3-1

University of Asia Pacific
Department of Civil Engineering
Final Examination: Fall 2015
Program: B.Sc. Engg. (3rd year 1st Semester)

Course Title: Principles of Accounting **Course : ACN 301**
Time : 2 hrs. **Full marks : 50**

(Answer any four from the followings)

Q.1. . The following data were taken from the records of Directpro Engineers Ltd. for the year ended December 31, 2015.

Raw Material, 1/1/15	$90,000	Factory Insurance	$40,000
Raw Material, 31/12/15	60,000	Factory -Depreciation	162,000
Finished Goods, 1/1/15	260,000	Raw material purchases	750,000
Finished Goods, 31/12/15	210,000	Administrative Expense	270,000
Work in process, 1/1/15	180,000	Sales	2,500,000
Work in process, 31/12/15	100,000	Utilities, Factory	36,000
Direct labor	150,000	Supplies, Factory	15,000
Indirect labor	300,000	Maintenance, Factory	87,000
Selling Expenses	140,000		

Cost of Goods Manufactured is 1,650,000.

INSTRUCTION:
Prepare a cost of goods sold schedule and an income statement for Directpro Engineers Ltd. for the year ended, December 31, 2015. **(12.5)**

Q.2.a. Wales Company is considering two different, mutually exclusive capital expenditure proposals. Project A will cost $395,000, has an expected useful life of 10 years, a salvage value of zero, and is expected to increase net annual cash flows by $70,000. Project B will cost $270,000, has an expected useful life of 10 years, a salvage value of zero, and is expected to increase net annual cash flows by $50,000. A discount rate of 9% is appropriate for both projects. Compute the net present value of each project. Which project should be accepted? **(6.5)**

Q.2.b. Nakheel Construction Company is under contract to build a shopping mall at a contract price of $8,000,000. The building will take 18 months to complete at an estimated cost of $6,800,000. Construction began in November 2011, and was finished in April 2013. Actual construction costs incurred in each year were: 2011, $1,360,000; 2012, $4,080,000; and 2013, $1,360,000.

INSTRUCTION:
Compute the gross profit to be recognized in each year keeping in mind revenue recognition and matching principles. **(6.0)**

Q.3. San Antonio Inc. provides engineering design service for local market. For the first 6 months of 2011, the company reported the following operating results while operating at 90% of capacity.

	Amount	Per Sqft.
Sales (90,000sqft)	$4,500,000	$50
Cost of Goods Sold	$3,600,000	$40
Gross Profit	$ 900,000	
Operating Expense	$ 360,000	
Net Profit	$ 540,000	

Fixed costs for the period were: Cost of goods sold $ 900,000 and selling and administrative expenses $225,000. In July, normally a slack manufacturing month due to political instability, San Antonio receives a special order to design for 6,000 sqft at $35 each from a Nepalese architectural firm. Acceptance of the order would increase $3000 additional variable selling and administrative expenses, but would not increase fixed costs and expenses.

INSTRUCTIONS:

a. Prepare an incremental analysis for the special order.
b. Should San Antonio Inc. accept the special order? **(10+2.5)**

Q.4. DDC Ltd. supervises construction of an extension to a residential building. The standard cost per unit of per square feet is as follows:

Direct materials 1 pounds at $7.00 per pound	$7.00
Direct labor 1.5 hours at $12.00 per hour	18.00
Variable manufacturing overhead	11.25
Fixed manufacturing overhead	3.75
Total standard cost per unit	$40.00

Actual costs for November in producing 4,900 square feet were as follows:

Direct materials (5,100 pounds)	$ 37,230
Direct labor (7,000 hours)	87,500
Variable overhead	56,170
Fixed overhead	19,680
Total manufacturing costs	$200,580

INSTRUCTIONS:

A. Compute the followings and make comments:
- Material price variance, where MPV= AQ(AP-SP)
- Material quantity variance, where MQV= SP(AQ-SQ)
- Labor price variance, where LPV= AH(AR-SR)
- Labor quantity variance, where LQV=SR(AH-SH)

B. Comment on the reasons behind unfavorable variance, if any. **(12.5)**

Q.5. Kathleen Jo is the advertising manager for Arup Real Estate Ltd.. She is currently working on a major promotional campaign for newly built commercial spaces. Her ideas include the installation of a new lighting system and increased display space that will add $24,000 in fixed costs to the $210,000 currently spent. In addition, Kathleen is proposing that a 6.67% price decrease (from $30 to $28) will produce an increase in sales volume from 16,000 to 20,000 sqft. Variable costs will remain at $15 per sqft.

