University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2015
Program: B.Sc. Engineering (Civil)

Course Title: Project Planning and Management | Course Code: CE401
Time: 3 hour | Full Marks: 50

(Answer No 4 and any 4 Questions)

1(a) Why is construction safety in Bangladesh not up to the standard? 3
(b) How do you investigate accidents in a construction site? What things need to follow? 4
(c) Describe 7 principles to prevent accident in construction site. 2

2 Write short notes of the following: (1.5x6) 9
(a) Accident and Injury
(b) Risk and Vulnerability
(c) Safety and Hazard
(d) Opportunity Cost
(e) MARR
(f) Inventory

3(a) What is meant by procurement? 2
(b) Briefly describe the points to remember while purchasing/procurement. 2
(c) What are the criteria to find out the potential sources/bidders in procurement? 2
(d) Describe briefly Open Tendering Method (OTM) 3

4(a) What are the benefits of Network Diagram? 2
(b) A firm has estimated the following time for its project. The company has quoted 30 days for the project to be completed. What would be the probability of success that the project will complete on time? 12

Activity	Predecessor	Optimistic Time	Most likely Time	Pessimistic Time
a	-	5	7	9
b	-	4	10	16
c	a,b	6	7	11
d	b	4	6	6
e	c	4	7	7
f	c,d	3	5	7
g	d, f	5	6	7

Also determine the total duration of the project, Free float, Total Float of each activities and critical patch of the project.

5(a) What do you understand by 'Time Value of Money'? 1.5
(b) When and why should you consider for replacement of an asset? 1.5
(c) Dr. Chowdhury purchased a car 10 years back at a cost of Tk 5.10 lac whose market value is Tk 6 lac now. It can be used for 3 more years at which time its value will be Tk 3.5 lac. Operation and maintenance expenses are Tk 1.80 lac per year. Dr. Chowdhury can purchase reconditioned car with the same functionality for Tk 15 lac. In 5 years the value of this car is estimated to be Tk 8.0 lac. Operation and maintenance expenses will be Tk 36000 per year. Should Dr. Chowdhury replace the old car using before Tax MARR of 12%? 6

... Continued

6(a) Describe 5 major problems that the contractor faced during the construction of Petronas Twin Tower. 1.5

(b) Describe the uniqueness of 'Burj-Al-Arab' project in view of planning and construction management. 1.5

(c) A factory has a current market value of $60,000 and can be kept in service for 4 more years. With an MARR of 12%/year, when should it be abandoned? The following data are projected for future years: 6

	Year 1	Year 2	Year 3	Year 4
Net revenue	$50,000	$50,000	$15,000	$30,000
Market value	$35,000	$20,000	$15,000	$15,000
Overhauling cost	-	$10,000	-	$15,000

Z Score Table- chart value corresponds to area below z score.

z	**0.09**	**0.08**	**0.07**	**0.06**	**0.05**	**0.04**	**0.03**	**0.02**	**0.01**	**0.00**
–3.4	0.0002	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
–3.3	0.0003	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005	0.0005	0.0005
–3.2	0.0005	0.0005	0.0005	0.0006	0.0006	0.0006	0.0006	0.0006	0.0007	0.0007
–3.1	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0009	0.0010
–3.0	0.0010	0.0010	0.0011	0.0011	0.0011	0.0012	0.0012	0.0013	0.0013	0.0013
–2.9	0.0014	0.0014	0.0015	0.0015	0.0016	0.0016	0.0017	0.0018	0.0018	0.0019
–2.8	0.0019	0.0020	0.0021	0.0021	0.0022	0.0023	0.0023	0.0024	0.0025	0.0026
–2.7	0.0026	0.0027	0.0028	0.0029	0.0030	0.0031	0.0032	0.0033	0.0034	0.0035
–2.6	0.0036	0.0037	0.0038	0.0039	0.0040	0.0041	0.0043	0.0044	0.0045	0.0047
–2.5	0.0048	0.0049	0.0051	0.0052	0.0054	0.0055	0.0057	0.0059	0.0060	0.0062
–2.4	0.0064	0.0066	0.0068	0.0069	0.0071	0.0073	0.0075	0.0078	0.0080	0.0082
–2.3	0.0084	0.0087	0.0089	0.0091	0.0094	0.0096	0.0099	0.0102	0.0104	0.0107
–2.2	0.0110	0.0113	0.0116	0.0119	0.0122	0.0125	0.0129	0.0132	0.0136	0.0139
–2.1	0.0143	0.0146	0.0150	0.0154	0.0158	0.0162	0.0166	0.0170	0.0174	0.0179
–2.0	0.0183	0.0188	0.0192	0.0197	0.0202	0.0207	0.0212	0.0217	0.0222	0.0228
–1.9	0.0233	0.0239	0.0244	0.0250	0.0256	0.0262	0.0268	0.0274	0.0281	0.0287
–1.8	0.0294	0.0301	0.0307	0.0314	0.0322	0.0329	0.0336	0.0344	0.0351	0.0359
–1.7	0.0367	0.0375	0.0384	0.0392	0.0401	0.0409	0.0418	0.0427	0.0436	0.0446
–1.6	0.0455	0.0465	0.0475	0.0485	0.0495	0.0505	0.0516	0.0526	0.0537	0.0548
–1.5	0.0559	0.0571	0.0582	0.0594	0.0606	0.0618	0.0630	0.0643	0.0655	0.0668
–1.4	0.0681	0.0694	0.0708	0.0721	0.0735	0.0749	0.0764	0.0778	0.0793	0.0808
–1.3	0.0823	0.0838	0.0853	0.0869	0.0885	0.0901	0.0918	0.0934	0.0951	0.0968
–1.2	0.0985	0.1003	0.1020	0.1038	0.1056	0.1075	0.1093	0.1112	0.1131	0.1151
–1.1	0.1170	0.1190	0.1210	0.1230	0.1251	0.1271	0.1292	0.1314	0.1335	0.1357
–1.0	0.1379	0.1401	0.1423	0.1446	0.1469	0.1492	0.1515	0.1539	0.1562	0.1587
–0.9	0.1611	0.1635	0.1660	0.1685	0.1711	0.1736	0.1762	0.1788	0.1814	0.1841
–0.8	0.1867	0.1894	0.1922	0.1949	0.1977	0.2005	0.2033	0.2061	0.2090	0.2119
–0.7	0.2148	0.2177	0.2206	0.2236	0.2266	0.2296	0.2327	0.2358	0.2389	0.2420
–0.6	0.2451	0.2483	0.2514	0.2546	0.2578	0.2611	0.2643	0.2676	0.2709	0.2743
–0.5	0.2776	0.2810	0.2843	0.2877	0.2912	0.2946	0.2981	0.3015	0.3050	0.3085
–0.4	0.3121	0.3156	0.3192	0.3228	0.3264	0.3300	0.3336	0.3372	0.3409	0.3446
–0.3	0.3483	0.3520	0.3557	0.3594	0.3632	0.3669	0.3707	0.3745	0.3783	0.3821
–0.2	0.3859	0.3897	0.3936	0.3974	0.4013	0.4052	0.4090	0.4129	0.4168	0.4207
–0.1	0.4247	0.4286	0.4325	0.4364	0.4404	0.4443	0.4483	0.4522	0.4562	0.4602
–0.0	0.4641	0.4681	0.4721	0.4761	0.4801	0.4840	0.4880	0.4920	0.4960	0.5000

