University of Asia Pacific
Department of Civil Engineering
Mid Semester Examination Spring 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)

a. The gradation required for a typical mix is given in Table 1 in column 1 and 2. The gradation of available for three types of aggregate A, B, and C are given in column 3, 4, and 5. Determine the proportions of A,B and C if mixed will get the required gradation in column 2.

Table 1

Sieve Size (mm)	Required Gradation Range	Filler (A)	Fine Aggregate (B)	Coarse Aggregate (C)
25.4	100	100	100	100
12.7	90-100	100	100	94
4.76	60-75	100	100	54
1.18	40-55	100	66.4	31.3
0.3	20-35	100	26	22.8
0.15	12-22	73.6	17.6	9
0.075	5-10	40.1	5	3.1

b. The following results were obtained by a mechanical sieve analysis. Classify the soil according to the AASHTO classification system and give the group index. State whether this material is suitable in its natural state for use as a subbase material.

Sieve Size	% passing by Weight	Liquid Limit= 33 Plastic Limit= 12
No. 4	30	
No. 40	40	
No. 200	30	

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 Spring 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. How flexible and rigid pavement differ in load spreading capability?
b. What is Atterberg Limit?
c. What is the permeability of soil? Characterize loose soil and dense soil in terms of permeability?
d. For measuring the resistance of aggregates to weathering action, which of test will you conduct? Which property of aggregate is tested by conducting aggregate impact test?
e. What is well graded bituminous mix?
f. What is bituminous mix design?
g. What does Marshall Stability measure?

2. **Answer any 1 (1X4 = 4)**

a. The results of Marshall test for five specimen is given in Table 1. Find the optimum bitumen content of the mix. Check the results with the specified test limit given in Table 2 and give comment.

Table 1: Marshall Test Data

Bitumen Content (%)	Stability (kg)	Flow (Unit)	Air Void (%)	Voids Filled with Bitumen (%)	Bulk Specific Gravity of Mix
3	499.4	9	12.5	34	2.17
4	717.3	9.6	7.2	65	2.21
5	812.7	12	3.9	84	2.26
6	767.3	14.8	2.4	91	2.23
7	662.8	19.5	1.9	93	2.18

Table 2: Specified Test Limit

Test Property	Specified Value
Marshall Stability (kg)	340 (minimum)
Flow Value, 0.25 mm	8-17
Air Void, %	3-5
Voids Filled with Bitumen, %	75-85

b. The specific gravities and weight proportions for aggregate and bitumen are as under for the preparation of Marshall mix design. The volume and weight of one Marshall specimen was found to be 475 cc and 1100 gm. Assuming absorption of bitumen in aggregate is zero, find theoretical specific gravity of mix, bulk specific gravity of mix, percent of air void, voids in mineral aggregate, voids filled with bitumen.

University of Asia Pacific
Department of Civil Engineering
Mid Semester Examination Spring 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. How flexible and rigid pavement differ in load spreading capability?
b. What is Atterberg Limit?
c. What is the permeability of soil? Characterize loose soil and dense soil in terms of permeability?
d. For measuring the resistance of aggregates to weathering action, which of test will you conduct? Which property of aggregate is tested by conducting aggregate impact test?
e. What is well graded bituminous mix?
f. What is bituminous mix design?
g. What does Marshall Stability measure?

2. Answer any 1 (1X4 = 4)

a. The results of Marshall test for five specimen is given in Table 1. Find the optimum bitumen content of the mix. Check the results with the specified test limit given in Table 2 and give comment.

Table 1: Marshall Test Data

Bitumen Content (%)	Stability (kg)	Flow (Unit)	Air Void (%)	Voids Filled with Bitumen (%)	Bulk Specific Gravity of Mix
3	499.4	9	12.5	34	2.17
4	717.3	9.6	7.2	65	2.21
5	812.7	12	3.9	84	2.26
6	767.3	14.8	2.4	91	2.23
7	662.8	19.5	1.9	93	2.18

Table 2: Specified Test Limit

Test Property	Specified Value
Marshall Stability (kg)	340 (minimum)
Flow Value, 0.25 mm	8-17
Air Void, %	3-5
Voids Filled with Bitumen, %	75-85

b. The specific gravities and weight proportions for aggregate and bitumen are as under for the preparation of Marshall mix design. The volume and weight of one Marshall specimen was found to be 475 cc and 1100 gm. Assuming absorption of bitumen in aggregate is zero, find theoretical specific gravity of mix, bulk specific gravity of mix, percent of air void, voids in mineral aggregate, voids filled with bitumen.

University of Asia Pacific
Department of Civil Engineering
Mid Semester Examination Spring 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)

a. The gradation required for a typical mix is given in Table 1 in column 1 and 2. The gradation of available for three types of aggregate A, B, and C are given in column 3, 4, and 5. Determine the proportions of A,B and C if mixed will get the required gradation in column 2.