Management is impressed with Kathleen's ideas but concerned about the effects that these changes will have on the break-even point and the margin of safety.

INSTRUCTIONS:

A. Compute the current break-even point in units (sqft), and compare it to the break-even point in units if Kathleen's ideas are used.

B. Compute the margin of safety ratio for current operations and after Kathleen's changes are introduced. (Round to nearest full percent.)

C. Prepare a CVP income statement for current operations and after Kathleen's changes are introduced. Would you make the changes suggested? **(4+4+4.5)**

Q.6. CASE STUDY:

Evaluate the performance of Eastern Housing Limited for the year 2014 and 2013 through ratio analysis. Use the financial data attached with the question paper. The performance should be evaluated in terms of the following ratios (Please make comments on your evaluation for each ratio) :

A. Current Ratio
B. Quick Ratio
C. Asset Turnover (Note that total assets of 2012 was 16,585,460,371)
D. Profit Margin
E. Debt to Total Assets Ratio **(10+2.5)**

eastern housing limited

Statement of Financial Position

Eastern Housing Limited
Statement of Financial Position
As at 31 July 2014

		Amount in taka	
		As at 31 July	
ASSETS	**Notes**	**2014**	**2013**
Non-current assets			
Property, plant and equipment	04	4,697,000,944	152,693,260
Deferred tax assets	05	5,413,516	3,758,236
		4,702,414,460	156,451,496
Current assets			
Inventories	06	16,640,124,159	15,746,055,177
Advance, deposits and prepayments	07	1,551,217,228	1,834,050,300
Interest receivable	08	12,950,719	12,622,672
Deposit into Bangladesh Bank under duress	09	350,000,000	350,000,000
Investments	10	166,675,499	152,300,730
Cash and cash equivalents	11	69,749,095	39,932,279
		18,790,716,700	18,134,961,158
TOTAL ASSETS		**23,493,131,160**	**18,291,412,654**
EQUITY AND LIABILITIES			
Equity attributable to owners of the company			
Share capital	12	806,350,540	716,756,040
General reserve		274,500,000	254,500,000
Dividend equalization reserve		145,000,000	125,000,000
Revaluation reserve		4,197,058,496	-
Retained earnings	13	437,501,160	390,127,723
		5,860,410,196	1,486,383,763
Liabilities			
Non-current liabilities			
Long term loan - secured	14	-	15,962,574
Sponsors' loan	15	202,500,000	202,500,000
		202,500,000	218,462,574
Current liabilities			
Long term loan - secured - current maturity	16	29,909,998	151,340,940
Lease - current maturity	17	-	10,388,984
Bank overdraft	18	1,974,686,412	860,854,321
Advance received against allotment	19	11,161,171,497	11,359,050,106
Creditors	20	4,250,422,958	4,190,251,180
Provision for taxation	21	14,030,099	14,680,786
		17,430,220,964	16,586,566,317
Total liabilities		17,632,720,964	16,805,028,891
TOTAL EQUITY AND LIABILITIES		**23,493,131,160**	**18,291,412,654**

FOOTNOTES:
1. Auditors' Report - Page 1.
2. The accompanying notes form an integral part of these financial statements.

