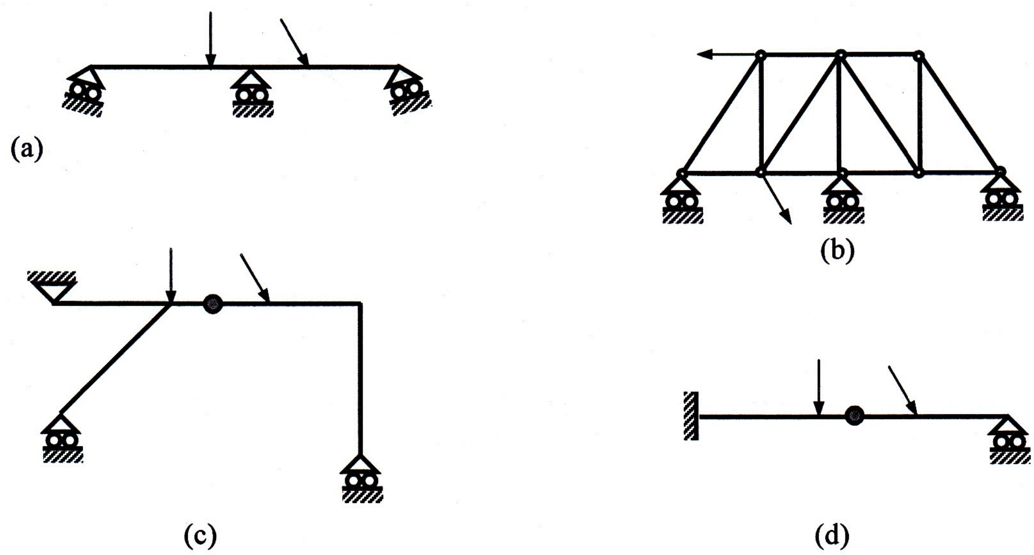
University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2014
Program: B.Sc. Engineering (Civil)

Course Title: Structural Engineering I | **Course Code: CE 311** (A)

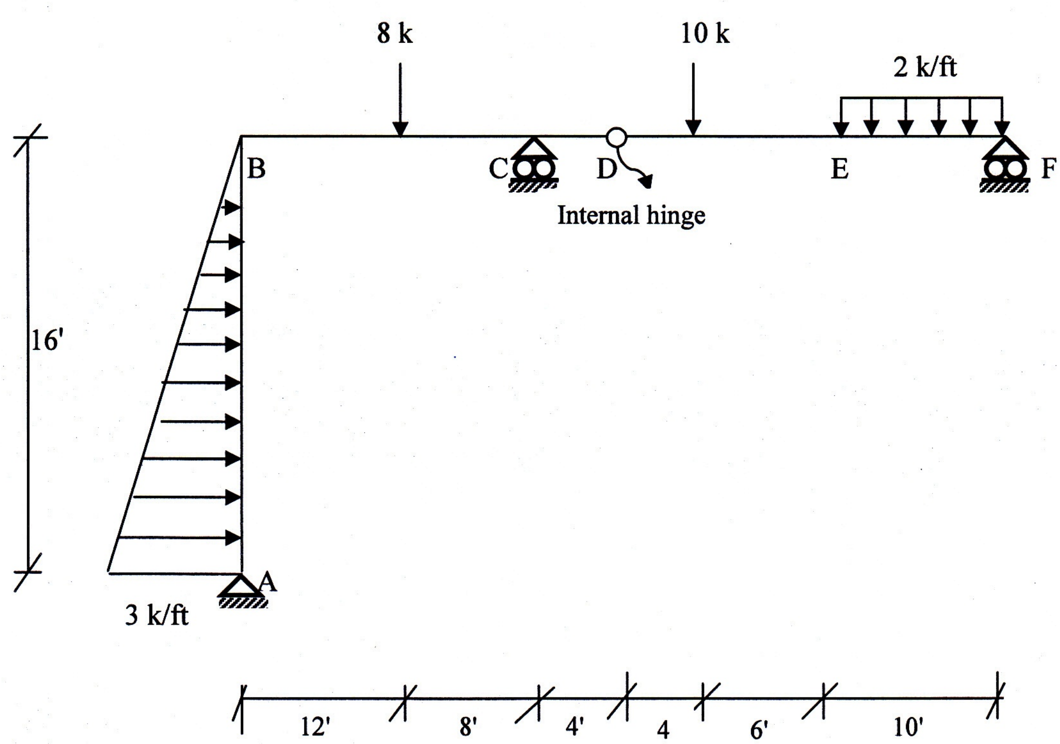
Time: 3.00 Hours | **Full Marks: 100 (10×10)**

There are **Fourteen (14)** questions. Answer any **Ten (10).**

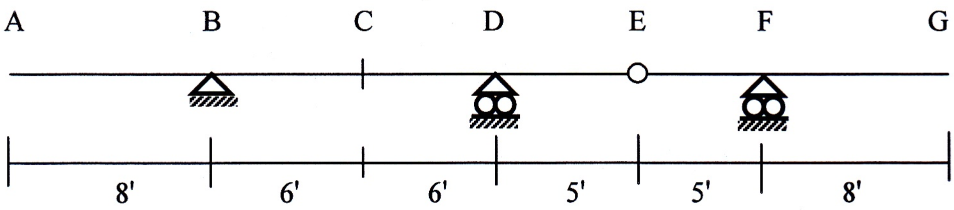
1. Classify each of the structures shown below as statically determinate or statically indeterminate, stable or unstable. If statically indeterminate, report the number of degrees of indeterminacy.



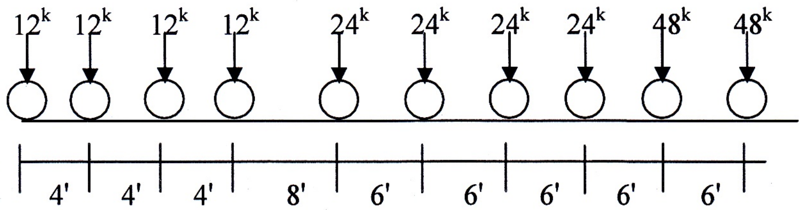
2. Draw the shear force and bending moment diagram for the entire structure in the following figure.



3. For the beam shown below, draw Influence lines for (i) Reaction at B, (ii) Shear at C, (iii) Shear just left of support D and (iv) Moment at C.

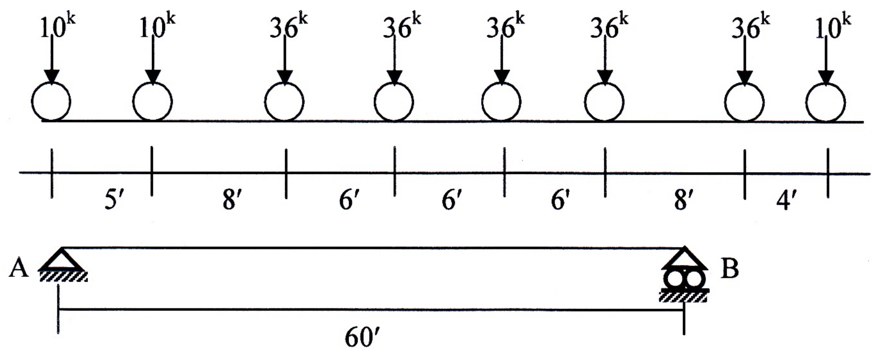


4. **Calculate the maximum bending moment at the midpoint of a simply supported beam of span 80 ft due to the wheel loads shown in the figure below.**

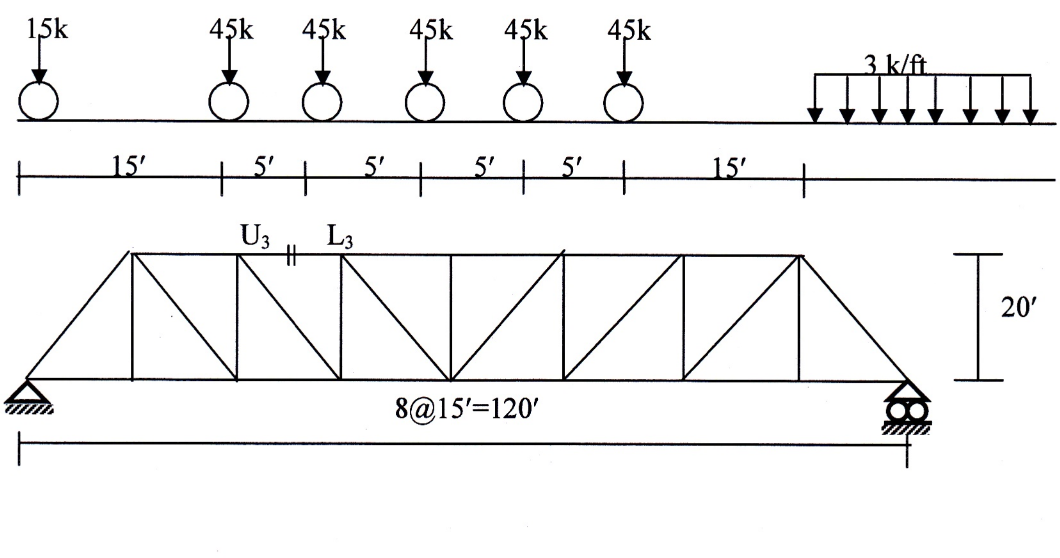


5. **Calculate the maximum shear at 20′ right of support A for a simply supported beam of span 80 ft due to the wheel loads shown in Question 4.**

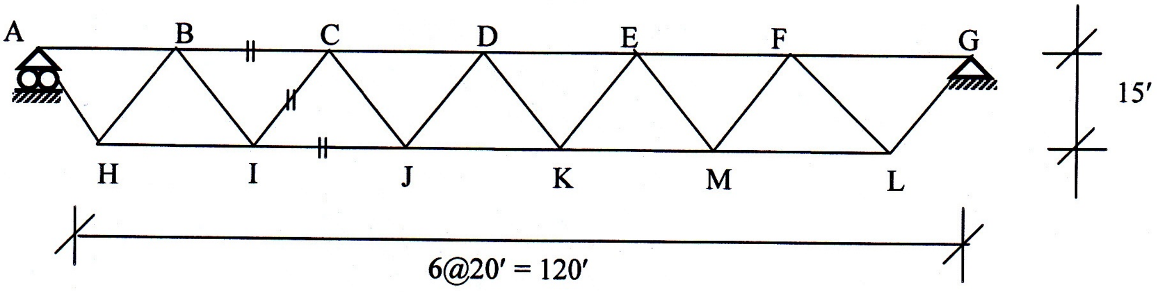
6. **Calculate the maximum reaction at left support A of a simply supported beam of span 60 ft due to the axle loads of a heavy freight locomotive shown below.**



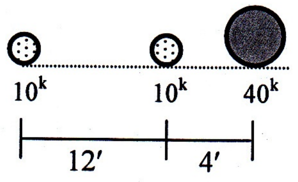
7. **Calculate the maximum bar force U_3L_3 of the truss for the moving wheel loads shown in following figure.**



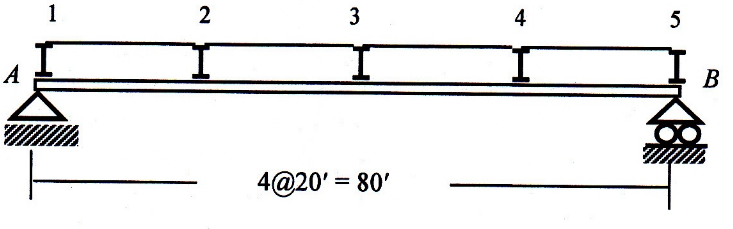
8. Draw influence line diagrams for bar forces of BC, CI and IJ for the truss shown in the figure below. Unit load moves from A to G.