Interest Rate **12.00%** **12.00%**

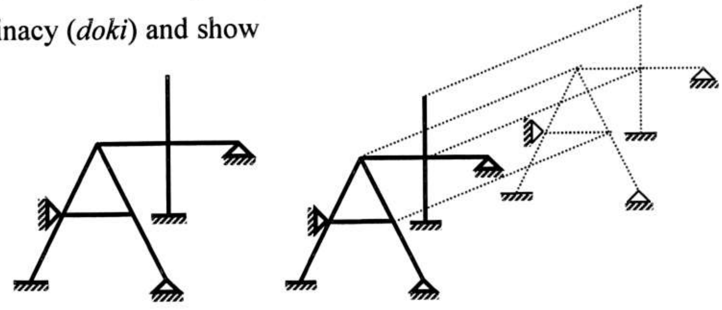
n	F/P	P/F	A/F	A/P	F/A	P/A	A/G	P/G	n
1	1.120	0.8929	1.0000	1.1200	1.000	0.893	0.000	0.000	**1**
2	1.254	0.7972	0.4717	0.5917	2.120	1.690	0.472	0.797	**2**
3	1.405	0.7118	0.2963	0.4163	3.374	2.402	0.925	2.221	**3**
4	1.574	0.6355	0.2092	0.3292	4.779	3.037	1.359	4.127	**4**
5	1.762	0.5674	0.1574	0.2774	6.353	3.605	1.775	6.397	**5**
6	1.974	0.5066	0.1232	0.2432	8.115	4.111	2.172	8.930	**6**
7	2.211	0.4523	0.0991	0.2191	10.089	4.564	2.551	11.644	**7**
8	2.476	0.4039	0.0813	0.2013	12.300	4.968	2.913	14.471	**8**
9	2.773	0.3606	0.0677	0.1877	14.776	5.328	3.257	17.356	**9**
10	3.106	0.3220	0.0570	0.1770	17.549	5.650	3.585	20.254	**10**
11	3.479	0.2875	0.0484	0.1684	20.655	5.938	3.895	23.129	**11**
12	3.896	0.2567	0.0414	0.1614	24.133	6.194	4.190	25.952	**12**
13	4.363	0.2292	0.0357	0.1557	28.029	6.424	4.468	28.702	**13**
14	4.887	0.2046	0.0309	0.1509	32.393	6.628	4.732	31.362	**14**
15	5.474	0.1827	0.0268	0.1468	37.280	6.811	4.980	33.920	**15**

Department of Civil Engineering
Final Examination Spring 2015 (Set B)
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 **any 10 (ten)** of the following 14 questions]

1. Determine the degree of kinematic indeterminacy (*doki*) and show the corresponding deflections and rotations of the 2D frame and 3D frame shown in Fig. 1, for the following cases
   (i) Not considering boundary conditions
   (ii) Considering boundary conditions
   (iii) Neglecting axial deformations.



2D Frame | Fig. 1 | 3D Frame

2. Fig. 2 shows a plane truss *abcdefg* whose joints *e* and *f* deflect 10-mm to left and right respectively due to the forces *P* applied. Use symmetry and calculate the
   (i) Axial force in all members, (ii) Applied forces *P* [Given: S_x = constant = 5 kN/mm].