Table 1

Sieve Size (mm)	Required Gradation Range	Filler (A)	Fine Aggregate (B)	Coarse Aggregate (C)
25.4	100	100	100	100
12.7	90-100	100	100	94
4.76	60-75	100	100	54
1.18	40-55	100	66.4	31.3
0.3	20-35	100	26	22.8
0.15	12-22	73.6	17.6	9
0.075	5-10	40.1	5	3.1

b. The following results were obtained by a mechanical sieve analysis. Classify the soil according to the AASHTO classification system and give the group index. State whether this material is suitable in its natural state for use as a subbase material.

Sieve Size	% passing by Weight	Liquid Limit= 33 Plastic Limit= 12
No. 4	30	
No. 40	40	
No. 200	30	

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 (No.10)	50max										
0.425 mm (No40)	30max	50max	51min								
0.075 mm (No.200)	15max	25max	10max	35max	35max	35max	35max	36min	36min	36min	36min
Characteristics of fraction passing											
Liquid limit Plastic Index	6max		N.P	40max 10max	41min 10max	40max 11min	41min 11min	40max 10max	41min 10max	40max 11min	40min 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
Midterm Examination Spring 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. Estimate depth of ground water evaporation that may turn a 33 cm depth of soil saline over a period of 5 months. The electrical conductivity of groundwater is 5 mmhos/cm. The electric conductivity (EC) value of saturated extract of soil is 1 mmhos/cm. The soil has a mean bulk density of 1.45 g/cm^3 and saturation point of 40 percent. The density of water is assumed as 1 g/cm^3. 3

3. Explain "Furrow Irrigation" and "Sprinkler Irrigation"? Which one is preferred in Bangladesh and why? 3

4. Determine the time required to irrigate a strip of land containing clay loam soil from a tube-well with a discharge of 0.20 m^3/s by using border flooding method. The infiltration capacity of the soil may be taken as 3 cm/h and the average depth of flow on the field as 10 cm. Also determine the maximum area that can be irrigated from this tube well. Assume any missing data. 4

5. Explain the following: i) Flood; ii) Polder; iii) Haor; iv) Integrated Water Resources Management 4

6. Explain the impacts of floods. 2

7. What are the structural and non-structural measures of flood control and management in Bangladesh? 3

University of Asia Pacific
Department of Civil Engineering
Mid Semester Examination Spring 2016 (Set A1)

Course #: CE 411 — Course Title: Structural Engineering III

Full Marks: 40 (= 4 × 10) — Time: 1 hour

1. Use Stiffness Method to calculate the deflections at joints *e* and *g* of the 2D truss loaded as shown in Fig. 1 [Given: $P = 30$ kN, $Q = 29$ kN, S_x = constant = 10 kN/mm].

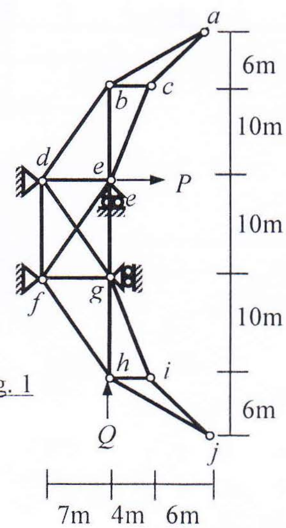


Fig. 1

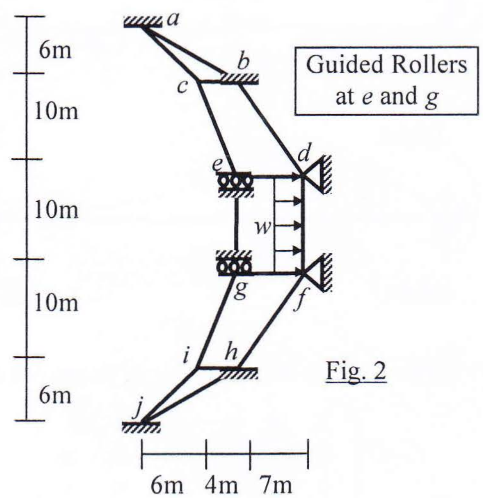


Fig. 2

2. Use Stiffness Method (neglecting axial deformations) to calculate the bending moment at joint *d* and *f* of member *df* of the frame loaded as shown in Fig. 2 [Given: $w = 30$ kN/m, EI = constant = 29,000 kN-m^2].

3. For the 3D truss *abcdefgh* shown in Fig. 3 (with given nodal coordinates)
   (i) Use Stiffness Method to calculate the force F that causes joint *c* to deflect 0.10′ leftwards.
   (ii) Calculate the other deflections of joint *c*

   [Given: S_x = constant = 500 k/ft].

Nodal coordinates (ft)
a(0,0,0), *b*(8,0,0), *c*(8,0,–24), *d*(0,0,–24)
e(0,–8,0), *f*(8,–8,0), *g*(8,–8,–24), *h*(0,–8,–24)

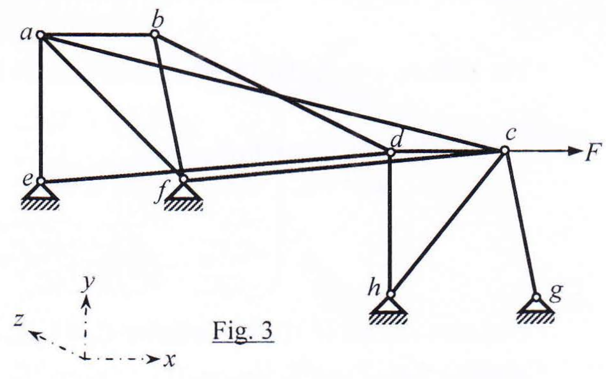


Fig. 3

4. (i) Determine degree of kinematic indeterminacy (*doki*) of the 3D frame shown in Fig. 4(i), considering boundary conditions and neglecting axial deformations.

