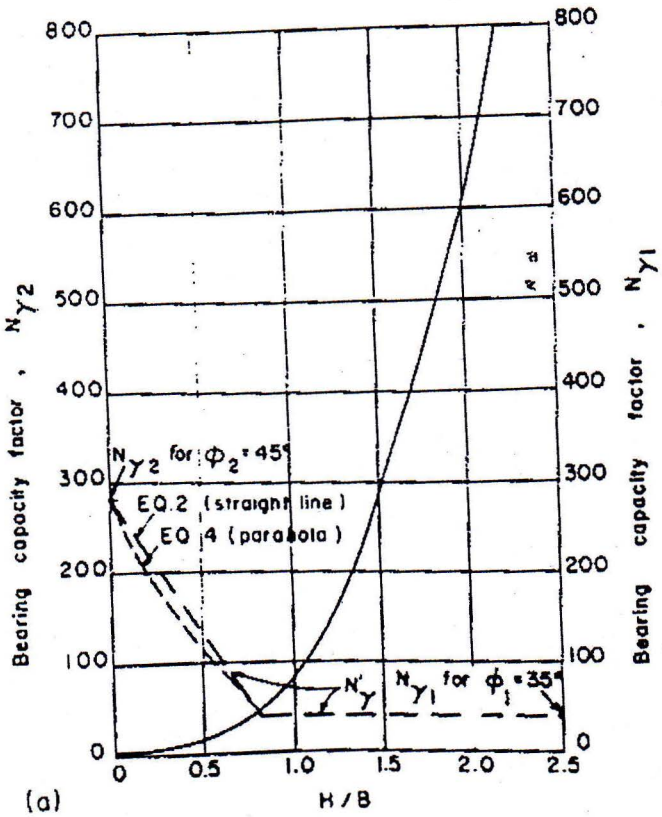
ϕ	N_c	N_q	N_γ
17	12.34	4.77	1.66
18	13.10	5.26	2.00
19	13.93	5.80	2.40
20	14.83	6.40	2.87
21	15.82	7.07	3.42
22	16.88	7.82	4.07
23	18.05	8.66	4.82
24	19.32	9.60	5.72
25	20.72	10.66	6.77
26	22.25	11.85	8.00
27	23.94	13.20	9.46
28	25.80	14.72	11.19
29	27.86	16.44	13.24
30	30.14	18.40	15.67
31	32.67	20.63	18.56
32	35.49	23.18	22.02
33	38.64	26.09	26.17

$S_c = 1 + 0.2\ (B/L)$
$S_q = 1 + 0.2\ (B/L)$
$S_\gamma = 1 + 0.4\ (B/L)$

$d_c = 1 + 0.2\ (D_f/B)$
$d_q = d_\gamma = 1 + 0.1\ D_f \tan(45^o + \varphi/2)$

Factor	Equipment Variables	Value
Borehole diameter factor, C_B	65–115 mm (2.5–4.5 in)	1.00
	150 mm (6 in)	1.05
	200 mm (8 in)	1.15
Sampling method factor, C_S	Standard sampler	1.00
	Sampler without liner (not recommended)	1.20
Rod length factor, C_R	3–4 m (10–13 ft)	0.75
	4–6 m (13–20 ft)	0.85
	6–10 m (20–30 ft)	0.95
	>10 m (>30 ft)	1.00


Bearing capacity factor , N_{q2}
Bearing capacity factor , N_{q1}
N_{q2} for $\phi_2=45°$
EQ.3 (Straight line)
N'_q
N_{q1} for $\phi_1=35°$
H/B
(b)


Bearing capacity factor , $N_{\gamma 2}$
Bearing capacity factor , $N_{\gamma 1}$
$N_{\gamma 2}$ for $\phi_2=45°$
EQ.2 (straight line)
EQ.4 (parabola)
N'_γ
$N_{\gamma 1}$ for $\phi_1=35°$
H/B
(a)

University of Asia Pacific
Department of Civil Engineering
Mid Term Examination Fall 2016
Program: B.Sc. Engineering (Civil)

Course Title: Project Planning and Construction Management — Course Code: CE 401
Time- 1 hour — Full marks: 30