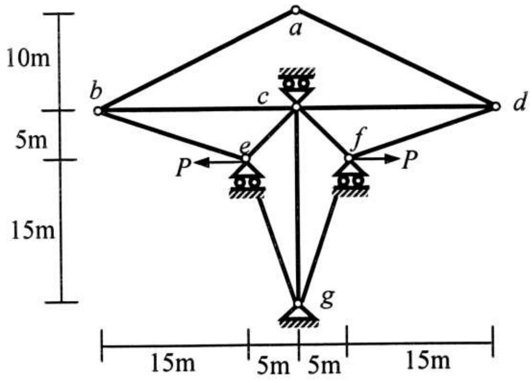


Fig. 2

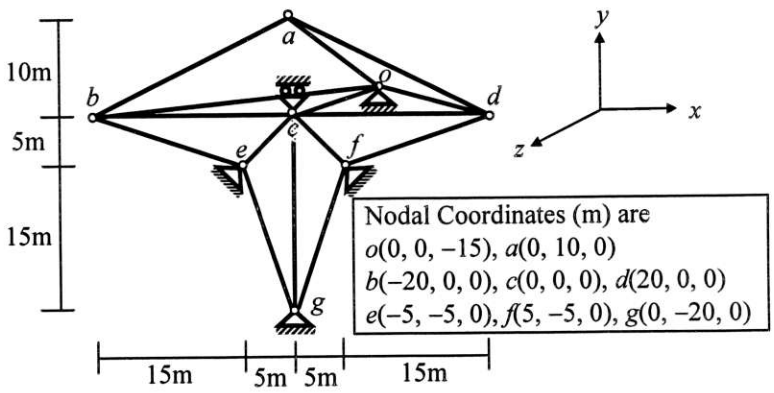


Fig. 3

3. Ignore zero-force members to form the stiffness matrix and write down the boundary conditions of the space truss *oabcdefg* shown in Fig. 3 [Given: S_x = constant = 5 kN/mm].

4. Consider axial and flexural deformations to assemble the stiffness matrix, load vector and specify boundary conditions for the frame *abcd* loaded as shown in Fig. 4 [Given: $E = 400 \times 10^3$ k/ft^2].

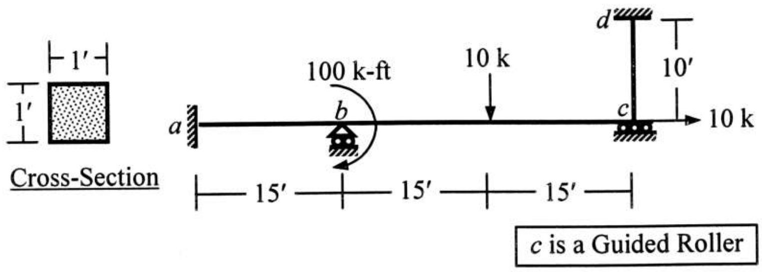


Fig. 4

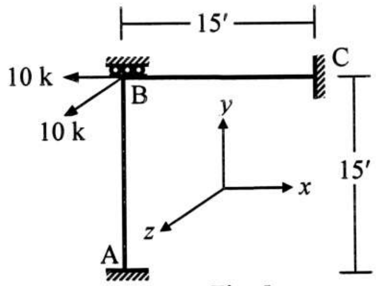


Fig. 5

5. The structure ABC loaded as shown in Fig. 5 is fixed at A and C, and has a guided roller support at B (which restrains deflection in *y*-direction and rotation around all axes; i.e., $u_y = 0$, $\theta_x = \theta_y = \theta_z = 0$). Calculate the deflections u_x and u_z (in *x*- and *z*-direction) at node B for the applied forces [Given: $EA = 400 \times 10^3$ k, $EI = 40 \times 10^3$ k-ft^2, $GJ = 30 \times 10^3$ k-ft^2].

of the beam ABC shown in Fig. 6, considering geometric nonlinearity [Given: EI = 40 × 10³ k-ft²].

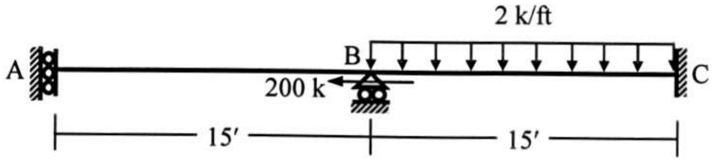


Fig. 6

7. For the beam shown in Fig. 6, calculate the approximate first natural frequency in transverse direction using consistent mass matrices and considering geometric nonlinearity
[Given: $EI = 40 \times 10^3$ k-ft², Mass per unit length = 0.0045 k-sec²/ft²].

8. Calculate the value of P needed to cause buckling of the beam ABC shown in Fig. 7, considering flexural deformations only with geometric nonlinearity [Given: $EI_{AB} = 2EI_{BC} = 40 \times 10^3$ k-ft²].

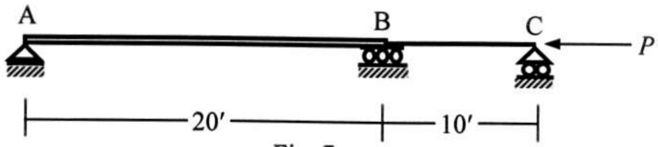


Fig. 7

9. Use bending moment diagram of beam ABCDE shown in Fig. 8 to calculate M_p (and corresponding f_y) needed to prevent formation of plastic hinge mechanism [Given: $M_{p(AB)} = 2M_{p(BCDE)} = M_p$].