Md. Saiful Huda Anaholy	**Dhiraj Malakar**	**Md. Abdul Wadud**	**Manzurul Islam**
Company Secretary	Managing Director	Director	Chairman

A. Qasem & Co.
Chartered Accountants

Dated: Dhaka
21 September 2014

Statement of Comprehensive Income

Eastern Housing Limited
Statement of Comprehensive Income
For the year ended 31 July 2014

	Notes	2014	2013
		Amount in taka	
		For the year ended 31 July	
Revenue	22	2,333,019,487	2,028,721,932
Cost of sales	23	(1,529,674,755)	(1,344,760,717)
Gross profit		803,344,732	683,961,215
Other income	24	17,723,530	11,726,555
Administrative expenses	25	(263,624,477)	(256,660,618)
Operating profit		557,443,785	439,027,152
Finance income	26	20,988,562	46,747,035
Finance charges	27	(213,965,389)	(159,934,566)
		364,466,958	325,839,621
Workers' profit participation fund	28	(18,223,348)	-
Profit before income tax		346,243,610	325,839,621
Income tax expenses	29		
Current tax		(99,255,349)	(99,702,158)
Deferred tax		1,655,280	559,066
		(97,600,069)	(99,143,092)
Profit for the Year		248,643,541	226,696,529
Other comprehensive income		4,197,058,496	-
Total comprehensive income/(loss) for the year		**4,445,702,037**	**226,696,529**
Total comprehensive income attributable to owners of the company		**4,445,702,037**	**226,696,529**
Earnings per share : Basic	30	**3.08**	**2.81**

FOOTNOTES:
1. Auditors' Report - Page 1.
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Company Secretary