Answer any 3 from the following questions

1. a. Name the categories of Construction Projects with examples. (2)
   b. What are the Environmental Constraints in Construction Management (3)
   c. Describe elements of Management Process, and explain their interactions in brief. (5)

2. a. Name the types of Hazards with examples. (2)
   b. Describe Contract Types. (8)

3. a. Compare Quality Control (QC) and Quality Assurance (QA). (4)
   b. What is Specifications? Describe 'Product Specifications', Installation Specifications' and 'Performance Specifications'. (6)

4. a. Describe 'Safety Obligations' from the aspects of Manager, Supervisor and Worker.(6)
   b. Write down the seven (7) principles to prevent accident. (4)

University of Asia Pacific
Department of Civil Engineering
Mid Semester Examination Fall 2016
Program: B.Sc. Engineering (Civil)
Section B

Course Title: Structural Engineering III | Course Code: CE 411
Time: 1 hour | Full Marks: 40 (= 4 × 10)

---

1. **Fig.1** shows a plane truss *abcdef* whose joint *b* moves leftward 0.5″ due to the applied force *P*. Calculate (i) Axial force in all members, (ii) Applied force *P* [Given: S_x = constant = 1000 k/ft].

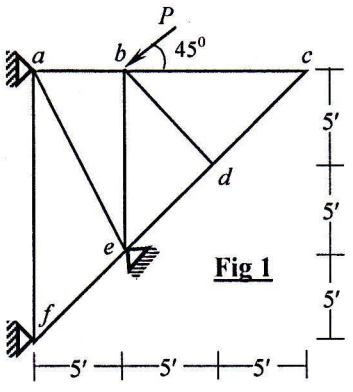


Fig 1

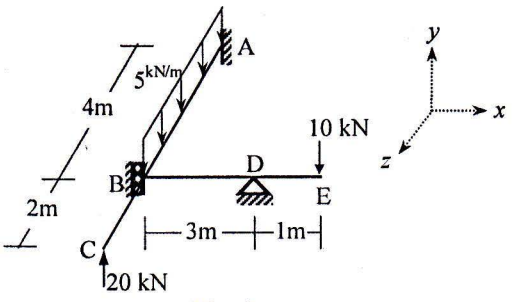


Fig. 2

2. For the grid *ABCDE* loaded as shown in **Fig.2**, use stiffness method to calculate the vertical deflection at joint B and rotations at joint D [Given: $EI = 10^5$ kN-m^2, $GJ = 10^4$ kN-m^2].

3. For the frame *ABCD* loaded as shown in **Fig.3**, calculate the unknown deflection and rotations neglecting axial deformation [Given: $EI_{AB} = 2EI_{BCD} = 40 \times 10^3$ k-ft^2].

A is a guided roller supports

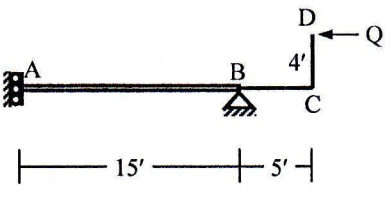


Fig 3

Nodal Coordinates (m) are
A (0, 0, 0), *B* (0, 12, 0)
C (0, 12, -15), *D* (0, 0, -15),
E (10, 0, 0), *F* (10, 0, -15)

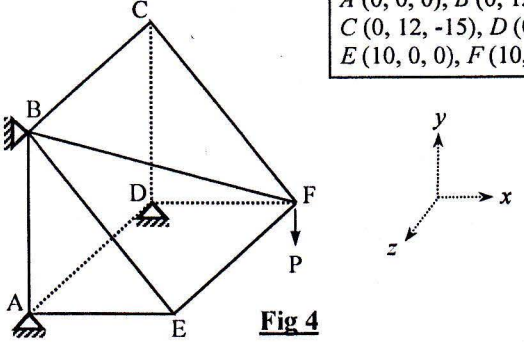


Fig 4

4. Ignore zero-force members and apply boundary conditions to formulate the stiffness matrix of the space truss *ABCDEF* loaded as shown in **Fig.4** [Given: S_x = constant = 5 kN/mm].