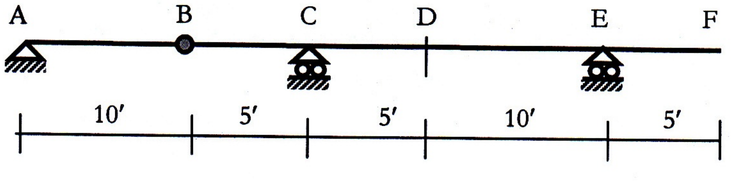
9. Calculate the absolute maximum bending moment of a simply supported beam of span 30 ft due to the wheel loads shown below.



10. Girder AB supports a floor system shown in the figure below. Draw the influence line for
i) Floor beam reaction at panel point 3.
ii) Support reaction at A
iii) Shear in panel 2-3
iv) Bending moment for girder at panel point 2.

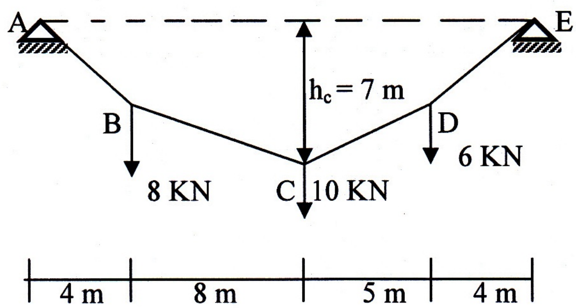


11. Using influence lines, calculate the maximum shear force and maximum bending moment at D due to a dead load of 4 kips per ft. and moving uniform load of 3 kips per ft.

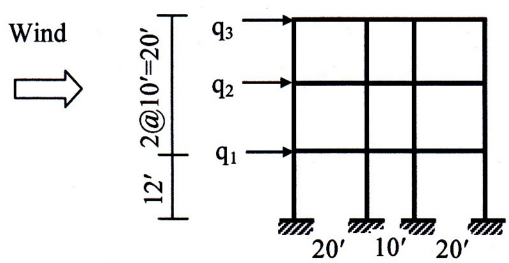


12. a) Derive the "General Cable Theorem".

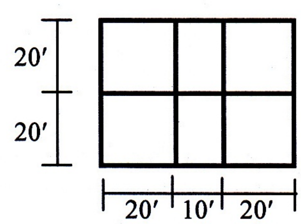
b) The cable shown below has supports A and E that lie at same elevation. Point C is on the cable 7 m below the line AE. Using general cable theorem determine the sags at B and D.



13. Calculate the (i) sustained wind pressure, (ii) sustained wind force at each story of the three-storied residential building (shown below) subjected to a basic wind speed of 210 km/hr with Exposure B.

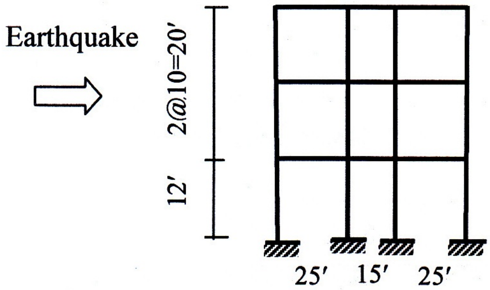


Side Elevation

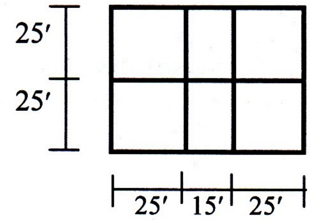


Building Plan

14. Calculate the (i) seismic base shear force, (ii) seismic force at each story of the three-storied hospital building (RCC) shown below located in Dhaka (Zone 2). Assume the structure to be a special moment resisting frame built on soil condition S_2, carrying a dead load of 200 lb/ft^2 (including partition load) and live load of 75 lb/ft^2.



Side Elevation



Building Plan

Wind Load Calculation

Table 6.2.9
Structure Importance Coefficients, C_I for Wind Loads

Structure Importance Category (see Table 6.1.1 for Occupancy)	Structure Importance Coefficient, C_I
I Essential facilities	1.25
II Hazardous facilities	1.25
III Special occupancy structures	1.00
IV Standard occupancy structures	1.00
V Low-risk structures	0.80

Table 6.2.10
Combined Height and Exposure Coefficient, C_z

Height above ground level, z (metres)	Coefficient, C_z (1)		
	Exposure A	Exposure B	Exposure C
0-4.5	0.368	0.801	1.196
6.0	0.415	0.866	1.263
9.0	0.497	0.972	1.370
12.0	0.565	1.055	1.451
15.0	0.624	1.125	1.517
18.0	0.677	1.185	1.573
21.0	0.725	1.238	1.623
24.0	0.769	1.286	1.667

Note : (1) Linear interpolation is acceptable for intermediate values of z.

Table 6.2.11
Gust Response Factors, G_h and G_z(1)

Height above ground level (metres)	G_h (2) and G_z		
	Exposure A	Exposure B	Exposure C
0-4.5	1.654	1.321	1.154
6.0	1.592	1.294	1.140
9.0	1.511	1.258	1.121
12.0	1.457	1.233	1.107
15.0	1.418	1.215	1.097
18.0	1.388	1.201	1.089
21.0	1.363	1.189	1.082
24.0	1.342	1.178	1.077

Note : (1) For main wind-force resisting systems, use building or structure height h for z.
(2) Linear interpolation is acceptable for intermediate values of z.

Table 6.2.15 (1)

Overall Pressure Coefficients, $\bar{C}_p^{(2)}$ for Rectangular Buildings with Flat Roofs

h/B	L/B					
	0.1	0.5	0.65	1.0	2.0	≥ 3.0
≤0.5	1.40	1.45	1.55	1.40	1.15	1.10
10.0	1.55	1.85	2.00	1.70	1.30	1.15
20.0	1.80	2.25	2.55	2.00	1.40	1.20
≥40.0	1.95	2.50	2.80	2.20	1.60	1.25

Note:(1) These coefficients are to be used with Method-2 given in Sec 2.4.6.6a(ii). Use $\bar{C}_p = \pm 0.7$ for roof in all cases.
(2) Linear interpolation may be made for intermediate values of $\bar{h}/B$ and L/B.

Earthquake Load Calculation

Table 6.2.23

Structure Importance Coefficients *I, I′*

Structure Importance Category (see Table 6.1.1 for occupancy)	Structure Importance Coefficient	
	I	*I′*
I Essential facilities	1.25	1.50
II Hazardous facilities	1.25	1.50
III Special occupancy structures	1.00	1.00
IV Standard occupancy structures	1.00	1.00
V Low-risk Structures	1.00	1.00

Table 6.2.24

Response Modification Coefficient for Structural Systems, *R*

Basic Structural System(1)	Description of Lateral Force Resisting System	*R* (2)
c. Moment Resisting Frame System	1. Special moment resisting frames (SMRF)	
	i) Steel	12
	ii) Concrete	12
	2. Intermediate moment resisting frames (IMRF), concrete(4)	8
	3. Ordinary moment resisting frames (OMRF)	
	i) Steel	6
	ii) Concrete (5)	5

Table 6.2.25

Site Coefficient, *S* for Seismic Lateral Forces (1)

Site Soil Characteristics		Coefficient, *S*
Type	**Description**	
S_1	A soil profile with either : a) A rock-like material characterized by a shear-wave velocity greater than 762 m/s or by other suitable means of classification, or b) Stiff or dense soil condition where the soil depth is less than 61 metres	1.0
S_2	A soil profile with dense or stiff soil conditions, where the soil depth exceeds 61 metres	1.2
S_3	A soil profile 21 metres or more in depth and containing more than 6 metres of soft to medium stiff clay but not more than 12 metres of soft clay	1.5
S_4	A soil profile containing more than 12 metres of soft clay characterized by a shear wave velocity less than 152 m/s	2.0

Note : (1) The site coefficient shall be established from properly substantiated geotechnical data. In locations where the soil properties are not known in sufficient detail to determine the soil profile type, soil profile S_3 shall be used. Soil profile S_4 need not be assumed unless the building official determines that soil profile S_4 may be present at the site, or in the event that soil profile S_4 is established by geotechnical data.

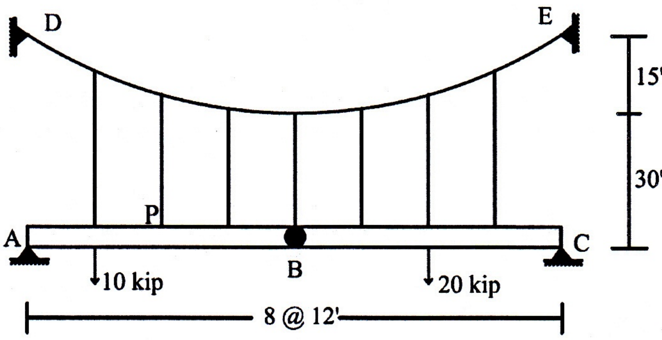
University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2014
Program: B. Sc. Engineering (Civil)

Course Title: Structural Analysis & Design I — Course Code: CE 311 (Sec B)

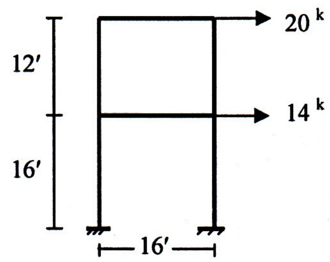
Time: 3.00 Hours — Full Marks: 100 (=10×10)

*There are **fourteen (14)** questions in this paper. Answer any **ten (10)**.*
Assume any missing data reasonably. Symbols have their usual meaning.