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21 September 2014

TABLE 2 Present Value of $1

$$PV = \frac{\$1}{(1+i)^n}$$

n/i	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%	5.5%	6.0%	7.0%	8.0%	9.0%	10.0%	11.0%	12.0%	20.0%
1	0.99010	0.98522	0.98039	0.97561	0.97087	0.96618	0.96154	0.95694	0.95238	0.94787	0.94340	0.93458	0.92593	0.91743	0.90909	0.90090	0.89286	0.83333
2	0.98030	0.97066	0.96117	0.95181	0.94260	0.93351	0.92456	0.91573	0.90703	0.89845	0.89000	0.87344	0.85734	0.84168	0.82645	0.81162	0.79719	0.69444
3	0.97059	0.95632	0.94232	0.92860	0.91514	0.90194	0.88900	0.87630	0.86384	0.85161	0.83962	0.81630	0.79383	0.77218	0.75131	0.73119	0.71178	0.57870
4	0.96098	0.94218	0.92385	0.90595	0.88849	0.87144	0.85480	0.83856	0.82270	0.80722	0.79209	0.76290	0.73503	0.70843	0.68301	0.65873	0.63552	0.48225
5	0.95147	0.92826	0.90573	0.88385	0.86261	0.84197	0.82193	0.80245	0.78353	0.76513	0.74726	0.71299	0.68058	0.64993	0.62092	0.59345	0.56743	0.40188
6	0.94205	0.91454	0.88797	0.86230	0.83748	0.81350	0.79031	0.76790	0.74622	0.72525	0.70496	0.66634	0.63017	0.59627	0.56447	0.53464	0.50663	0.33490
7	0.93272	0.90103	0.87056	0.84127	0.81309	0.78599	0.75992	0.73483	0.71068	0.68744	0.66506	0.62275	0.58349	0.54703	0.51316	0.48166	0.45235	0.27908
8	0.92348	0.88771	0.85349	0.82075	0.78941	0.75941	0.73069	0.70319	0.67684	0.65160	0.62741	0.58201	0.54027	0.50187	0.46651	0.43393	0.40388	0.23257
9	0.91434	0.87459	0.83676	0.80073	0.76642	0.73373	0.70259	0.67290	0.64461	0.61763	0.59190	0.54393	0.50025	0.46043	0.42410	0.39092	0.36061	0.19381
10	0.90529	0.86167	0.82035	0.78120	0.74409	0.70892	0.67556	0.64393	0.61391	0.58543	0.55839	0.50835	0.46319	0.42241	0.38554	0.35218	0.32197	0.16151
11	0.89632	0.84893	0.80426	0.76214	0.72242	0.68495	0.64958	0.61620	0.58468	0.55491	0.52679	0.47509	0.42888	0.38753	0.35049	0.31728	0.28748	0.13459
12	0.88745	0.83639	0.78849	0.74356	0.70138	0.66178	0.62460	0.58966	0.55684	0.52598	0.49697	0.44401	0.39711	0.35553	0.31863	0.28584	0.25668	0.11216
13	0.87866	0.82403	0.77303	0.72542	0.68095	0.63940	0.60057	0.56427	0.53032	0.49856	0.46884	0.41496	0.36770	0.32618	0.28966	0.25751	0.22917	0.09346
14	0.86996	0.81185	0.75788	0.70773	0.66112	0.61778	0.57748	0.53997	0.50507	0.47257	0.44230	0.38782	0.34046	0.29925	0.26333	0.23199	0.20462	0.07789
15	0.86135	0.79985	0.74301	0.69047	0.64186	0.59689	0.55526	0.51672	0.48102	0.44793	0.41727	0.36245	0.31524	0.27454	0.23939	0.20900	0.18270	0.06491
16	0.85282	0.78803	0.72845	0.67362	0.62317	0.57671	0.53391	0.49447	0.45811	0.42458	0.39365	0.33873	0.29189	0.25187	0.21763	0.18829	0.16312	0.05409
17	0.84438	0.77639	0.71416	0.65720	0.60502	0.55720	0.51337	0.47318	0.43630	0.40245	0.37136	0.31657	0.27027	0.23107	0.19784	0.16963	0.14564	0.04507
18	0.83602	0.76491	0.70016	0.64117	0.58739	0.53836	0.49363	0.45280	0.41552	0.38147	0.35034	0.29586	0.25025	0.21199	0.17986	0.15282	0.13004	0.03756
19	0.82774	0.75361	0.68643	0.62553	0.57029	0.52016	0.47464	0.43330	0.39573	0.36158	0.33051	0.27651	0.23171	0.19449	0.16351	0.13768	0.11611	0.03130
20	0.81954	0.74247	0.67297	0.61027	0.55368	0.50257	0.45639	0.41464	0.37689	0.34273	0.31180	0.25842	0.21455	0.17843	0.14864	0.12403	0.10367	0.02608
21	0.81143	0.73150	0.65978	0.59539	0.53755	0.48557	0.43883	0.39679	0.35894	0.32486	0.29416	0.24151	0.19866	0.16370	0.13513	0.11174	0.09256	0.02174
24	0.78757	0.69954	0.62172	0.55288	0.49193	0.43796	0.39012	0.34770	0.31007	0.27666	0.24698	0.19715	0.15770	0.12640	0.10153	0.08170	0.06588	0.01258
25	0.77977	0.68921	0.60953	0.53939	0.47761	0.42315	0.37512	0.33273	0.29530	0.26223	0.23300	0.18425	0.14602	0.11597	0.09230	0.07361	0.05882	0.01048
28	0.75684	0.65910	0.57437	0.50088	0.43708	0.38165	0.33348	0.29157	0.25509	0.22332	0.19563	0.15040	0.11591	0.08955	0.06934	0.05382	0.04187	0.00607
29	0.74934	0.64936	0.56311	0.48866	0.42435	0.36875	0.32065	0.27902	0.24295	0.21168	0.18456	0.14056	0.10733	0.08215	0.06304	0.04849	0.03738	0.00506
30	0.74192	0.63976	0.55207	0.47674	0.41199	0.35628	0.30832	0.26700	0.23138	0.20064	0.17411	0.13137	0.09938	0.07537	0.05731	0.04368	0.03338	0.00421
31	0.73458	0.63031	0.54125	0.46511	0.39999	0.34423	0.29646	0.25550	0.22036	0.19018	0.16425	0.12277	0.09202	0.06915	0.05210	0.03935	0.02980	0.00351
40	0.67165	0.55126	0.45289	0.37243	0.30656	0.25257	0.20829	0.17193	0.14205	0.11746	0.09722	0.06678	0.04603	0.03184	0.02209	0.01538	0.01075	0.00068