   (ii) Formulate stiffness matrix of the grid *abcd* shown in Fig. 4(ii) [Given: EI = 60,000 k-ft^2, GJ = 40,000 k-ft^2].

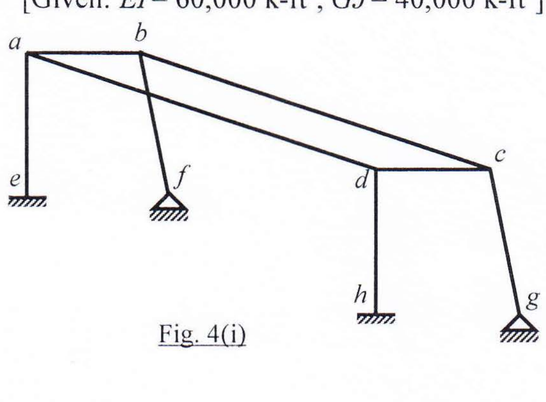


Fig. 4(i)

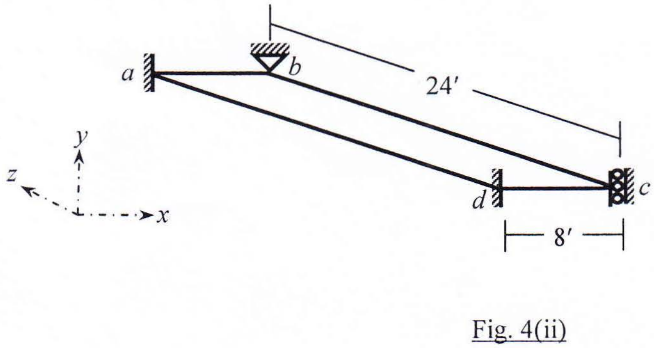


Fig. 4(ii)

List of Useful Formulae for CE 411

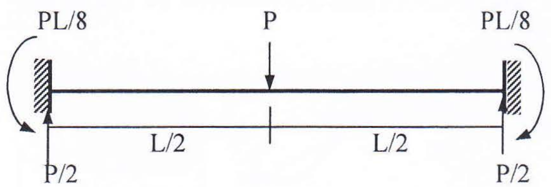
* The stiffness matrix $\mathbf{K_m}^G$ of a 2D truss member in the global axis system is given by

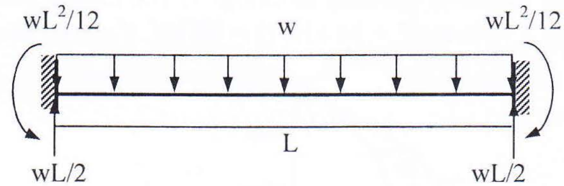
$$\mathbf{K_m}^G = S_x \begin{pmatrix} C^2 & CS & -C^2 & -CS \\ CS & S^2 & -CS & -S^2 \\ -C^2 & -CS & C^2 & CS \\ -CS & -S^2 & CS & S^2 \end{pmatrix}$$

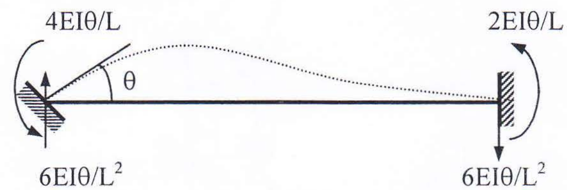
and Truss member force, $P_{AB} = S_x\,[(u_B - u_A)\,C + (v_B - v_A)\,S]$

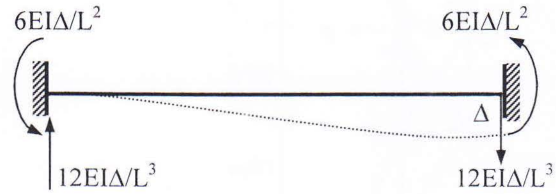
[where $C = \cos\theta$, $S = \sin\theta$]

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









* The stiffness matrices $\mathbf{K_{AB}}$ of Beam AB and Column AB (for u_A, v_A, θ_A, u_B, v_B, θ_B) are

$$\mathbf{K_{Beam}} = \begin{pmatrix} S_x & 0 & 0 & -S_x & 0 & 0 \\ 0 & S_1 & S_2 & 0 & -S_1 & S_2 \\ 0 & S_2 & S_3 & 0 & -S_2 & S_4 \\ -S_x & 0 & 0 & S_x & 0 & 0 \\ 0 & -S_1 & -S_2 & 0 & S_1 & -S_2 \\ 0 & S_2 & S_4 & 0 & -S_2 & S_3 \end{pmatrix} \qquad \mathbf{K_{Column}} = \begin{pmatrix} S_1 & 0 & S_2 & -S_1 & 0 & S_2 \\ 0 & S_x & 0 & 0 & -S_x & 0 \\ S_2 & 0 & S_3 & -S_2 & 0 & S_4 \\ -S_1 & 0 & -S_2 & S_1 & 0 & -S_2 \\ 0 & -S_x & 0 & 0 & S_x & 0 \\ S_2 & 0 & S_4 & -S_2 & 0 & S_3 \end{pmatrix}$$