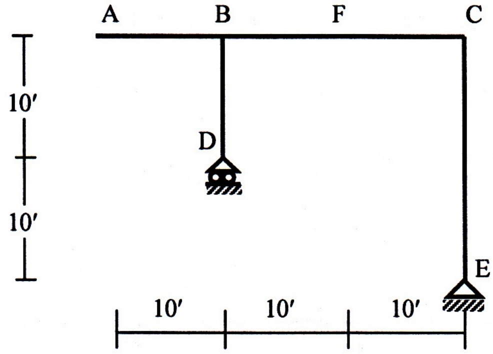
1. Calculate the force on each hanger and also determine the shear force and bending moment at 'P' for the following ABC frame of cable suspension bridge. B is an internal hinge.



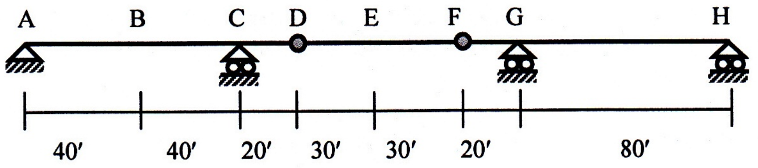
2. Draw shear force and bending moment diagrams of beams and columns of the two-storied frame subjected to lateral load as shown in the figure, assuming (i) Equal share of story shear forces between columns, (ii) Internal hinge at column mid spans.



3. For the frame shown below, draw the influence lines for (i) Y_D, Y_E, (ii) V_F, $V_{B(AC)L}$, (iii) M_F, $M_{B(AC)}$, if the unit load moves over (a) beam AC, (b) column EC.

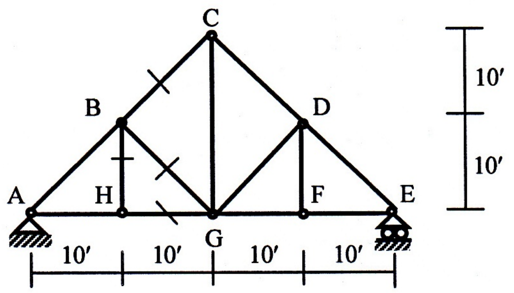


4. For the beam shown below, draw the influence lines for
   (i) R_A, R_C
   (ii) V_B, V_{CR}
   (iii) M_C, M_E



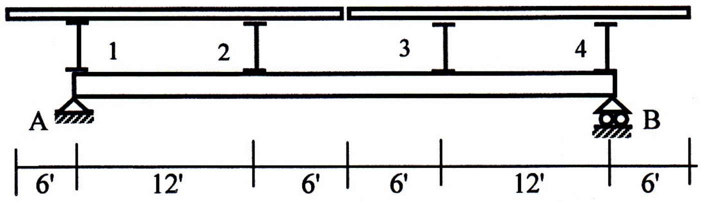
D and F are Internal Hinges

5. For the truss shown below, draw the influence lines for F_{BC}, F_{BG}, F_{GH}, and F_{BH}. Note, each bottom cord joint consists of a cross girder and load moves over the floor beam placed over the girders.



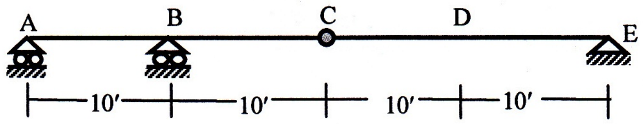
6. Girder AB supports a floor system as shown in the figure below. Draw the Influence line for

   (i) Floor beam reaction at panel point "1" and "2"
   (ii) Support reaction at "A"
   (iii) Shear in panel 1-2 and
   (iv) Bending moment for girder at panel point "2".



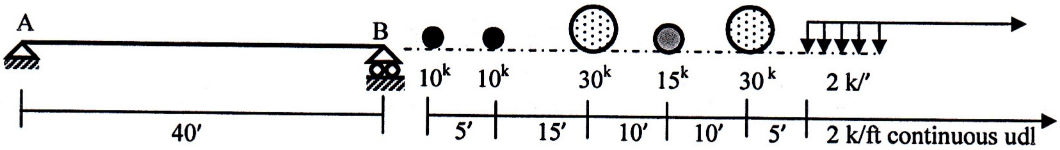
7. Determine - i) Maximum Reaction at support D
   ii) Maximum Shear at point D
   iii) Maximum Moment at point B

   on the beam shown due to
   - A single concentrated live load of 10 kips
   - A uniform live load of 3 k/ft
   - A beam weight of 1k/ft



C is an Internal Hinge

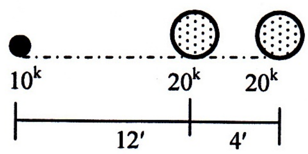
Calculate the maximum value of R_A for the wheel load arrangement shown below.



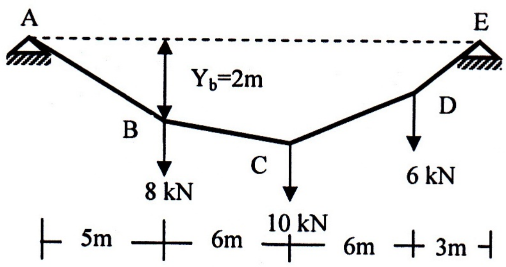
9. Calculate the maximum shear at 15′ right of support A for the beam and the moving loads in *Question 8.*

10. Calculate the maximum moment at mid span for the beam and the moving loads in *Question 8.*

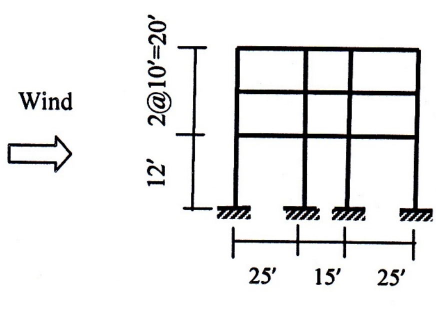
11. Calculate the absolute maximum bending moment of a simply supported beam of span 30 ft due to the wheel loads shown in the figure below.



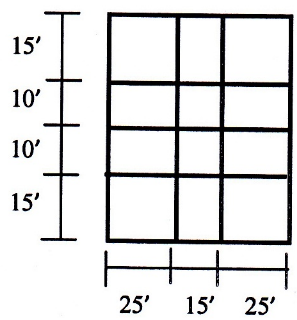
12. (a) State "General cable theorem".
(b) The cable shown below has supports A and E that lie at the same elevation. Point B on the cable is 2m below the line AE. Use the general cable theorem to calculate the sags at C and D. Also calculate the maximum cable tension.



13. Calculate the wind load at each story (i.e. at joints) of a three-storied concrete made school building (shown below) located at a flat terrain in Dhaka (Basic wind speed = 130 mph). Assume the structure to be subjected to Exposure B.

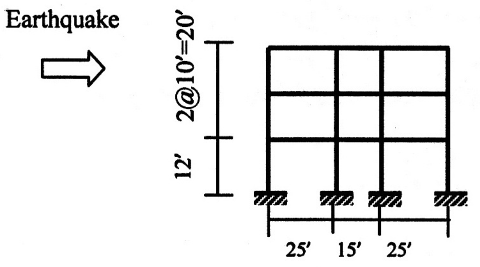


Side Elevation

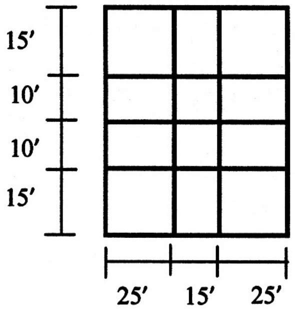


Building Plan

14. Calculate the seismic load at each story (i.e. at joints) of a three-storied concrete made hospital building (shown below) located in Dhaka (Zone 2). Assume the structure to be a Standard Moment Resisting Frame (SMRF) built on soil condition S_3, carrying a Dead Load of 150 lb/ft^2 and Live load of 40 lb/ft^2.



Side Elevation



Building Plan

Annexure and Formula

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Wind:

$q_z = 0.00256\, C_I\, C_z\, V_b^2$

$p_z = C_G\, C_t\, C_p\, q_z$

Category	C_I or I
Essential facilities	1.25
Hazardous facilities	1.25
Special occupancy	1.00
Standard occupancy	1.00
Low-risk structure	0.80

Height z (ft)	C_z		
	Exp A	Exp B	Exp C
0~15	0.368	0.801	1.196
50	0.624	1.125	1.517
100	0.849	1.371	1.743
150	1.017	1.539	1.890
200	1.155	1.671	2.002
300	1.383	1.876	2.171
400	1.572	2.037	2.299
500	1.736	2.171	2.404
650	1.973	2.357	2.547
1000	2.362	2.595	2.724

Overall **Pressure Co-efficient (C_P)**
for rectangular buildings with flat roof:

h/B	L/B					
	0.1	0.5	0.65	1.0	2.0	≥ 3.0
≤ 0.5	1.40	1.45	1.55	1.40	1.15	1.10
1.0	1.55	1.85	2.00	1.70	1.30	1.15
2.0	1.80	2.25	2.55	2.00	1.40	1.20
≥ 4.0	1.95	2.50	2.80	2.20	1.60	1.25

Height z (ft)	C_G (for non-slender structures)		
	Exp A	Exp B	Exp C
0~15	1.654	1.321	1.154
50	1.418	1.215	1.097
100	1.309	1.162	1.067
150	1.252	1.133	1.051
200	1.215	1.114	1.039
300	1.166	1.087	1.024
400	1.134	1.070	1.013
500	1.111	1.057	1.005
650	1.082	1.040	1.000
1000	1.045	1.018	1.000

For Flat Terrain, $C_t = 1$

Earthquake:

$V = (ZIC/R)\, W$

$C = 1.25\, S/T^{2/3}$

$T = C_t (h_n)^{3/4}$

$F_j = (V - F_t)\, [w_j h_j / \sum w_i h_i]$

Soil Type	S
S_1	1
S_2	1.2
S_3	1.5
S_4	2

Response Modification Factor		R
Moment Resisting Frame System	SMRF (steel)	12
	SMRF (concrete)	12
	IMRF	8
	OMRF (steel)	6
	OMRF (concrete)	5

$C_t = 0.083$ for steel moment resisting frames
$= 0.073$ for RCC moment resisting frames, and eccentric braced steel frames
$= 0.049$ for all other structural systems

Z = 0.075, 0.15 and 0.25 for Seismic Zones 1, 2 and 3 respectively

Wheel Load:

1. $\Delta R = \{(\sum P)\, d_1 + P'e\}/L - P_1$
2. $\Delta V = \{(\sum P)\, d_1 + P'e + P_0\, e_0\}/L - P_1$
3. $\Delta M = (P_2\, d_1 + P'e)\,(i/b) - (P_1\, d_1 + P_0\, e_0)\,(i/a)$
4. $M_{(Max)} = (\sum P/L)\,(L/2 - a/2)^2 - P\, b$

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2014
Program : B.Sc Engineering (Civil)

Course Title: Design of Concrete Structures I **Course Code: CE 315 (Sec A)**
Time : 3 hr **Full Marks : 60**