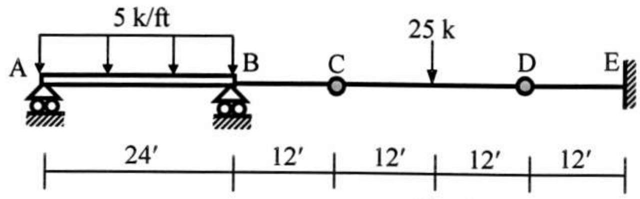
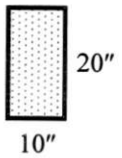


Fig. 8



Beam X-section

C and D are Internal Hinges

10. Answer Question 9 using Energy Method, considering collapse mechanisms of AB, BCD, CD and CDE.

11. For the frame *abcd* loaded as shown in Fig. 9, use the Energy Method to calculate the force

(i) P needed to form beam mechanism, (ii) Q needed to form sidesway mechanism

[Given: $M_{p(column)} = 2M_{p(beam)} = 200$ kN-m].

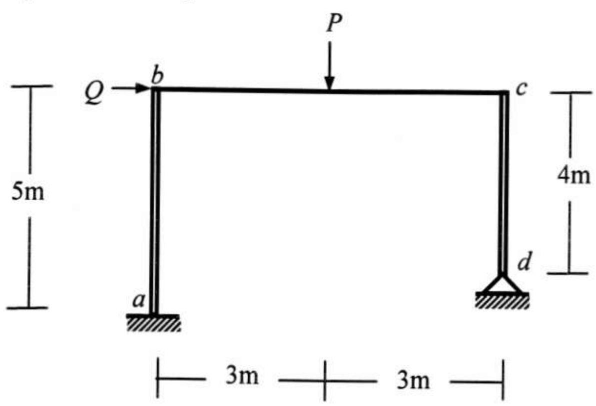


Fig. 9

12. For a single-storied (30′ × 30′) RC building having 10″ thick flat slab with 100 psf live load on it supported by four (25″ × 25″) square columns, use the CAA method to calculate the relative displacement at time $t = 0.05$ second, when subjected to ground acceleration $a_g = 10\,Sin(10t)$ (ft/sec²).

Assume stiffness $k = 3EI/L^3$, damping $c = 0$ and the total weight of the system to be concentrated in the slab, and initial displacement and velocity are both zero
[Given: Height of columns = 15′, E of concrete = 400×10^3 k/ft², Unit weight of concrete = 150 lb/ft³].

It is supported by circular foundation of radius 4-ft on the surface of sub-soil (half-space) with shear-wave velocity (v_s) equal to 300 ft/sec

[Given: $EI = 20 \times 10^3$ k-ft^2, Unit weight of soil = 0.12 k/ft^3, Poisson's ratio = 0.30].

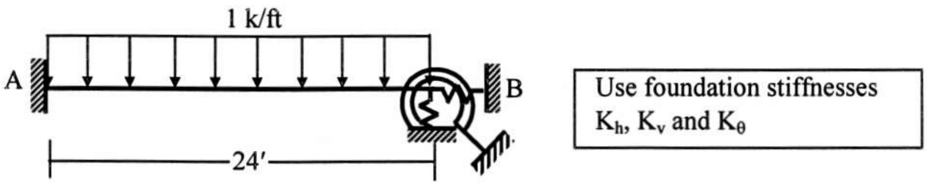


Fig. 10

14. Briefly explain why

(i) Axial deformations are sometimes neglected for the structural analysis of frames but not trusses.

(ii) Joint rotations are considered in calculating the *doki* of frames, but not trusses.

(iii) A structure becomes unstable at buckling load (explain in terms of stiffness matrix).

(iv) The effect of foundation flexibility can be beneficial or harmful to the structure.

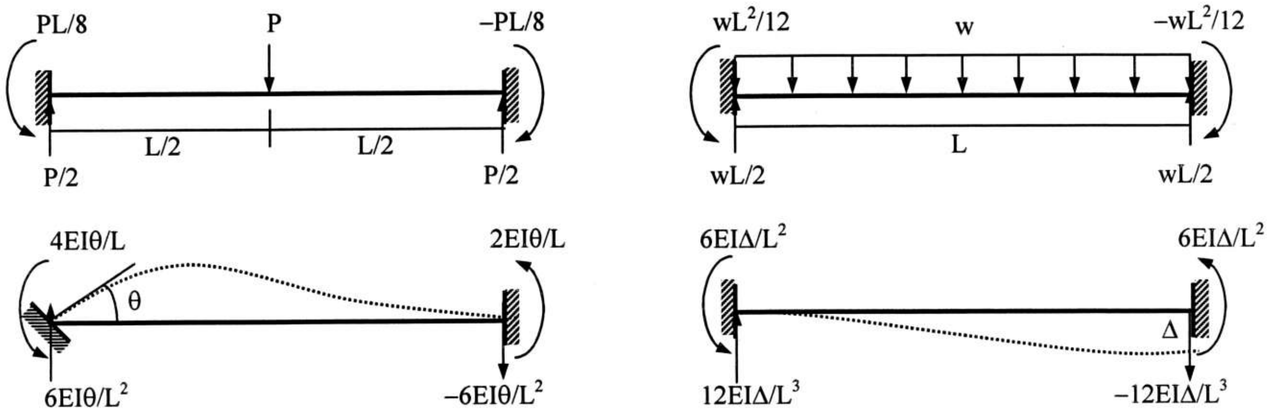
(v) Frames can be approximately modeled by lumped-mass systems.