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

* 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

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

* Direction cosines of 3D truss member $C_x = L_x/L$, $C_y = L_y/L$, $C_z = L_z/L$; 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 = GJ/L

* Doki for 2D Truss = 2j – r, 3D Truss = 3j – r, Grid = 3j – r, 2D Frame = 3j – r, 3D Frame = 6j – r

University of Asia Pacific
Department of Civil Engineering
Mid Semester Examination Spring 2016
Program: B.Sc. Engineering (Civil)
Section B (Set 2)

Course Title: Structural Engineering III — Course Code: CE 411

Time: 1 hour — Full Marks: 40 (= 4 × 10)

---

1. Ignore zero-force members and apply boundary conditions to formulate the stiffness matrix of the space truss *ABCD* shown in **Fig.1** [Given: S_x = constant = 500 k/ft].

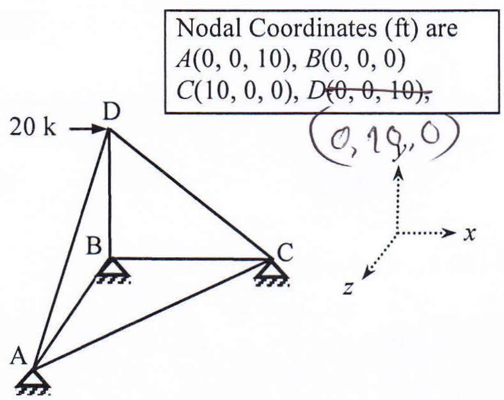


Fig 1

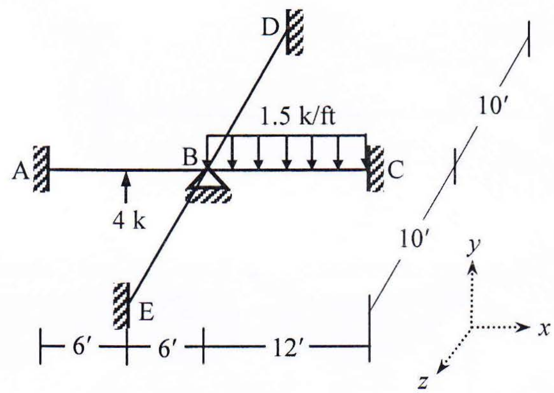


Fig. 2

2. For the grid *ABCDE* loaded as shown in **Fig.2**, use the stiffness method to calculate the vertical deflection and rotations [Given: $EI = 40 \times 10^3$ k-ft^2, $GJ = 30 \times 10^3$ k-ft^2].

3. For the frame shown *ABCDE* loaded as shown in **Fig.3**, calculate the unknown deflection and rotations neglecting axial deformation [Given: $EI = 10^4$ kN-m^2].

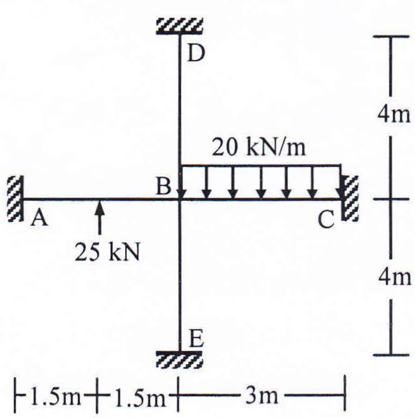


Fig 3

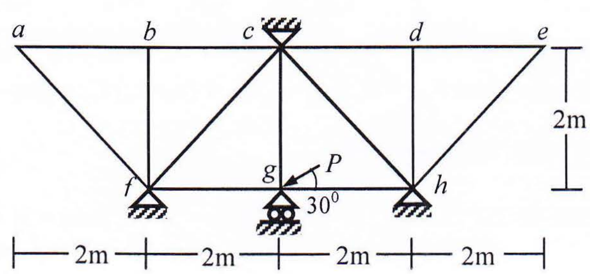


Fig 4

4. **Fig.4** shows a plane truss *abcdefgh* whose support *g* settles 10 mm due to the applied force *P*. Calculate (i) Axial force in all members, (ii) Applied force *P* [Given: S_x = constant = 5 kN/mm].