Answer any 3 Questions from each section (Assume any missing data)
Use either USD or WSD method if not specified
The symbols have their usual meaning

Section A

1. a) Calculate the uniformly distributed load (in addition to beam self-weight) which will cause the hollow section (Fig. 1) to begin crack. Given, Simply supported span = 28 ft, $f'_c = 4$ ksi, $f_y = 60$ ksi, n=9, concrete unit weight = 150 pcf. (5)

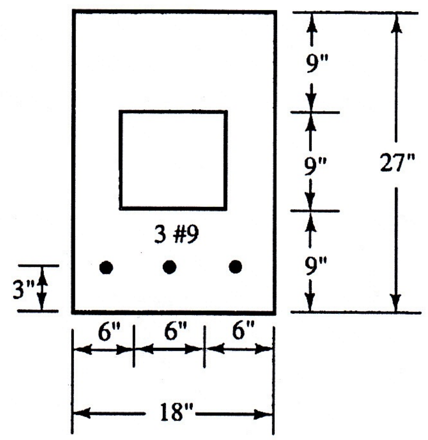

Fig. 1

b) Use Transformed Area method to determine the allowable resisting moment of the beam (Fig. 1), if the allowable bending stresses of concrete and steel are $f_c = 1.35$ ksi and $f_s = 20$ ksi. (5)

2. a) What is the justification of selecting strength reduction factor (φ) based on net tensile strain (ϵ_t)? Discuss the variation of φ with ϵ_t as given in ACI code addressing the tension controlled and compression controlled design. (3)

b) A rectangular concrete beam of width b = 14″ is limited by architectural considerations to a maximum total depth h = 32″. The beam must carry a service (i.e. unfactored) DL moment of 200 k-ft and service LL moment of 450 k-ft. Design the flexural reinforcement for the beam using compression steel if necessary. Assume double layer tension reinforcement. Use, d=28″, d′ = 3″, $f'_c = 4$ ksi, $f_y = 60$ ksi, n = 9. (7)

3. Design a T beam for the floor system shown in Fig 2. Given, $M_D = 200$ k-ft, $M_L = 400$ k-ft, $f'_c = 4000$ psi, $f_y = 60000$ psi, $f_s = 24$ ksi, n=9 and simple span= 24 ft. (10)

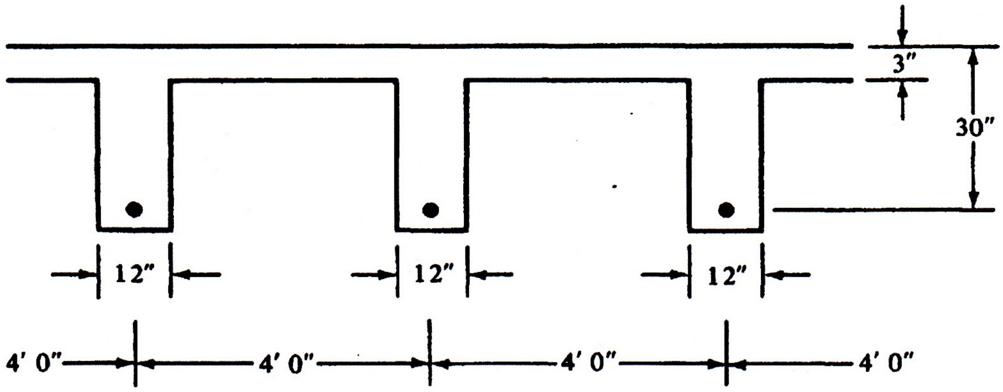

Fig. 2

4. Design the beam (Fig. 3) for shear with a 1.5 k/ft service DL over entire span and a 30 kip concentrated service LL at midspan. Also show the stirrup spacing over the half span. Use #3 U stirrups. Given, $f'_c = 4000$ psi, $f_y = 60000$ psi, $f_s = 24$ ksi. Loads are unfactored. (10)

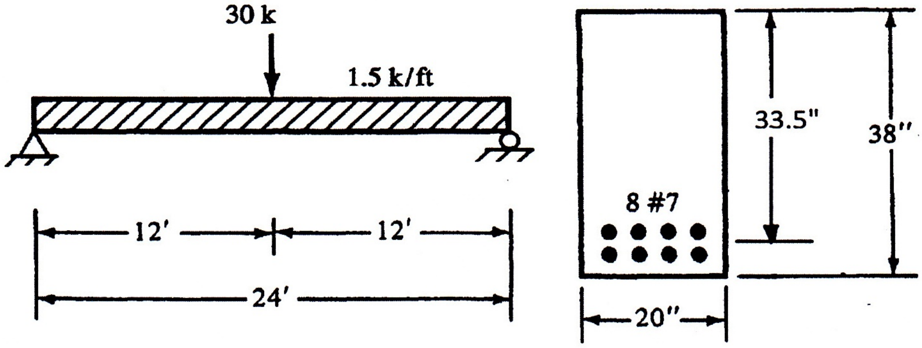

Fig. 3

Section B

5. a) Differentiate between USD and WSD. Which method of design provides maximum factor of safety? Justify your answer. (2)

b) A rectangular beam has a width of 12" and an effective depth to the centroid of the tension reinforcement of 17". The tension reinforcement consists of three no. 9 bars in a row. Calculate the design moment capacity of the beam using both USD and WSD. Given, $f'_c = 5$ ksi, $f_y = 60$ ksi, $f_s = 24$ ksi, $E_s = 29000$ ksi, $E_c = 3222.22$ ksi. (8)

6. a) Write down the ACI specifications for determining the effective width of T-beams and L-beams. (2)

b) Define development length. Explain the relationship of (i) Location of reinforcement and (ii) Coating of bars, with development length by means of the factors Ψ_t and Ψ_e. (2)

c) Calculate the nominal and design moment capacity of the beam shown in Fig. 4. Given, $f'_c = 5$ ksi, $f_y = 60$ ksi, $f_s = 24$ ksi, $E_s = 29000$ ksi, $E_c = 3222.22$ ksi. (6)

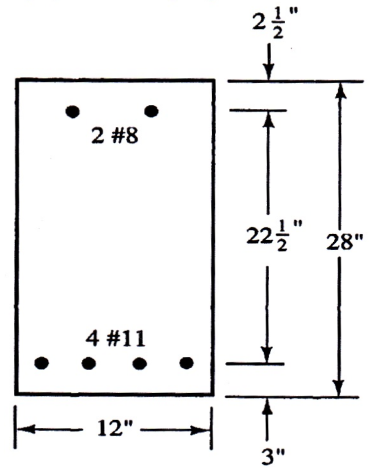

Fig. 4

7. a) The beam of Fig. 5 is subjected to a service DL of 1 k/ft and service LL of 2 k/ft. After designing the beam for maximum flexure, 3-#10 uncoated bar has been selected. Given, normal weight concrete $f'_c = 5$ ksi, $f_y = 60$ ksi, $f_s = 24$ ksi, $E_s = 29000$ ksi, $E_c = 3222.22$ ksi.

(i) Calculate the theoretical cut-off point of the centre rebar. (3)

(ii) Also, calculate the actual cut-off point of the centre rebar considering the fact that, adequate development length is to be provided. Consider simplified equation for development length calculation. (5)

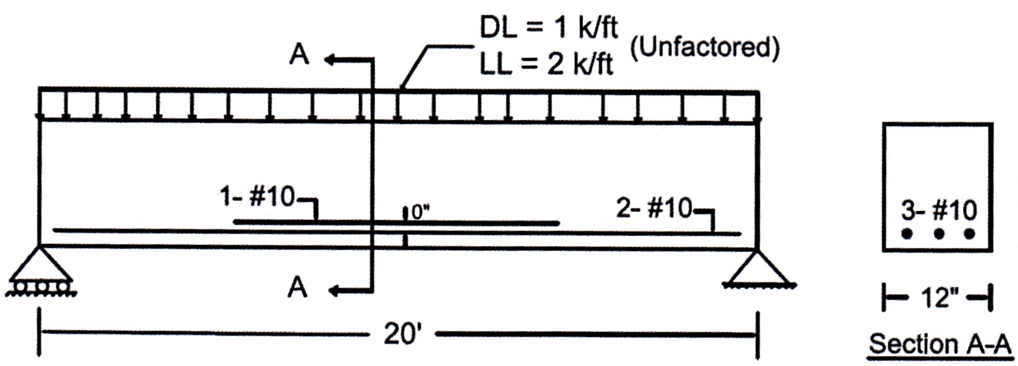

Fig. 5

b) Although the reaction from the support surface introduces vertical compression at the end of the beam, the maximum shear to be considered for design will be computed at a distance 'd' from the interior face of support, explain why? (2)

8. a) A reinforced concrete one way slab is built integrally with its supports and consists of two equal spans. The slab panels are continuous in one direction and each panel has a clear span of 16 ft (Fig. 6). The service live load is 100 psf and 4000 psi concrete is specified for use with steel with a yield stress equal to 60000 psi. Design the slab and show the reinforcement detailing. Note, this slab is okay for serviceability. Use ACI moment co-efficients (indicated on the top of the longitudinal slab section shown in Fig. 6). (8)

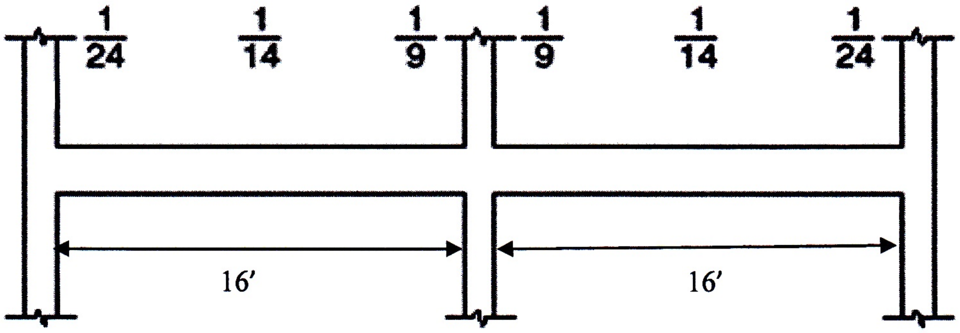

Fig. 6

b) How can you differentiate one-way slab from two-way slab system? (2)

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Formulae:

$$\phi M_n = M_u = \phi A_s f_y d\left(1 - \frac{1}{1.7}\frac{\rho f_y}{f'_c}\right)$$

$$\rho = \frac{0.85 f'_c}{f_y}\left(1 - \sqrt{1 - \frac{2R_n}{0.85 f'_c}}\right)$$

$$\phi = 0.65 + (\varepsilon_t - 0.002)\left(\frac{250}{3}\right)$$

$$\frac{M_u}{\phi b d^2} = \rho f_y\left(1 - \frac{1}{1.7}\frac{\rho f_y}{f'_c}\right)$$

$$A_{s\,\min} = \frac{3\sqrt{f'_c}}{f_y} b_w d$$

nor less than $\frac{200 b_w d}{f_y}$

$$A_s f_y = 0.85 f'_c \beta_1 c b + A'_s\left(\frac{c - d'}{c}\right)(0.003)(29{,}000)$$

$$M_n = A_{s1} f_y\left(d - \frac{a}{2}\right) + A_{s2} f_y (d - d')$$

$$\beta_1 = 0.85 - \left(\frac{f'_c - 4000}{1000}\right)(0.05) \geq 0.65$$

$$a = \frac{A_s f_y}{0.85 f'_c b} = \beta_1 c$$

$$\phi M_n = \phi A_s f_y\left(d - \frac{a}{2}\right)$$

$$k = \sqrt{2\rho n + (\rho n)^2} - \rho n$$

$$j = 1 - \frac{k}{3}$$

$$f_c = \frac{2M}{b d^2 k j}$$

$$f_s = \frac{M}{A_s j d}$$

$f_c = 0.45\, f'_c$

$$V_s = \frac{V_u - \phi V_c}{\phi}$$

$$s = \frac{A_v f_y d}{V_s}$$

$$s = \frac{A_v f_y}{0.75\sqrt{f'_c}\, b_w}$$

$$\leq s = \frac{A_v f_y}{50 b_w}$$

Compute maximum spacing: $d/2 \leq 24$ in., if $V_s \leq 4\sqrt{f'_c}\, b_w d$.