* 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 $C = \cos\theta$, $S = \sin\theta$]

<u>Fixed End Reactions for One-dimensional Prismatic Members under Typical Loadings</u>



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

* $\mathbf{K_{total}} = \mathbf{K} + \mathbf{G}$, 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-Mass matrix for axial rod

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

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 Spring 2015
Program: B. Sc. Engineering (Civil)

Course Title: Geotechnical Engineering II — Course Code: CE 441
Time: 3 hours — Full Marks: 120 (20 X 6 = 120)

Answer any 6 (six) of the following 8 (eight) questions

1. (a) Is it possible to collect absolutely undisturbed sample during geotechnical sampling? Justify your answer. **5**

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

(c) Write short notes on (any two): **4 x 2=8**

(i) Standard Penetration Test (ii) Collection of preliminary information (iii) Site reconnaissance

(d) The outside and inside diameters of a split spoon sampler are 2 inches and 1-3/8 inches, respectively. The degree of disturbance (DOD) of a Shelby tube sampler is one-twelfth the DOD of the split spoon sampler. If the inside diameter of the Selby tube sampler is 73 mm, determine its outside diameter. **3**

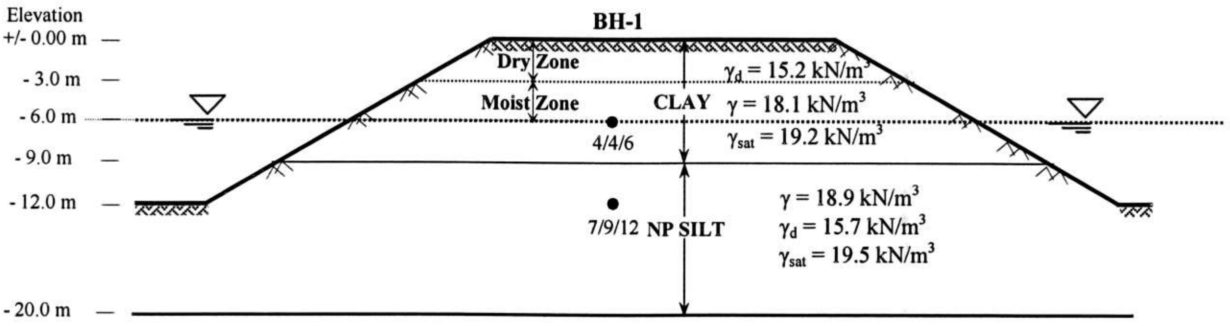
2. (a) Consider two scenarios for two very adjacent sites (having same level), site A and site B as follows: **10**

Site A: For a low-rise building project, foundation of this site was designed properly and was already constructed. A 6-ft diameter circular footing was seen to be constructed at the site for a column load of 85 kips.

Site B: For a proposed building, at this site the exploration depth was about 20 feet blow EGL (Existing Ground Level). Assume an anticipated bearing capacity for this site to be similar to that of site A (adjacent one) and a maximum footing size of 12 feet by 16 feet. Assume the foundation bearing level to be about 10 feet below EGL.

Check whether the depth of exploration for site B is sufficient or not. Justify your findings in comparison to the induced stress at the foundation level.

(b) A borehole was advanced as a part of a preliminary geotechnical investigation for a site in Bangladesh as shown 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**). Use hammer efficiency as 55%. **10**

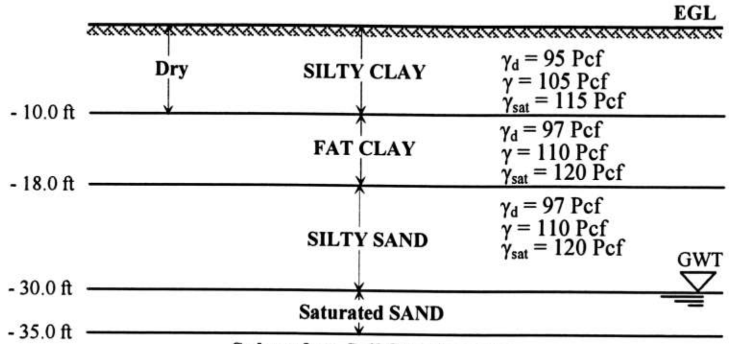


Subsurface Soil Stratigraphy

3. (a) Discuss about shallow and deep foundations? Categorize shallow foundations. **5 + 3**

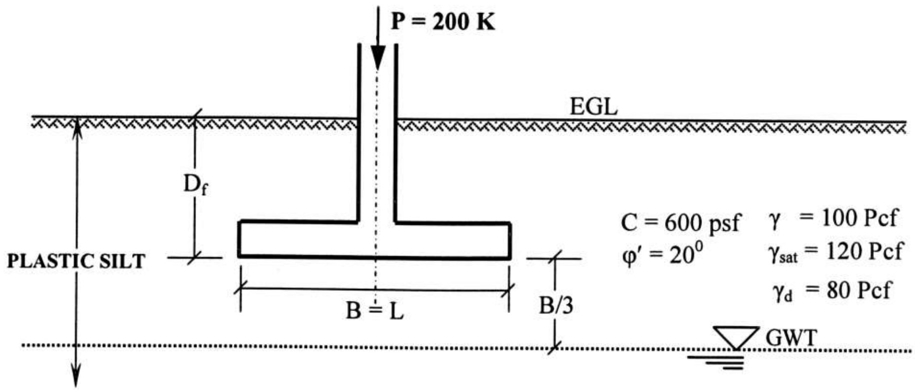
(b) Draw sketches of different combined footings. Categorize deep foundations. No description is required. **3 + 5**