List of Useful Formulae for CE 411

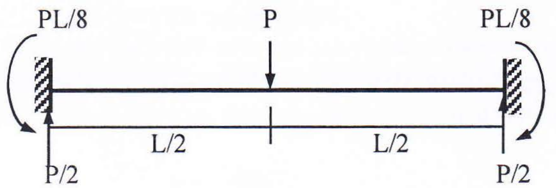
* The stiffness matrix $\mathbf{K_m}^G$ of a 2D truss member in the global axis system is given by

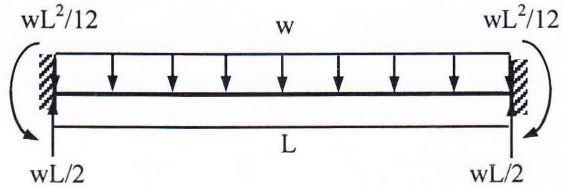
$$\mathbf{K_m}^G = S_x \begin{pmatrix} C^2 & CS & -C^2 & -CS \\ CS & S^2 & -CS & -S^2 \\ -C^2 & -CS & C^2 & CS \\ -CS & -S^2 & CS & S^2 \end{pmatrix}$$

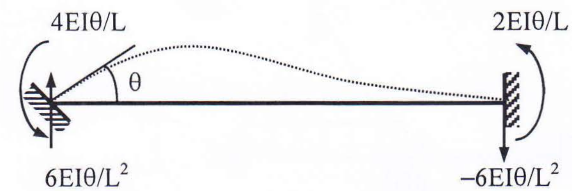
and Truss member force, $P_{AB} = S_x\,[(u_B - u_A)\,C + (v_B - v_A)\,S]$

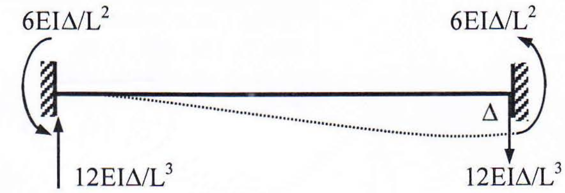
[where $C = \cos\theta$, $S = \sin\theta$]

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









* The stiffness matrices $\mathbf{K_{AB}}$ of Beam AB and Column AB (for u_A, v_A, θ_A, u_B, v_B, θ_B) are

$$\mathbf{K_{Beam}} = \begin{pmatrix} S_x & 0 & 0 & -S_x & 0 & 0 \\ 0 & S_1 & S_2 & 0 & -S_1 & S_2 \\ 0 & S_2 & S_3 & 0 & -S_2 & S_4 \\ -S_x & 0 & 0 & S_x & 0 & 0 \\ 0 & -S_1 & -S_2 & 0 & S_1 & -S_2 \\ 0 & S_2 & S_4 & 0 & -S_2 & S_3 \end{pmatrix} \qquad \mathbf{K_{Column}} = \begin{pmatrix} S_1 & 0 & S_2 & -S_1 & 0 & S_2 \\ 0 & S_x & 0 & 0 & -S_x & 0 \\ S_2 & 0 & S_3 & -S_2 & 0 & S_4 \\ -S_1 & 0 & -S_2 & S_1 & 0 & -S_2 \\ 0 & -S_x & 0 & 0 & S_x & 0 \\ S_2 & 0 & S_4 & -S_2 & 0 & S_3 \end{pmatrix}$$

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

* 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

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

* Direction cosines of 3D truss member $C_x = L_x/L$, $C_y = L_y/L$, $C_z = L_z/L$; 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 = GJ/L

* Doki for 2D Truss = 2j – r, 3D Truss = 3j – r, Grid = 3j – r, 2D Frame = 3j – r, 3D Frame = 6j – r

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

Course Title: Project Planning and Management — Course Code: CE 401
Time: 1 hour — Full Marks: 20

(Answer All Questions)

1(a)	It is often said that Failure to plan is planning to fail – Please explain.	1
(b)	In your judgment, which is the most important phase of Project life cycle? Why?	1
(c)	Why do we plan?	2
2(a)	Explain why construction is an unique industry.	1
(b)	Write down the three attributes of project management. Can we optimize them?	1
(c)	What do we mean by WBS? Please explain.	2
3(a)	What are the elements of legal contract?	1
(b)	Why do we need written contract?	1
(c)	Write down the essential documents that forms contract.	1
4(a)	What do we mean by project? Write down the characteristics of project.	1.5
(b)	What are the difference between project management and operation management?	1.5
(c)	From the following information, find out the total duration of the project. Critical path and free floats of all activities.	6

Activity	Duration (mins)	Predecessor
Make Menu	30	-
Shop for Ingredients	60	Make Menu
Prepare Ingredients	60	Shop for Ingredients
Prepare Appetizers	60	Shop for Ingredients
Cook Food	30	Prepare Ingredients
Wash Tableware	45	Make Menu
Set Table	15	Wash Tableware
Serve Dinner	0	Set Table, Cook Food, Prepare Appetizers

University of Asia Pacific
Department of Civil Engineering
Mid Term Examination Spring 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. (a)) During soil exploration, standard penetration tests were carried out at a test site. Given that $\gamma = 16.5$ kN/m^3. Given that Rod length = 5 m; Sampler type: standard; Borehole diameter: 150 mm — 3
   - (i) Calculate the field SPT N and N_{60}, if the number of blows (in each 150 mm of penetration) are recorded 10, 15 and 18. Hammer efficiency is 0.4.
   - (ii) Calculate the field SPT N value, if the number of blows (in each 75 mm of penetration) are recorded 6, 7, 11, 12, 12 and 16.
   - (iii) Determine $(N_1)_{60}$ if $N_{60} = 14$ at a depth of 4 m.