Compute maximum spacing: $\frac{d}{4} \leq 12$ in., if $V_s > 4\sqrt{f'_c}\, b_w d$.

$$\frac{\ell_d}{d_b} = \frac{f_y \psi_t \psi_e \lambda}{20\sqrt{f'_c}}$$

Section B

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2014
Program: B.Sc. Engineering (Civil)

Course Title: Design of Concrete Structures I | Course Code: CE 315
Time: 3.0 hr | Full Marks: 100

Part A

[Answer any three (03) out of the following four (04) questions]

Full Marks: 30 [=3*(5+5)]

1. (i) Explain the difference between analysis and design of an RC section.

   (ii) What is a doubly reinforced RC section? Explain how it differs from a singly reinforced section.

2. (i) What is the balanced steel ratio (ρ_b)? Why does ACI recommend maximum steel ratio < ρ_b?

   (ii) What are the load and resistance factors? Explain why they are used in USD.

3. (i) What is one-way slab? Give some common examples of one-way slabs in engineering structures.

   (ii) Narrate the ACI code provisions for choosing the minimum thickness of one-way slabs.

4. (i) What is development length? Mention the factors influencing development length of deformed bars

   (ii) Explain why the development length of compression bars is smaller than that of tension bars.

Part B

[Answer any seven (07) out of the following ten (10) questions]

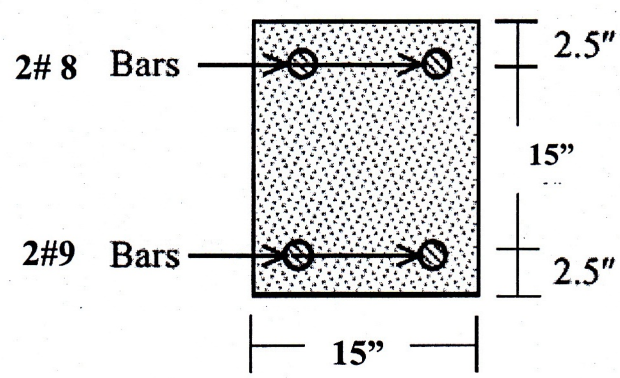
Full Marks: 70 [=7*10]

[Given: $f_c' = 3$ ksi, $f_y = 60$ ksi, $f_{call} = 1.35$ ksi, $f_{sall} = 30$, ksi for all questions]

[Assume reasonable values for any missing data]

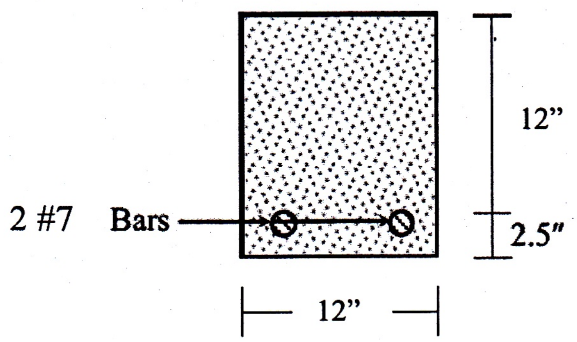
5. (a). Calculate the nominal compression and tensile force capacity of the RC section.

   (b). Calculate the stresses in concrete and steel when the section is subjected to one-fifth of its ultimate load capacity.

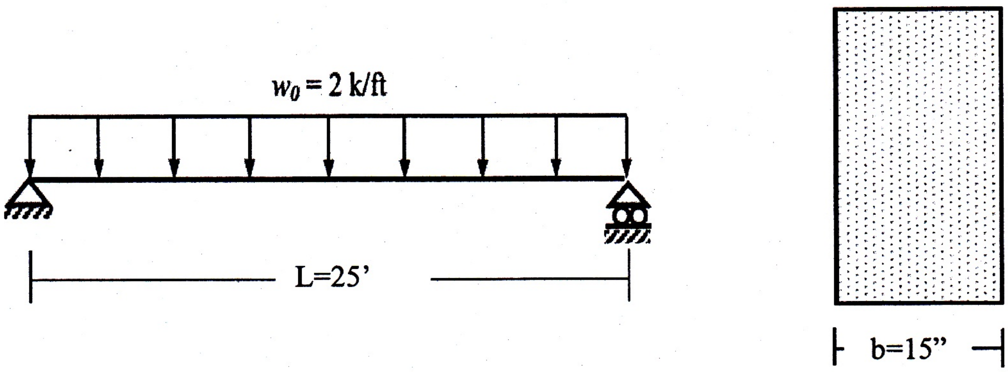


6. (a). Calculate the 'Cracking' positive moment capacity (M_{cr}) of the RC section shown below when allowable tensile stress in concrete, $f_t = 0.351$ ksi

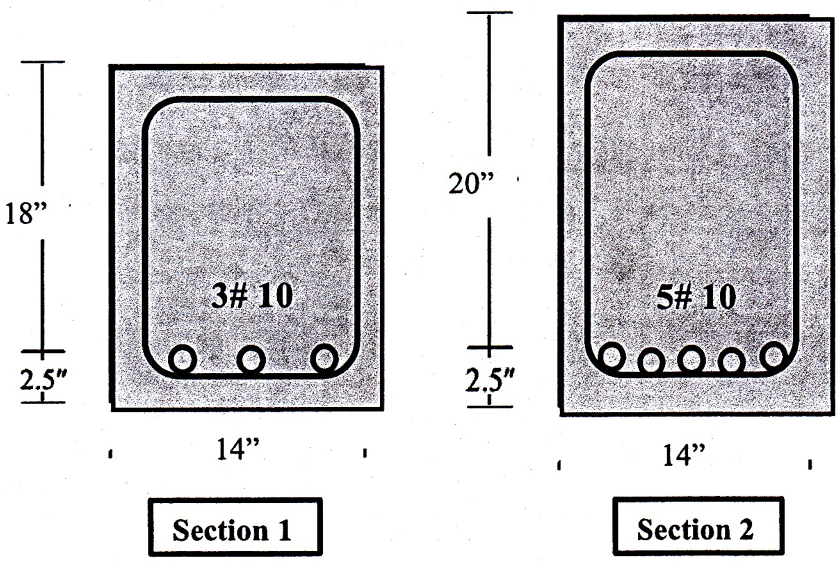
   (b) Calculate the allowable positive moment (M_{call} and M_{sall}) in the same RC section when it is cracked.



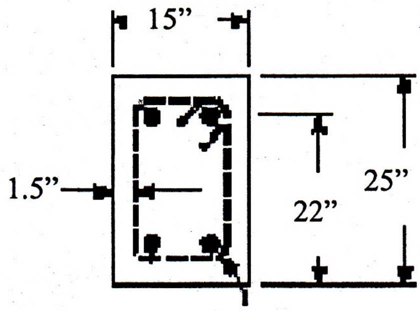
7. Use WSD Method to design the simply supported RC beam as shown, consider self-weight of the beam section.



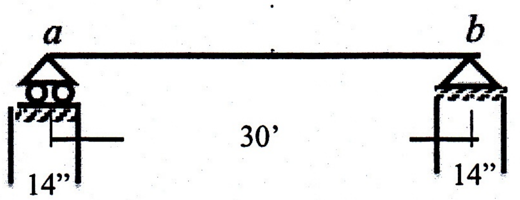
8. Calculate the nominal moment capacity of the singly reinforced beam sections using Whitney's rectangular stress block.



9. A beam section (b = 15″, h = 25″, d = 22″, clear cover = 1.5″), made of normal-density concrete with f_c' = 3 ksi, is reinforced with epoxy coated 2#10 bars (d_b = 1.25″, A_s = 3.5 in^2, with f_y = 60 ksi), whereas the reinforcement required from structural analysis is 3.10 in^2, in addition to #3 stirrups @6″c/c, Calculate the development length l_d of the bars, using given table in formula sheet.

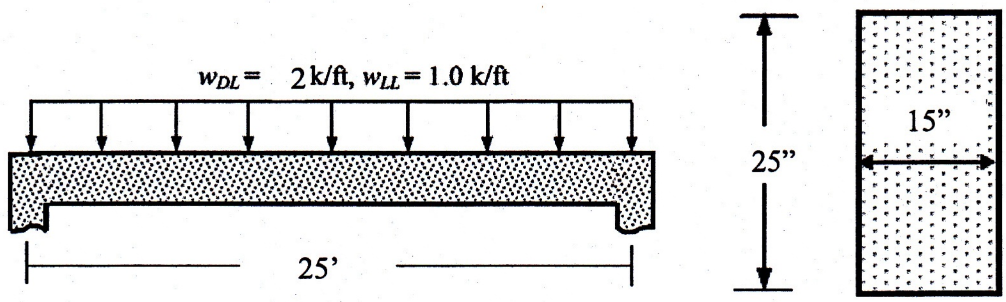


10. Design the RC slab shown below (carrying FF = 45 psf, RW = 55 psf, LL = 60 psf, in addition to self weight) by WSD method.