(c) For fully compensated condition, if the depth of the bottom of a mat foundation is 30 ft below EGL, determine the number of stories that could be built considering uniform per floor load 300 psf and soil stratigraphy as shown. **4**

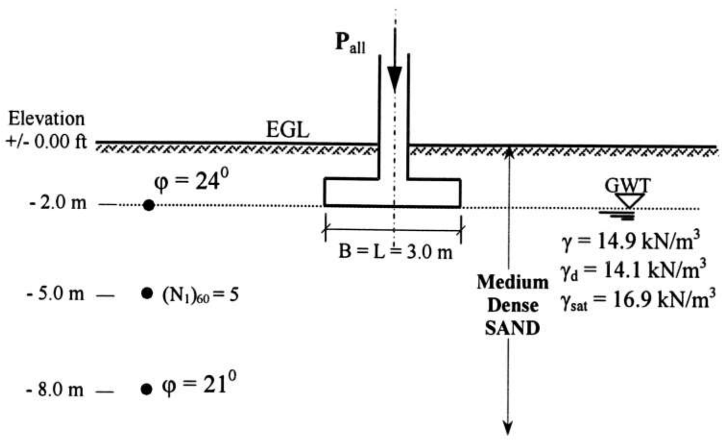


Subsurface Soil Stratigraphy

4. (**a**) Using General Bearing Capacity Equation (GBCE), design the size of the square footing for the conditions as shown below. Use a factor of safety of 2.5 and $B = 2\ D_f$. **10**



(**b**) Using Terzaghi's Bearing Capacity Equation (TBCE), calculate the allowable column load for the conditions as shown below. Use FS = 3. Use empirical correlation to estimate angle of internal friction. **10**



5. (**a**) An eccentrically loaded foundation is shown below. Determine the allowable load the foundation can carry. Use Meyerhof's effective area method and FS = 2.5. **8**

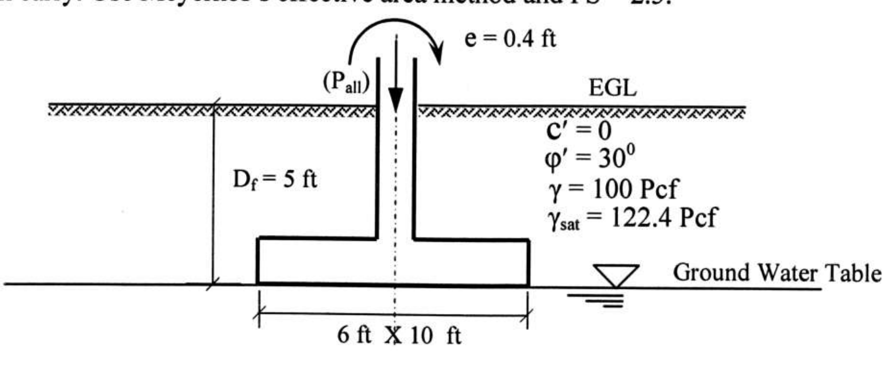
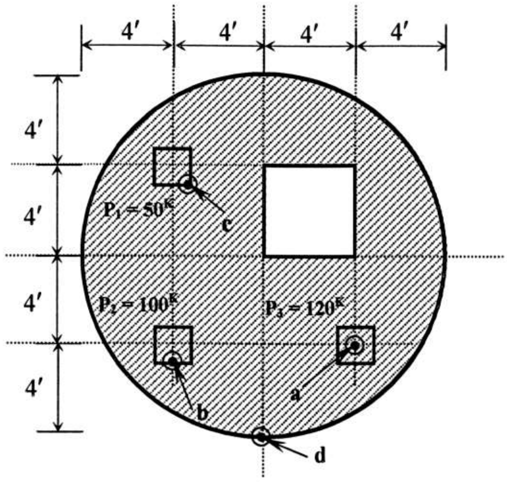
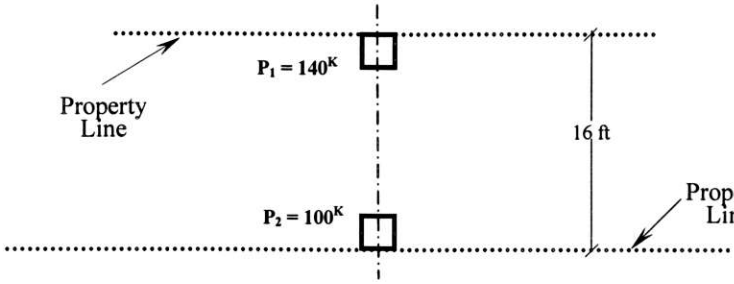


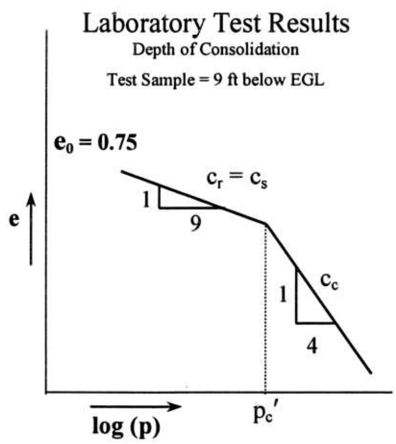
figure. Calculate the soil pressures at points a, b, c d and at the geometric centroid of the foundation (All the columns are 12 by 12 inches in size).