   (b) Calculate allowable bearing capacity of a strip footing, if the footing is placed at a depth of 2.5 m below the ground surface. Provide a factor of safety 2.0. The subsoil is identified as medium sand ($\phi = 30^o$). Given that — 2
   $\gamma' D_f N_q = 243.6$ kN/m^2; $0.4\gamma' B N_\gamma = 157.6$ kN/m^2
   $d_c = 1 + 0.2(Df/B) \tan(45^o + \phi/2)$
   $d_q = d_\gamma = 1 + 0.1D_f \tan(45^o + \phi/2)$

2. Determine the ultimate bearing capacity of 600 mm diameter concrete pile (bored) for the following soil profile: — 5

   Layer 1(0-4 m): clay, c= 45 kPa, $\gamma = 17$ kN/m^3

   Layer 2 (4 – 10 m): sand; c= 0, ϕ'=30^o; $\gamma_{sat} = 19$ kN/m^3

   Layer 3 (10 – 15 m): clay; c= 100 kPa, $\gamma_{sat} = 20$ kN/m^3

   Assume critical depth = 15*diameter; friction angle = $0.7\phi'$; $\alpha = 0.6$; $N_c = 8.6$; $K_s = 0.45$

3. Estimate the allowable bearing capacity of a 2 m x 2m square footing, placed at a depth 1.5 m below the ground level. Provide a factor of safety equal 2. Use Meyerhof's theory of bearing capacity and Hanna's design charts for modified bearing capacity factors. — 5

   The ground water table is located at GL. The data of the soil layers is as follows:

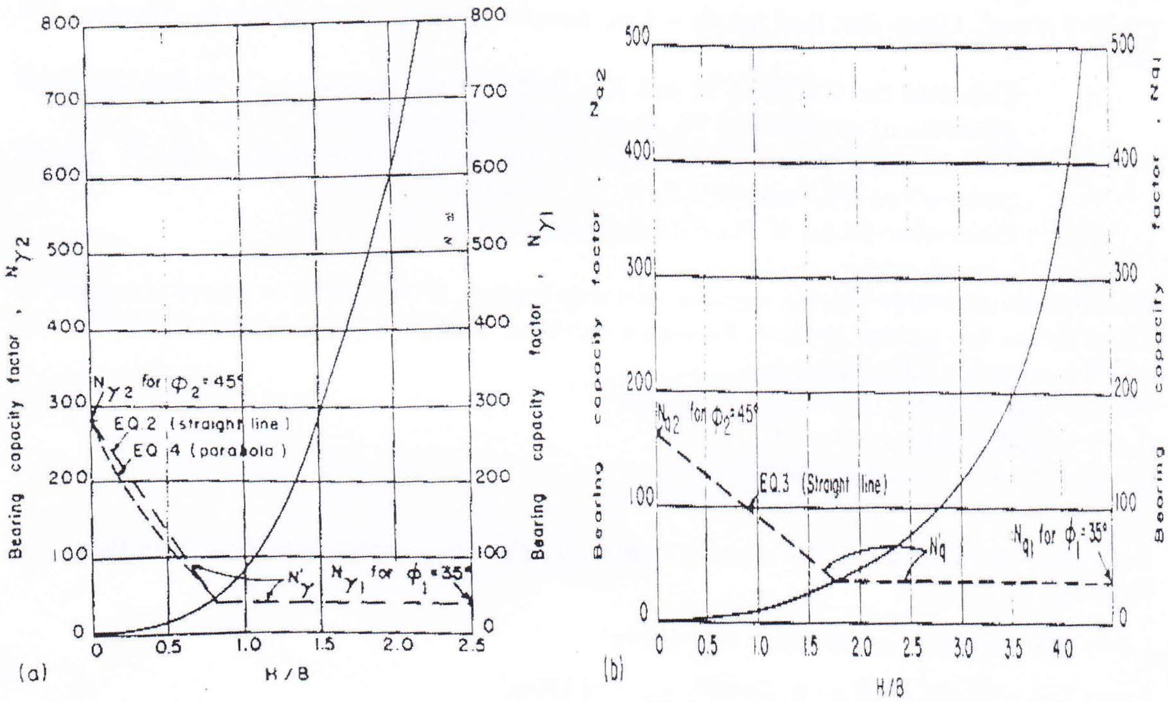
   Layer-1: $\varphi_1 = 19°$; 3 m thick; $\gamma_{sat} = 17.2$ kN/m^3;

   Layer-2: $\varphi_2 = 33°$; Deep bed; $\gamma_{sat} = 18.2$ kN/m^3;

   When $\phi = 19^o$: $N_c = 13.93$; $N_q = 5.8$ and $N_\gamma = 2.4$
   When $\phi = 33^o$: $N_c = 38.64$; $N_q = 26.09$ and $N_\gamma = 26.17$
   Given that $s_c = 1+0.2(B/L)$; $s_q = 1+0.2(B/L)$; $s_\gamma = 1+0.4(B/L)$