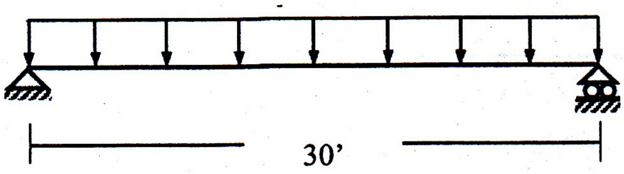


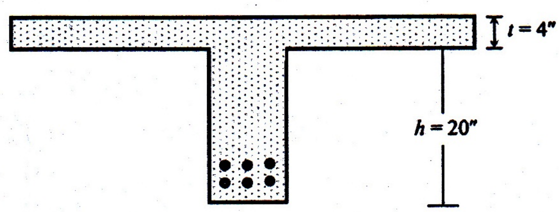
11. Use the ACI provisions to calculate the concrete shear strength for a beam section with A_s= 5.5 in^2, b = 12″, h = 30″, d = 26″, when (i) shear force V_u = 50 kip, M_u = 100 k-ft (ii) compressive force N_u = 100 kip, (iii) tensile force N_u = 100 kip.

12. Use the USD Method to design the vertical stirrups for the simply supported RC beam loaded as shown, in addition to self-weight (assume column dimension =14" x14").

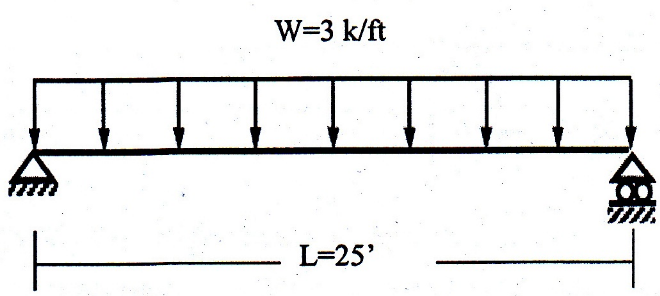


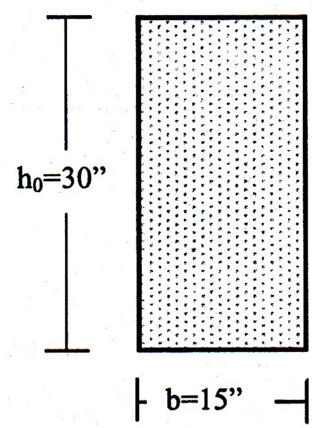
13. Using USD method, determine, total load, b_{eff} for the T-beam loaded as shown below, in addition to its self-weight if it is part of a beam system carrying a 4″ thick slab (with $FF = 60$ psf, $RW = 80$ psf and $LL = 150$ psf, $\acute{Ø} = 0.9$) a transverse distance of 12′ c/c apart. Check whether this beam acts like T beam (Note: you do not need to calculate reinforcements).





14. Use the WSD Method to design the doubly reinforced simply supported RC beam loaded as shown below, in addition to its self-weight.





List of Useful Formulae for CE 315

Fundamentals

* Tensile strength of concrete $f_t' = 7.5\sqrt{f_c'}$ $\quad E_c = 57500\sqrt{f_c'}$ $\quad E_s = 29 \times 10^6$ psi $\quad$ Modular ratio, $n = E_s/E_c$
* Within elastic limit, Flexural stress $f_c = M\,\bar{y}/\bar{I}$ $\quad P_n = 0.85f_c'A_c + f_yA_s$ $\quad P_c = f_c[A_g + (n-1)A_s]$
* Steel Ratio $\rho_s = A_s/bd$ $\quad$ Minimum Steel Ratio $\rho_{min} = 3\sqrt{f_c'}/f_y$, often taken as $= 200/f_y$ $\quad P_t = f_t[A_g + (n-1)A_s]$:

WSD

* 'Cracked' elastic section $\quad$ Analysis: $k = -n\rho_s + \sqrt{[2n\rho_s + (n\rho_s)^2]}$ $\quad j = 1 - k/3$

  Design: $k = n/(n+r)$ [where $r = f_{s(all)}/f_{c(all)}$] $\quad j = 1 - k/3$
* Singly Reinforçed Beam: $\quad M_s = A_s f_s jd$ and $\quad M_c = (f_c kj/2)\, bd^2 = R\, bd^2$
* Balanced Stress Steel Ratio $\rho_{sb} = k/2r$, when $M_s = M_c$
* Doubly Reinforced Beam: $M_1 = Rbd^2$, $\quad A_{s1} = M_1/(f_s jd)$

  $M_2 = M - M_1$, $\quad A_{s2} = M_2/[f_s(d-d')]$ and $A_s' = M_2/[f_s'(d-d')]$, where $f_s' = f_s(k - d'/d)/(1-k)$

USD

f_c'(ksi)	≤ 4	4~8	≥ 8
α	0.72	$0.72 - 0.04\,(f_c' - 4)$	0.56
β	0.425	$0.425 - 0.025\,(f_c' - 4)$	0.325

* Balanced Steel Ratio $\rho_b = (\alpha f_c'/f_y)\,\{87/(87+f_y)\}$

To calculate M_u, V_u, P_u, overload factors for DL, LL, W, EQ can be set as 1.2, 1.4, 1.6, 1.7, 1.87 respectively.

* Singly Reinforced Analysis: $a = A_s f_y/(0.85f_c'\, b)$ $\quad M_n = A_s f_y (d - a/2) = \rho_s f_y (1 - 0.59\,\rho_s f_y/f_c')\, bd^2$ (For tension failure)

$m = 87/\alpha f'_c$ $\quad c = (0.85a)/\alpha$ $\quad c = d\,[-(m\rho_s/2) + \sqrt{\{(m\rho_s/2)^2 + m\rho_s\}}]$ $\quad M_n = 0.85 f_c' ab\,(d - a/2)$ (For compression failure)

* Design: $\quad$ Singly Reinforced if $M_n = \rho f_y (1 - 0.59\,\rho f_y/f_c')\, bd^2$

  $a = d\,[1 - \sqrt{\{1 - 2M_n/(f_c bd^2)\}}]$, $\quad A_s = (0.85f_c'\, ab)/f_y$

  Doubly Reinforced $\quad M_1 = M_{max}$ $\quad A_{s1} = \rho_{max}\, bd$,

  $M_2 = M_n - M_1$ $\quad A_{s2} = M_2 / f_y (d - d')$

  $c = A_{s1} f_y/(\alpha f_c'\, b)$ $\quad c/d' = \varepsilon_c/(\varepsilon_c + \varepsilon_1)$ $\quad A_s' = M_2/\{f_s'(d - d')\}$

* T-beam b_{eff} is the minimum of $L/4$, $(16t + b_w)$, and (c/c distance between adjacent beams)

* USD Analysis: $\quad A_{sf} = 0.85f_c'(b_{eff} - b_w)t / f_y$ $\quad M_{nf} = A_{sf} f_y (d - t/2)$

  $A_{sw} = A_s - A_{sf}$ $\quad a = A_{sw} f_y/(0.85f_c'\, b_w)$ $\quad M_{nw} = A_{sw} f_y (d - a/2)$ $\quad \Big\}\ M_n = M_{nf} + M_{nw}$

Design: $A_{sf} = 0.85f_c'(b_{eff} - b_w)t / f_y$, $M_{nf} = A_{sf} f_y (d - t/2)$; while A_{sw} can be obtained from $M_{nw} = M_n - M_{nf}$

$$a = d\,[1 - \sqrt{\{1 - 2M_n/(0.85f_c'\, b_{eff} d^2)\}}]$$

development length of deformed bars in tension $l_d/d_b = (3/40)\,(f_y/\sqrt{f_c'})\,(\alpha\beta\gamma\lambda)/\{(c + K_{tr})/d_b\}$

Table 10.1: Parameters of Development Length of Tension Bars

Symbol	Parameter	Variable	Value
α	Reinforcement Location Factor	* Horizontal Reinforcement over ≥ 12" concrete * Other Reinforcement	1.3 1.0
β	Coating Factor	* Epoxy-coated bars with cover <3d_b or clear spacing <6d_b * All other epoxy-coated bars or wires * Uncoated bars * Maximum value of $\alpha\beta$	1.5 1.2 1.0 1.7
γ	Reinforcement Size Factor	* ≥ #7 bars * ≤ #6 bars and deformed wires	1.0 0.8 (?)
λ	Lightweight Aggregate Concrete Factor	* When lightweight aggregate concrete is used * When normal-weight concrete is used	1.3 1.0
c	Spacing or Cover Dimension (in)	* Bar center to nearest concrete cover * One-half the c/c spacing of bars	Smaller than both
K_{tr}	Transverse Reinforcement Index	S = Maximum spacing of transverse reinforcement A_{tr} = Area of all transverse reinforcement within S f_{tr} = Yield strength of transverse reinforcement, ksi n = No. of bars being developed along the plane of splitting	$A_{tr}f_{tr}/(1.5Sn)$

Shear Design

* $S = A_v\, f_v\, d/(V_{ext} - V_{cr}) = A_v\, f_v/\{(v_{ext} - v_c)\, b\}$ for vertical stirrups, and

Summary of ACI Shear Design Provisions (Vertical Stirrups)

	WSD	USD	Additional Provisions
Design Shear Force	V_w	$V_n = V_u/\phi$ [ϕ = 0.75]	Calculated at d from Support face
Min^m Section Depth	$V_w/5\sqrt{f_c'}b_w$	$V_n/8\sqrt{f_c'}b_w$	$f_y \le 60$ ksi
Concrete Shear Strength v_c	$1.1\sqrt{f_c'}$	$1.9\sqrt{f_c'} + 2500\rho_s(Vd/M)$ OR $2\sqrt{f_c'}$	$\sqrt{f_c'} \le 100$ psi $Vd/M \le 1.0$
No Stirrup	$V_w \le V_c/2$	$V_n \le V_c/2$	
Max^m Spacing	d/2, 24" $S = A_v f_y/50b_w$	d/2, 24" $S = A_v f_y/50b_w$	To be halved if $V_n \ge 4\sqrt{f_c'}b_wd$ OR $V_w \ge 2\sqrt{f_c'}b_wd$ in WSD

Effect of Axial Force on Shear Strength

* Axial Compression

$$v_c = 1.9\sqrt{f_c'} + 2500\rho_s(V_u d/M_u)$$

$v_c = 2\sqrt{f_c'}\,(1 + N_u/2000A_g)$

* Axial Tension

$v_c = 2\sqrt{f_c'}\,(1 + N_u/500A_g)$, but not less than zero (N_u is negative for tension). As an alternative $v_c = 0$

Table 9.1: Minimum Thickness of Non-Prestressed One-way Slabs (for f_y = 60 ksi)

Simply Supported	One end continuous	Both ends continuous	Cantilever
L/20	L/24	L/28	L/10

Table 9.2: Minimum Ratios of Temperature and Shrinkage Reinforcement in Slabs

Slabs with f_y = 40 or 50 ksi	0.0020
Slabs with $f_y \ge 60$ ksi	$0.0018 \times (60/f_y) \ge 0.0014$

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2014
Program: B. Sc. Engineering (Civil)

Course Title: Environmental Engineering I — Course Code: CE 331

Time: 3 hours — Full marks: 100

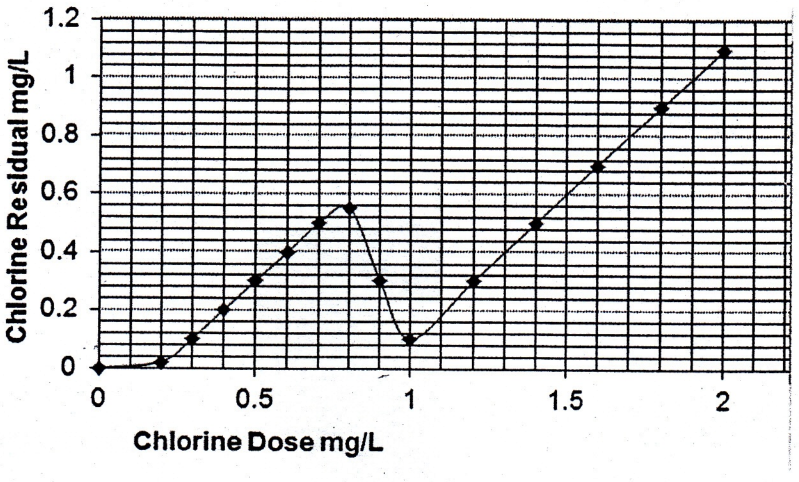
Question No. 1 is compulsory. Answer any FOUR from the rest. (5 X 20 = 100)
(Note: Assume any missing data)

1. A **45 m^3/hour** drinking water treatment plant is being designed for a small community. The plant needs a settling tank for chemical precipitation followed by disinfection.