List of Useful Formulae for CE 411

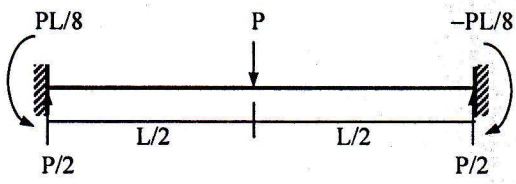
* The stiffness matrix $\mathbf{K_m}^G$ of a 2D truss member in the global axis system is given by

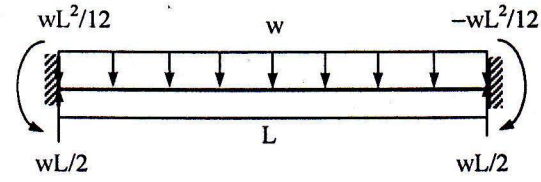
$$\mathbf{K_m}^G = S_x \begin{pmatrix} C^2 & CS & -C^2 & -CS \\ CS & S^2 & -CS & -S^2 \\ -C^2 & -CS & C^2 & CS \\ -CS & -S^2 & CS & S^2 \end{pmatrix}$$

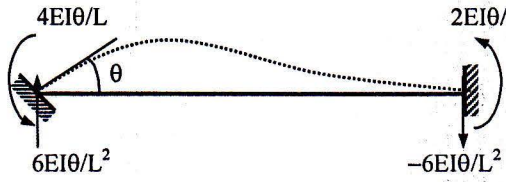
and Truss member force, $P_{AB} = S_x [(u_B - u_A) C + (v_B - v_A) S]$

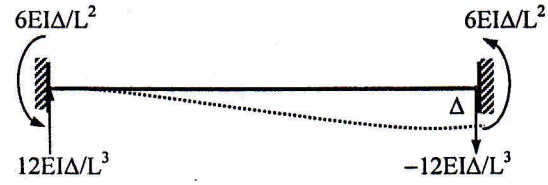
[where $C = \cos\theta$, $S = \sin\theta$]

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 $P_{AB} = S_x [(u_B - u_A) C_x + (v_B - v_A) C_y + (w_B - w_A) C_z]$

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

University of Asia Pacific
Department of Civil Engineering
Mid Semester Examination Fall 2016
Program: B.Sc. Engineering (Civil)

Course Title: Transportation Engineering II | Course Code: CE 451
Time: 1 Hour | Full Marks: 20

1. Answer any 5 (5X2 =10)

a. Why providing sub-base course sometimes necessary and sometimes not necessary?
b. What is the difference of load distribution between Flexible Pavement and Rigid Pavement?
c. Explain how natural shape of soil indicates the strength of soil?
d. What are the test value limit of aggregate impact test and crushing test for using as pavement material?
e. What is Gilsonite? How do we use it for pavement construction?
f. What is penetration test of bitumen? Explain 80/100, 60/70 and 30/40 penetration grade bitumen?

2. Answer following (1X4 = 4)

The following results were obtained by a mechanical analysis. Classify the soil according to the AASHTO classification system and give the group index. Also comment whether this soil can be used as Sub-base pavement material.

Table 1: Sieve Analysis, % Finer

No. 40	No. 20	No. 100	Liquid Limit	Plastic Limit
84	58	8	-	N.P.

Table 2: AASTHO Classification of Soils and Soil Aggregate Mixtures

General Classification	General Materials (35% or less passing 0.075 mm)							Silt-clay materials (more than 35% passing 0.075 mm)			
Group Classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve Analysis % passing 2.00 mm (No10)	50max										
0.425 mm (No40)	30max	50max	51min								
0.725 mm (No200)	15max	25max	10max	35max	35max	35max	35max	36min	36min	36min	36min
Characteristics of fraction passing	6max										
Liquid limit			N.P	40max	41min	40max	41min	40max	41min	40max	40min
Plastic Index				10max	10max	11min	11min	10max	10max	11min	11min
Usual types of significant Constituent material	Stone fragment Gravel and sand		Fine Sand	Silty or clayey Gravel and sand				Silty soils		Clayey soils	
General rating	Excellent to Good							Fair to poor			

University of Asia Pacific
Department of Civil Engineering
Mid Semester Examination Fall 2016
Program: B.Sc. Engineering (Civil)

Course Title: Transportation Engineering II | Course Code: CE 451
Time: 1 Hour | Full Marks: 20

3. Answer Any One (1X6 = 6)

The table 3 shows the particle size distributions of two aggregates A and B which are to be blended to produce an acceptable aggregate for use in manufacturing an asphalt concrete for highway pavement construction. If the required limits of particle size distribution for the mix are as shown in the table below, determine a suitable ratio for blending aggregates A and B to obtain an acceptable combined aggregate.