4. Calculate the consolidation settlement of a 2 m x 2 m square footing (Flexible), transfering a vertical load of 400 kN to the ground. There exists a deep bed of clay layer below 5 m thick sand deposit. The clay soil is fully saturated. The footing is placed at a depth 2 m. 5

γ_{sat} = 18.2 kN/m^3;preconsolidaton pressure= 180 kPa; compression index = 0.09



Factor	Variables	Correction Factor
Borehole diameter	65 – 115 mm	1
	150 mm	1.05
	200 mm	1.15
Sampling Method	Standard sampler	1
	Sampler without liner	1.2
Rod Length	3 – 4m	0.75
	4 – 6 m	0.85
	6 – 10 m	0.95
	>10 m	1

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

Course Title: Geotechnical Engineering II (Foundation Engineering) — Course Code: CE 441 (B)
Time: 1 hour — Full Marks: 40 (= 20 × 2)

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

1. (a) Briefly describe the standard penetration test (SPT). What are the factors that affect the SPT number? (4 + 1 = 5)

   (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 12 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} = 19 kN/m^3. (2 + 5 = 7)

   (c) The following figure (Fig. 1) shows the corrected SPT values, (N_{60}) for field conditions in sand. Determine the corrected SPT values, $(N_1)_{60}$ due to overburden pressure. Also determine the variation of internal friction angle, ϕ'. (8)

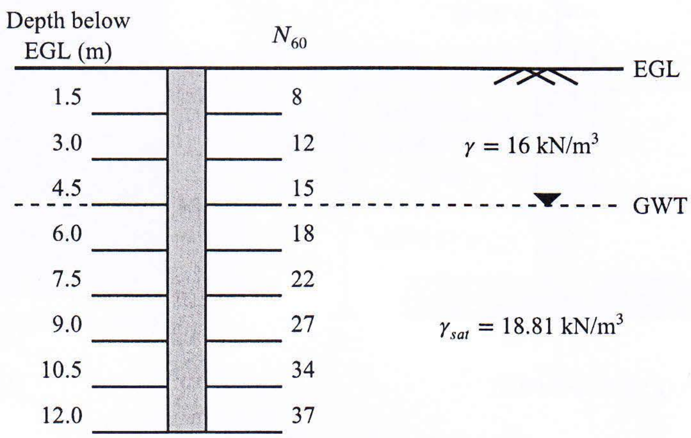


Figure 1: for QUESTION 1(c)

2. (a) Briefly describe the general shear failure, local shear failure, and punching shear failure of individual shallow foundation. (6)

   (b) Following are the results of a standard penetration test in the field (sandy soil). Estimate the net allowable bearing capacity of a mat foundation which is 12 m × 8 m in plan. Given that, depth of the mat, D_f, is 3 m, and, allowable settlement of the mat, S_e, is 40 mm. (6)

Depth (m)	1.5	3.0	4.5	6.0	7.5	9.0	10.5	12.0	13.5	15.0	16.5	18.0
N_{60}	7	9	12	15	19	21	24	26	25	23	24	27

   (c) An individual shallow foundation as shown in Fig. 2 is required to carry an allowable load of 7 MN. The site restriction imposes that the length of the footing, L, needs to be 4 m. If the factor of safety is 3, what will be the size of the foundation? Use Terzaghi's bearing capacity equation and factors. (8)

3. (a) What do you understand by an eccentrically loaded foundation? (3)

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

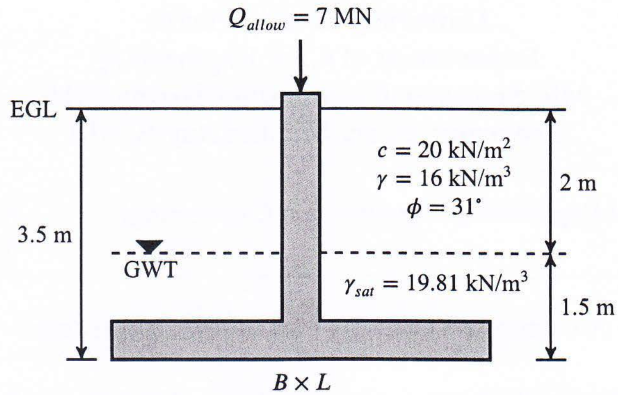


Figure 2: for QUESTION 2(c)

(c) For the eccentrically loaded rectangular footing as shown in the following figure (Fig. 3), determine the net allowable bearing capacity assuming a factor of safety of 3. Use Meyerhof's effective area method. (12)