(a) Design (indicate diameter and depth in meters) a **circular** settling basin for the plant using an overflow rate of 0.5m^3/m^2-hr. The detention time is 3 hours. (8)

(b) What percent of particles with a settling velocity of 0.8 m/hour will settle out in this tank? (2)

(c) The disinfection chlorine demand curve for the river water used in the plant is presented below. Answer questions i) through iv) relevant to this figure



i) What is the chlorine dose at Break Point in mg/L (2)

ii) What is the chlorine dose for maintaining a Free Residual of 0.3 mg/L? (2)

iii) What types of residuals are formed during the chlorine doses ranging from 0.2 to 0.8 mg/L? What compound reacts with chlorine in this region? (3)

iv) Why does the chlorine residual decrease during the chlorine doses ranging from 0.8 to 1.0 mg/L? (3)

2. (a) Indicate the chemical or chemicals (write the chemical formula with name) needed for each of the water treatment processes indicated below. Also indicate the name of the precipitate if formed during the treatment process. (11)

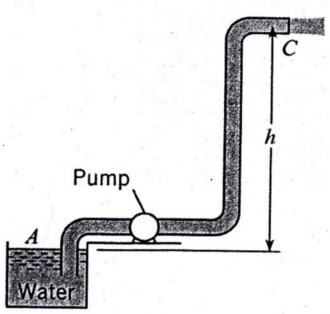
Treatment	Chemical Added	Precipitate Formed
Coagulation-Flocculation		
Disinfection		
Softening (hardness removal) If water has only temporary hardness having $Ca(HCO_3)_2$, $Mg(HCO_3)_2$		
Softening (hardness removal) If water has only $MgSO_4$		

(b) A **1,550m³/hour** drinking water plant needs rapid mix basins for chemical addition. If the detention time is 60 seconds and the volume of the tank cannot exceed 8 m^3, how many tanks will be needed? What is the power in watts that needs to be supplied to **each tank** if the velocity gradient G is 80 sec^{-1}? Assume that the absolute viscosity of the water is 8.91×10^{-4} Pascals.second. (6)

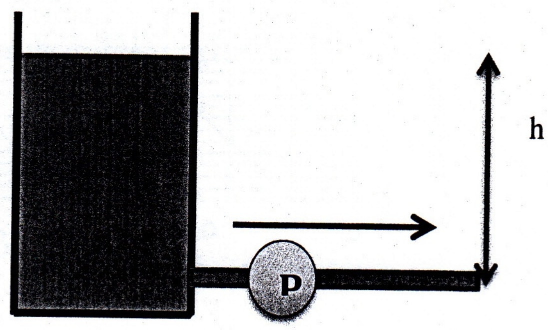
(c) How can an operator tell when to backwash a rapid sand filter? (3)

3. (a) What are the instances when pumps are required in a water distribution system? When would you use an electric pump and when would you use a centrifugal pump? (6)

(b) Derive the expression for the pump head for case I and case II as shown below. (5)



Case I



Case II

(c) Water is supplied at a rate of 35 gallons per capita per day for a city with a population of 50,000. The pump house is located at 135 ft from ground and the treatment plant is located at 220 ft from ground. Total length of the pipe has to be within 2500 ft and the velocity through the pipe has to be maintained at 5 fps. The pump has to work for 10 hours daily at an efficiency of 65%. Design the transmission main (diameter of the pipe) and the pumping unit (working and break horse power). Assume friction factor, f = 0.01. (9)

4. (a) Why is it not feasible to install regular tube wells in coastal areas, although freshwater is available at shallow depths? What kind of adjustment or change is introduced to overcome this difficulty? (4)

(b) Which alternative water supply options can be adopted if nearby pond water is required to be used for drinking purpose? Explain the technologies in brief. (6)

(c) Water has to be pumped from an elevation of 25 ft to an elevation of 40 ft. The pump is located at an elevation of 32 ft. The pipe has total length of 1200 ft (supply main, 200 ft and distribution main, 1000 ft), diameter = 10 inches and friction faction = 0.01. Pump characteristics curve has to be plotted using the following data of flow versus head.

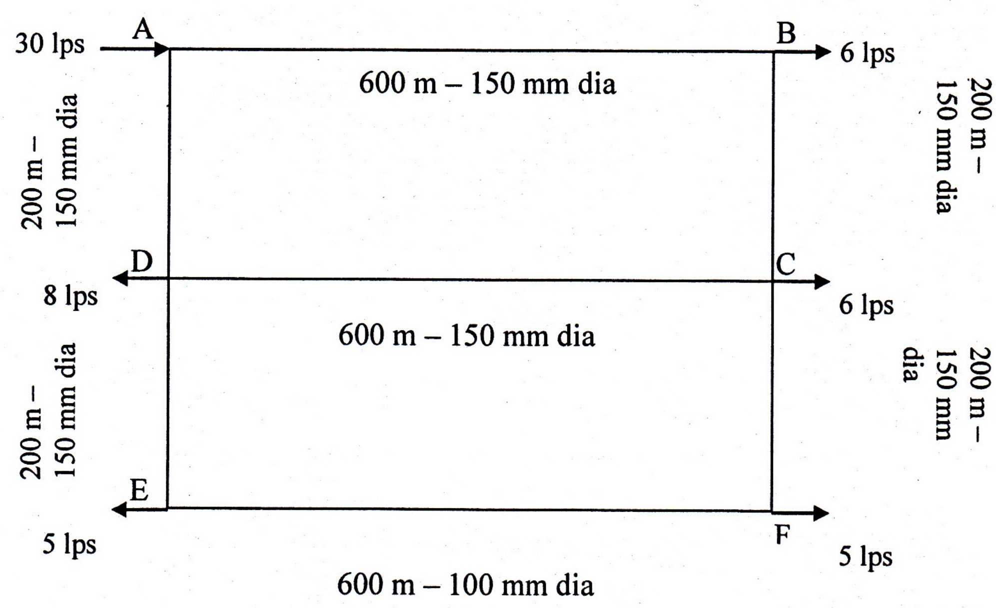
Q, gpm	0	1000	2000	3000	4000	5000
H, ft	75	72	70	60	50	0

Find out the discharge of water in the system. [Assume: pipe entrance is well rounded i.e. r/D>0.2, $K_{entrance} = 0.03$, $K_{bend} = 0.35$, $K_{exit} = 1$] (10)

5. (a) What are the main principles behind the design procedure of looped network? (3)

(b) What is a storage reservoir and why is it required in the distribution system? (4)

(c) Calculate the flow in each of the pipes in the following looped pipe network (using Hardy Cross method and two trials are required): (13)



6. (a) What is the function of blank pipe at the bottom of the strainer ? (4)

(b) Design the appropriate details of a well following the given steps and according to the data provided below: (4 X 4 =16)

Sample Depth (ft)	D_{10}	D_{30}	D_{60}	U = D_{60} / D_{10}	FM	% Course Sand	% Medium Sand	% Fine Sand
170-210	0.12	0.195	0.3	2.50	1.26	3	67	30
210-220	0.15	0.21	0.33	2.20	1.41	4	70	26
220-270	0.17	0.28	0.3	1.76	1.63	6	77	17
270-310	0.17	0.28	0.31	1.82	1.69	11	72	17
310-370	0.17	0.24	0.38	2.24	1.5	5	75	20
370-410	0.17	0.29	0.395	2.32	1.63	5	80	15
410-430	0.15	0.22	0.37	2.47	1.47	5	71	24

i) Find out the water bearing/most productive part of the aquifer (depth range) from the given grain size distribution summary at different depths showing suitable reasoning.

ii) Find out the length of the casing pipe, considering static water level at 250 ft, drawdown of 15 ft with water level declination of 2.5 ft per year, design life of 30 years and a safe distance of 10 ft. Assume, 80% of the aquifer screening can be made and find out the length of the strainer.

iii) Find out the yield from the well, if 40 slot strainer is used with the diameter of 4.5 inches. (Assume, the minimum permissible velocity of 0.1 fps and factor of safety of 2.0). What is the yield per day from the well, if it pumps water for 10 hours per day?

iv) If the well has to serve a community with 55,000 people with water demand of 40 liter per capita per day, how many wells will be required to be installed?

v) Provide the well log in a schematic diagram. **(BONUS MARKS = 3)**

Useful Equations

$t_d = V/Q$

$v_o = Q/As$

$$P = 100\frac{v_s}{v_o}$$

$$G = \sqrt{\frac{P}{uV}}$$

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2014
Program: B.Sc. Engineering (Civil)

Course Title: Geotechnical Engineering I — Course Code: CE 341
Time: 3 hours — Full Marks: 100

Section A

There are 5 questions. Answer any 4 questions. **(4x13=52 marks)**

1. (a) Briefly discuss on the significance of particle size distribution curve in coarse grained soil classification according to unified soil classification system. 3
   (b) Derive the expression to calculate total flow-rate (per meter length) below the sheet pile wall, taking the advantage of flow-net. 5
   (c) Determine compression index, swelling index coefficient of compressibility, coefficient of volume compressibility and coefficient of consolidation for the following records. 5
   In a consolidation test, the pressure on a sample was increased from 150 to 300 kN/m^2. The void ratio after 100% consolidation under150 kN/m^2 was 0.945 and that under 300 kN/m^2 was 0.812. The coefficient of permeability was 25x10^{-6} mm/s.