Table 3

Sieve Size (mm)	Required Gradation Range	(A)	(B)
19	96-100	100	98
9.5	65-80	80	76
4.75	40-55	50	45
2	35-40	43	33
0.425	15-35	20	30
0.075	5-8	4	8

a. The aggregate mix used for the design of an asphalt mixture consists of 42% coarse aggregates, 51% fine aggregates, and 7% mineral fillers. If the respective bulk specific gravities of these materials are 2.60, 2.71, and 2.69, and the effective specific gravity of the aggregates is 2.82, determine the optimum asphalt content as a percentage of the total mix if results obtained using the Marshall method are shown in the table 4. The specific gravity of the asphalt is 1.02. The pavement has to be built for medium traffic (Use Table 5 for required specifications.)

Table 4: Marshal Test result

Percent Asphalt	Weight In Air (g)	Weight In Water (g)	Stability (lb)	Flow (0.01 in.)	Maximum Specific Gravity of Paving Mixture
5.5	1325.3	785.6	1796	13	2.54
6	1330.1	793.3	1836	14	2.56
6.5	1336.2	800.8	1861	16	2.58
7	1342	804.5	1818	20	2.54
7.5	1347.5	805.1	1701	25	2.56

University of Asia Pacific
Department of Civil Engineering
Mid Semester Examination Fall 2016
Program: B.Sc. Engineering (Civil)

Course Title: Transportation Engineering II | Course Code: CE 451
Time: 1 Hour | Full Marks: 20

Table 5: Suggested Test Limit

(a) Maximum and Minimum Values			
Marshall Method Mix Criteria	**Light Traffic**	**Medium Traffic**	**Heavy Traffic**
Stability N (lb)	3336(750)	5338 (1200)	8006 (1800)
Flow, 0.25 mm (0.1 in)	8 to 18	8 to 16	8 to 14
Air Voids %	3 to 5	3 to 5	3 to 5

(b) Mineral Percent Voids in Mineral Aggregates	
Standard Sieve Designation	**%**
No. 16	23.5
No. 4	21
No. 8	18
3/8 in.	16
1/2 in.	15
3/4 in.	4
1 in.	13
1 1/2 in.	12
2 in.	11.5
2 1/2 in.	11

University of Asia Pacific
Department of Civil Engineering
Midterm Examination Fall 2016
Program: B.Sc. Engineering (Civil)

Course code: CE 461
Course title: Irrigation and Flood Control

Time: 60 Minutes Total marks: 20

Answer all questions

1. What are the harmful effects of excess irrigation? 1

2. Calculate the irrigation requirement of a wheat crop when the leaching requirement of a wheat soil is 17% and the soil water has been depleted 70%. The available water holding capacity of the root zone is 16 cm. 3

3. What is meant by "Border Flooding", and how does it differ from "Check Flooding" and "Free Flooding"? 3

4. Determine the time required to irrigate a strip of land containing sandy loam soil from a tube-well with a discharge of 0.15 m^3/s by using border flooding method. The infiltration capacity of the soil may be taken as 1.5 cm/h and the average depth of flow on the field as 10 cm. Assume any missing data. 3

5. Explain the following: i) Flood; ii) Artesian flow; iii) Irrigation water requirement; iv) Integrated Water Resources Management (IWRM); v) Barrage 5

6. Write five important steps that need to be taken to implement IWRM in Bangladesh in order to increase irrigation water availability and managing flood. 3

7. Derive the relationship between depth of irrigation water, electric conductivity of drainage water, electric conductivity of irrigation water and consumptive use of water. 2