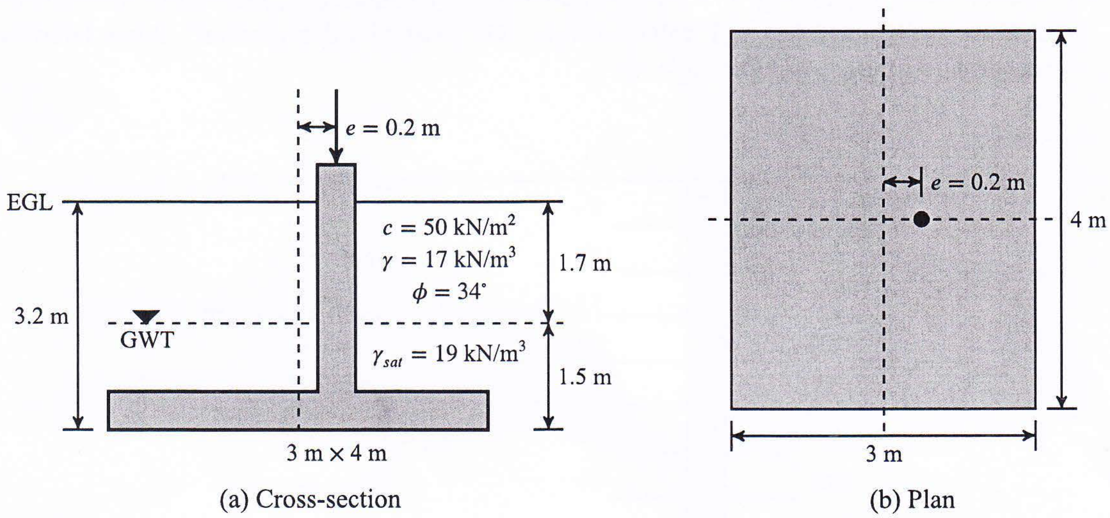


Figure 3: for QUESTION 3(c)

Necessary Equations and Tables

$$C_N = \frac{3}{2 + \frac{\sigma_0'}{p_a}}$$

$$\phi' = \sqrt{20\,(N_1)_{60}} + 20$$

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

ϕ	N_c	N_q	N_γ
29°	34.24	19.98	17.21
30°	37.16	22.46	19.75
31°	40.41	25.28	22.72
32°	44.04	28.52	26.21
33°	48.09	32.23	30.33

Table 2: Bearing capacity factors for general bearing capacity equation

ϕ	N_c	N_q	N_γ (Meyerhof)
32°	35.49	23.18	22.02
33°	38.64	26.09	26.17
34°	42.16	29.44	31.15
35°	46.12	33.30	37.15
36°	50.59	37.75	44.43

Table 3: Shape, depth, and load inclination factors for general bearing capacity equation

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

$$q_{net} = \frac{N_{60}}{0.08}\left(\frac{B + 0.3}{B}\right)^2 F_d \left(\frac{S_e}{25}\right)$$

Where,

q_{net} = net allowable bearing capacity (kN/m^2)

$$F_d = 1 + 0.33\left(\frac{D_f}{B}\right) \leq 1.33$$

University of Asia Pacific
Department of Civil Engineering
Mid Semester Examination Spring 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. How flexible and rigid pavement differ in load spreading capability?
b. What is Atterberg Limit?
c. What is the permeability of soil? Characterize loose soil and dense soil in terms of permeability?
d. For measuring the resistance of aggregates to weathering action, which of test will you conduct? Which property of aggregate is tested by conducting aggregate impact test?
e. What is well graded bituminous mix?
f. What is bituminous mix design?
g. What does Marshall Stability measure?

2. **Answer any 1 (1X4 = 4)**

a. The results of Marshall test for five specimen is given in Table 1. Find the optimum bitumen content of the mix. Check the results with the specified test limit given in Table 2 and give comment.

Table 1: Marshall Test Data

Bitumen Content (%)	Stability (kg)	Flow (Unit)	Air Void (%)	Voids Filled with Bitumen (%)	Bulk Specific Gravity of Mix
3	499.4	9	12.5	34	2.17
4	717.3	9.6	7.2	65	2.21
5	812.7	12	3.9	84	2.26
6	767.3	14.8	2.4	91	2.23
7	662.8	19.5	1.9	93	2.18

Table 2: Specified Test Limit

Table 2: Specified Test Limit

Table 2: Specified Test Limit

Test Property	Specified Value
Marshall Stability (kg)	340 (minimum)
Flow Value, 0.25 mm	8-17
Air Void, %	3-5
Voids Filled with Bitumen, %	75-85

[illegible]

University of Asia Pacific
Department of Civil Engineering
Mid Semester Examination Spring 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)**

a. The gradation required for a typical mix is given in Table 1 in column 1 and 2. The gradation of available for three types of aggregate A, B, and C are given in column 3, 4, and 5. Determine the proportions of A,B and C if mixed will get the required gradation in column 2.

Table 1

Sieve Size (mm)	Required Gradation Range	Filler (A)	Fine Aggregate (B)	Coarse Aggregate (C)
25.4	100	100	100	100
12.7	90-100	100	100	94
4.76	60-75	100	100	54
1.18	40-55	100	66.4	31.3
0.3	20-35	100	26	22.8
0.15	12-22	73.6	17.6	9
0.075	5-10	40.1	5	3.1

b. The following results were obtained by a mechanical sieve analysis. Classify the soil according to the AASHTO classification system and give the group index. State whether this material is suitable in its natural state for use as a subbase material.

Sieve Size	% passing by Weight	Liquid Limit= 33 Plastic Limit= 12
No. 4	30	
No. 40	40	
No. 200	30	

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											
Liquid limit			N.P	40max	41min	40max	41min	40max	41min	40max	40min
Plastic Index	6max			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			