2. (a) Identify differences between consolidation and compaction. 3
   (b) Derive the expression of settlement calculation for a clay soil, which was initially in normally consolidated state. 5
   (c) Briefly discuss on the drainage conditions of three types of triaxial tests. 3
   (d) Draw a typical Mohr circle presenting the data of unconfined compressive strength test. Show the relation between unconfined compressive strength and unconfined cohesion. 2

3. (a) Identify differences between standard Proctor test and modified Proctor test. 3
   (b) Derive the expression of coefficient of passive earth pressure (K_p) for cohesionless soil. 5
   (c) Draw typical shear stress vs shear displacement curve for loose and dense sand. 2
   (d) Draw Mohr circles for at-rest, active and passive earth pressure conditions, and also the Mohr-Coulomb failure envelope. 3

4. (a) Estimate the energy delivered in standard proctor test. 3
   (b) Compute OCR and pre-consolidation pressure at point A in the following timeline. The following data presents the stress-states of that points. 5
   (a) In the year 2007, the soil, supporting a structure, was normally consolidated. $\sigma_{present}' = 450$ kPa.
   (b) In 2010, the old structure was demolished. $\sigma_{present}' = 150$ kPa.
   (c) In January 2011, new construction commenced. $\sigma_{present}' = 240$ kPa.
   (d) In 2014, due to progress of the construction project, $\sigma_{present}' = 480$ kPa.
   (c) Calculate the maximum dry density of the soil having 2.13 g/cm^3 bulk density at optimum moisture content. From a laboratory compaction test on a sample of the soil, the optimum moisture content is found to be 14.28%. 5
   Also calculate the dry density at optimum moisture content for zero air void condition.

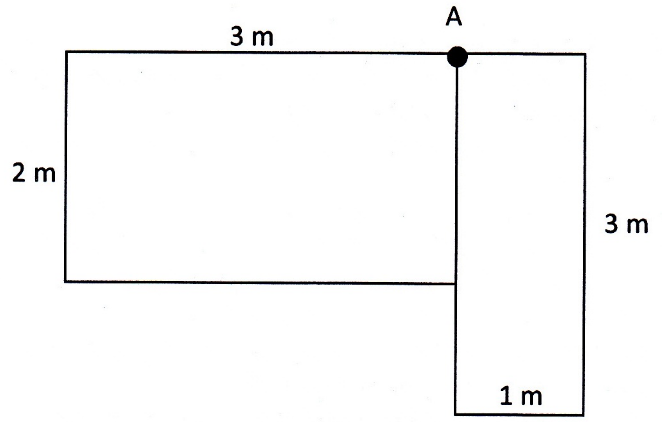
5. (a) Define 'Relative Density'. Derive the expression to calculate field relative density. 3
(b) Write Bernoulli's equation and Darcy's law for a soil media. 2
(c) Derive the expression of coefficient of permeability for fine grained soil. Mention the name of the permeameter used in the laboratory for this purpose. 3
(d) Briefly discuss on the following for fine grained soil: 5
(i) Index properties
(ii) Soil structure

Section B

There are seven questions. Answer any 6 questions. **(6x8 = 48 marks)**

6. A concrete gravity dam, 150 m long and 90 m wide, lies on a permeable soil with a coefficient of permeability of 30×10^{-3} mm/s. The head of water is maintained at 30 mm upstream and zero at the tail-end. The soil is underlain by an impervious stratum. 8
A flownet is constructed for this condition which yielded 8 flow lines and 16 equipotential drops.
(i) Calculate the seepage loss per day (flow rate) under the dam, considering a two-dimensional flow.
(ii) Plot the distribution of the uplift pressure on the base of the dam.

7. A total load of 900 kN is uniformly distributed over a rectangular footing of size 2m x 3m. Find the vertical stress at a depth of 2.5 m below the point A. If another footing size 1m x 3m with a total load of 450 kN is constructed adjoining the previous footing, what is the additional vertical stress at the same point below A due to the construction of the second footing. 8
Influence chart for vertical stress below corner of rectangular load is attached.



For m=1.2

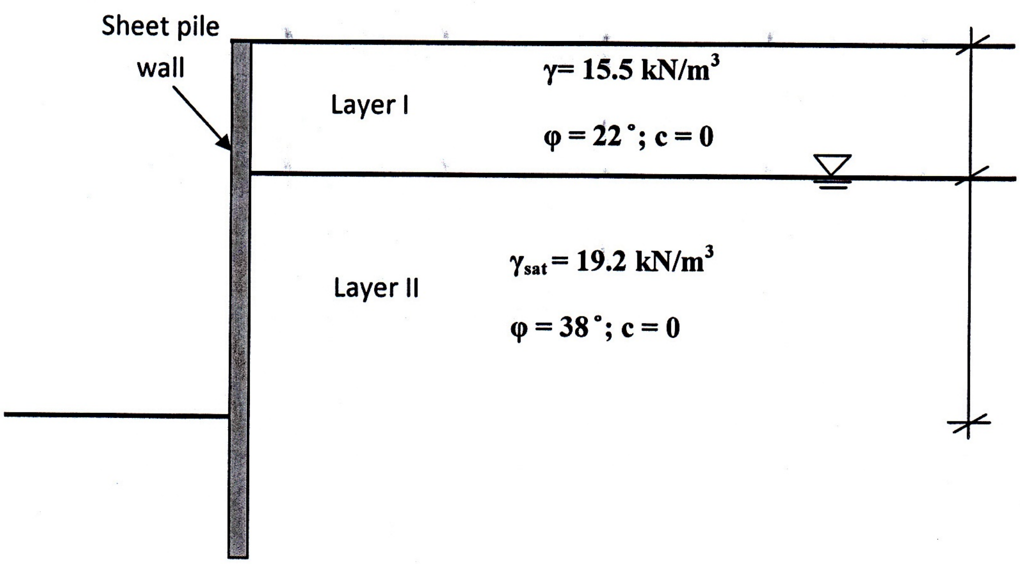
n	0.2	0.3	0.4	0.5	0.6	0.7	0.8
Influence factor, I	0.05733	0.083	0.106	0.126	0.143	0.157	0.168

8. Classify the following soils:

(a) Percent finer than 0.075 mm = 52 4
Percent of coarse fraction passing 4.75 mm sieve = 62
Liquid limit = 35%
Plastic limit = 25%

(b) Percent of soil material in the pan = 3.5 4
Percent of coarse fraction passing 4.75 mm sieve = 60
30% of the total soil material having a diameter less than 1.18 mm
10% of the total soil material having a diameter less than 0.3 mm
Liquid limit = 33%
Plastic limit = 33%

9. Draw the lateral earth pressure diagrams for both the active and passive conditions for the following backfill soil. 8



10. A 6 m thick saturated clay layer has a compression index of 0.28. At a stress of 120 kN/m^2 the void ratio was 1.02. Calculate the void ratio if the stress on soil is increased to 180 kN/m^2. Also calculate the primary consolidation settlement for each of the following cases: 8

(i) Pre-consolidation pressure= 120 kN/m^2
(ii) Pre-consolidation pressure= 220 kN/m^2
(iii) Pre-consolidation pressure= 150 kN/m^2

11. If the shear box is 60 mm square and the proving ring constant is 20 N per division, estimate the shear strength parameters of the soil. 8
Would failure occur on a plane within this soil at a point where the normal stress is 320

kN/m^2 and the corresponding shear stress is 138 kN/m^2?

The following results were obtained from a direct shear test on a sandy clay sample:

Normal load (N)	**Shear load proving ring reading (division)**
360	13
720	19
1080	26
1440	26

12. Triaxial compression tests were conducted on a specimen. All tests were run slowly, permitting complete drainage. 8
Determine shear strength parameters for the given soil.

Deviator stress at failure (kN/m^2)	**Confining pressure (kN/m^2)**
331	481
155	231
133	131
119	53

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2014
Program: B.Sc. Engineering (Civil)

Course Title: Open Channel flow — Course Code: CE 361
Time: 3 Hours — Full Marks: 150

All notations are having usual meaning. Assume any reasonable data, if not given

Section A

Answer any 3 (Three) out of 4 (Four) questions

1. (a) What do you mean by uniform flow? What are the conditions imply for uniform flow? (05)

   (b) Write down the relationship between Chezy's C, Darcy-Weisbach friction factor f and Manning's n. (05)

   (c) A circular channel 2 m in diameter is laid on a slope of 0.001 and carries a discharge of 4 m^3/s. Compute the normal depth and velocity when n= 0.013. (15)

2. (a) What do you mean by best hydraulic section? Compare between the non-silting and the non-scouring velocity. (09)

   (b) Design a stable alluvial channel using the Lacey's theory. The channel is to carry 10 m^3/s and having mean sediment size 1 mm. (16)

3. (a) What is hydraulic jump? Describe the types of jump occurs in open channel flow. (09)

   (b) A hydraulic jump occurred in a horizontal rectangular channel of 6 m wide and 0.52 m depth. The length of the jump is found 29.56 m. Determine (16)
      i. Type of jump
      ii. Efficiency of the jump
      iii. Relative height of the jump

4. (a) Write short notes on laminar viscous sublayer and section factor of a channel (06)

   (b) Prove that in a critical flow Froude number is equal to unity. (06)

   (c) What is shear stress? Derive an expression of drag velocity of a channel. (13)

Section B

Answer any 3 (Three) out of 4 (Four) questions

5. (a) Write some factors affecting Manning's n. (05)

   (b) Water flows in open channel at a depth of 1 m and a mean velocity of 3 m/s. Compute the discharge and determine the state of flow if the channel is (20)
   i. Wide
   ii. Triangular with s=2
   If elementary waves are created in these channels, determine the speeds of the wave fronts upstream and downstream.

6. (a) Write short notes on Momentum equation. (05)

   (b) Write down the practical applications of hydraulic jump. (05)

   (c) For a trapezoidal channel with b=6m and s=2, compute the critical depth by the Newton-Raphson method if Q=14 m^3/s and $\alpha=1$. (15)

7. (a) Prove that conveyance computed by Manning equation for triangular section is 5.33. (05)

   (b) Show that best hydraulic rectangular section is one half of a square. (05)

   (c) Compute the hydraulic exponent for uniform flow computation N of a trapezoidal channel with b=6.1 m, s=2 and h=2 m based on the Chezy's formula. (15)

8. (a) Write short notes on Jumps in sloping channel with classifications. (09)

   (b) A rectangular channel is 1 m wide and inclined at an angle of 3.5° with the horizontal. Determine the type of jump when the discharge is 0.15 m^3/s, the initial depth of flow section is 0.02 m and the tail water depth is found 0.70m. Also compute the energy loss in the jump if the length of the jump is 2 m. (16)