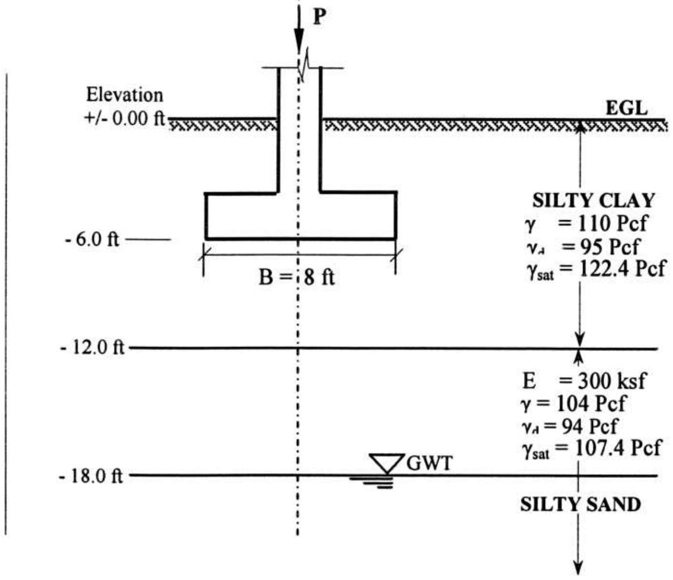


6. (**a**) For the following loading, geometric and boundary conditions design the size of a combined footing. Consider allowable bearing capacity and all column dimensions 2.0 ksf and 12-inch by 12-inch, respectively. **8**

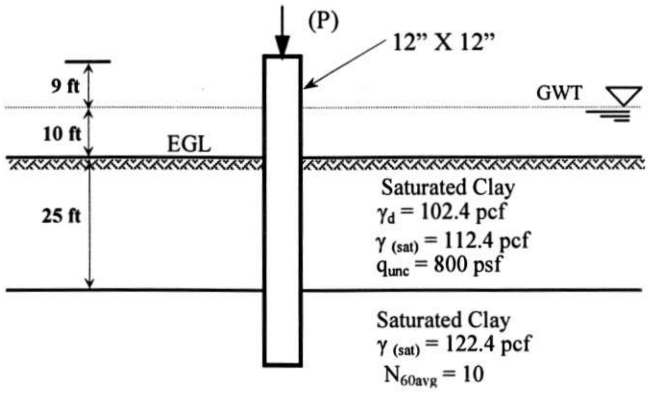


(**b**) A rectangular footing (8 ft X 12 ft), designed as per allowable bearing capacity based on shearing failure, is shown in the following figure. OCR of the cohesive deposit is 2.0. Estimate settlements for both sand and clay layers. Use $q_a = p = 5.0$ ksf. **12**

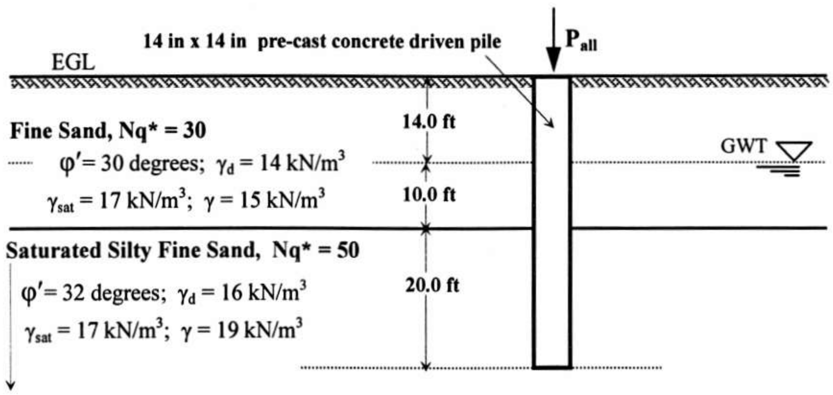




7. **(a)** A pre-cast concrete pile as installed is shown below. Calculated allowable capacity (Q_a) of the pile is 36.8 kips (for a factor of safety of 2.5 for both skin resistance and end bearing). Determine the total length of the pile. **8**



(b) For the following condition, calculate the allowable capacity of the single pile. **12**

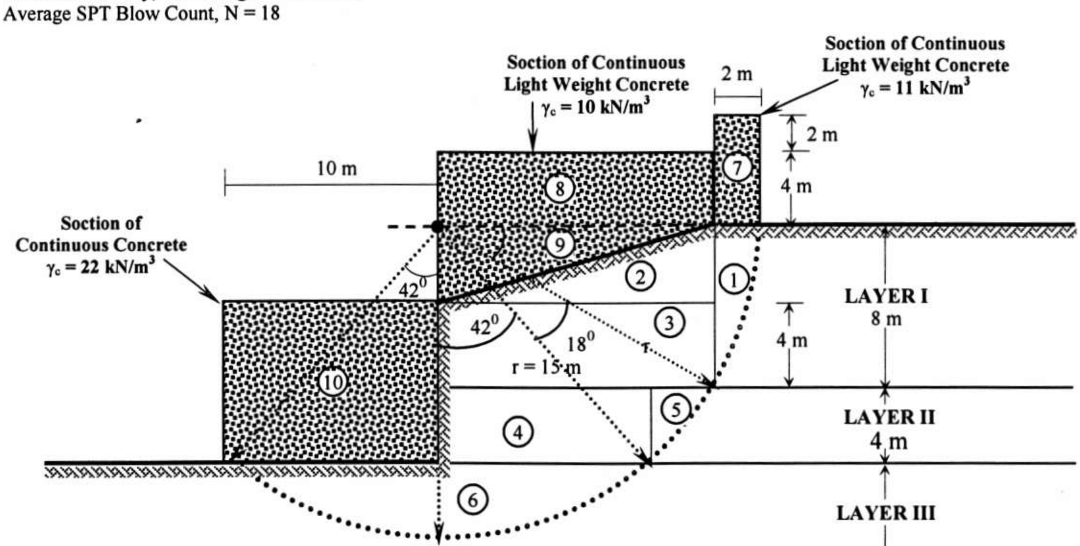


8. **(a)** Draw arrangement of group piles for the 11 piles. **3**

(b) Mention a few natural and anthropogenic features where slope stability problems are frequently encountered. **3**

(c) Determine the factor of safety (slope stability) against the failure arc through the slope as shown below. **14**

LAYER I: Sandy Clay; Unit Weight = 17 kN/m³
Average SPT Blow Count, N = 8
LAYER II: Clay; Unit Weight = 18.0 kN/ m³
Average SPT Blow Count, N = 14
LAYER III: Clay; Unit Weight = 19 kN/ m³
Average SPT Blow Count, N = 18



University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2015
Program: B.Sc. Engineering (Civil)

Course Title: Transportation Engineering II | Course Code: CE 451
Time: 3 Hours | Full Marks: 100

Section- A: Answer any 4 (Four) out of 5 (Five) questions

1. (a) What is the purpose of providing fittings and fastenings in railway tracks? (02)

   (b) What are the requirements of ideal fastening? (05)

   (c) Describe in short: Chair and Key. (03)

2. (a) What are the functions of formation? (03)

   (b) Describe some techniques that you may suggest to improve railway embankment stability. (07)

3. (a) What are the objectives of signaling? (04)

   (b) Write short notes on: (06)
   - i. Semaphore signal
   - ii. Disc signal

4. (a) What are the essential principles of interlocking? (03)

   (b) When does it become necessary to maintain a track? (03)

   (c) Mention some characteristics of a well maintained railway track (04)

5. (a) What are the criteria to select a suitable site for railway station? (04)

   (b) Classify stations from both operational and functional considerations. (03)

   (c) Describe Yard in brief. (03)

Section- B: Answer any 6 (Six) out of 7 (Seven) questions

1. (a) Describe various operations in subgrade preparation for a highway. (04)

   (b) Write short notes on: (06)
   - i. Macadam base course
   - ii. Cement stabilized soil base course
   - iii. Prime coat

2. (a) List some tests of aggregate and their recommended limits to be used in highway. (06)

   (b) Why are bricks used as aggregate in Bangladesh for road construction? (04)

3. (a) Compare between Tar and Asphalt. (03)

   (b) Describe: (04)
   - i. Cutback asphalt
   - ii. Emulsified asphalt

   (c) Which characteristics are most desirable in choosing bitumen? (03)

4. (a) Compare between flexible pavement and rigid pavement. (05)

   (b) A flexible pavement has been designed with the parameters below: (05)
   4″ hot mix asphalt concrete (a1 =0.44)
   7″ dense graded crushed limestone (a2 =0.18)
   10″ crushed stone (a3 =0.11)
   R = 90%; S_o = 0.4; PSI_i =4.2; PSI_f =2.5; $PSI_{env\ loss}$ =0.2
   Effective roadbed modulus = 10000 psi
   How many 20k single axle trucks (factor 1.5) can be carried by the pavement?
   If 1000 trucks (growth rate 7%) use this pavement daily, how many years will this pavement serve?
   Use AASHTO design chart for flexible pavements attached with question.

5. (a) What is surface distress? What are the modes of surface distress on flexible pavements? (04)

   (b) Write short notes on: (06)
   - i. Fatigue cracking
   - ii. Corrugation and shoving
   - iii. Water bleeding and pumping

6. (a) Describe: (06)
   - i. Transverse Contraction joint
   - ii. Transverse Expansion joint

   (b) Compare between Tie bar and Dowel bar. (04)

7. (a) A 2 lane highway is 60′ long with slab thickness 7 inch. Each lane is 12′ wide. Find distributed steel area and length of tie for the pavement if $f_s = 30$ ksi and $f_c' = 3500$ psi. Show plan and x-section of pavement reinforcement. (05)

Given: $A_s = w\,f\,l/2f_s$

$A_s = b\,f\,w\,h/12f_s$

$L_t = (0.5 f_s d_b / f_{cb}) + 3"$

(b) Define: (05)

i. High type bituminous pavement

ii. Marshall stability

iii. Marshall flow

AASHTO Design chart for flexible pavements