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

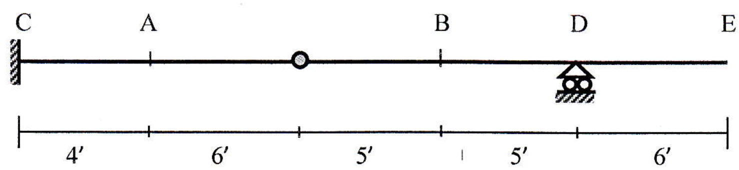
Course Title: Structural Analysis & Design I — Course Code: CE 311(A)
Time: 3.00 Hours — Full Marks: 100 (=10×10)

*****Answer Part I and Part II on separate answer scripts*****

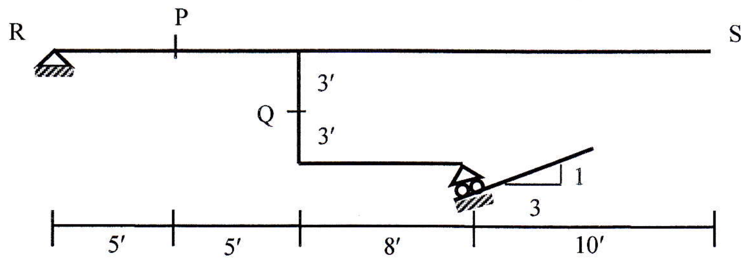
Part I

*There are **six (06)** questions in this part. Answer any **four (04)**.*
Assume any missing data reasonably.

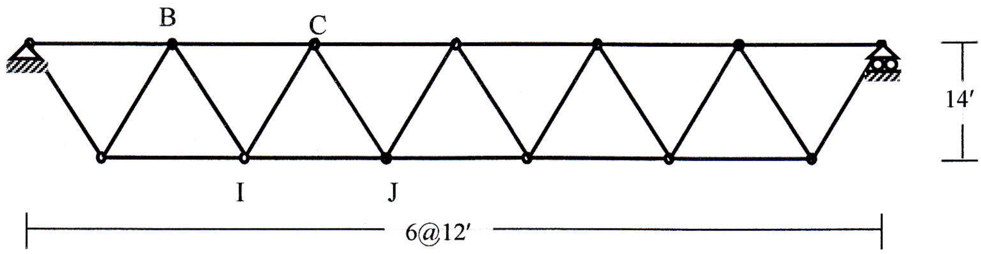
1. Draw influence lines for [10]
(a) Bending moment at A
(b) Bending moment at B
(c) Shear force at A
(d) Shear force at B
(e) Vertical reaction at D
for the beam shown below



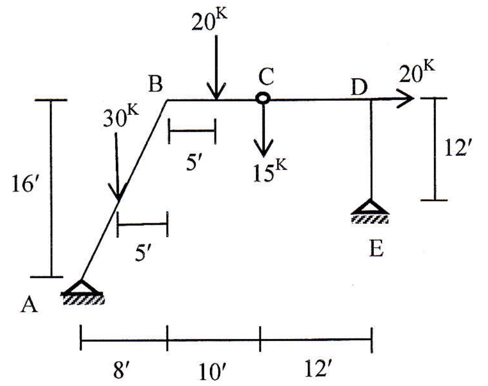
2. For the frame shown below draw influence lines for M_P and M_Q if the unit load moves over beam RS. [10]



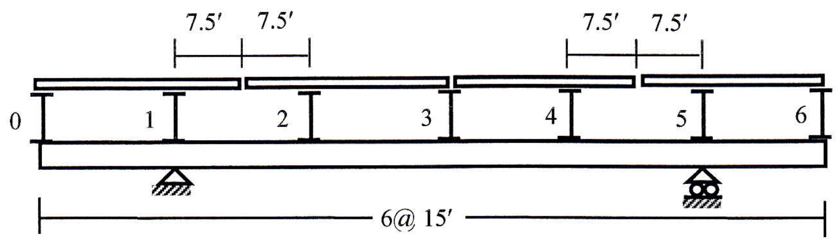
3. For the truss shown below, draw the influence lines for bar forces in member IJ, CI and BC [Load moves over the top cord]. [10]



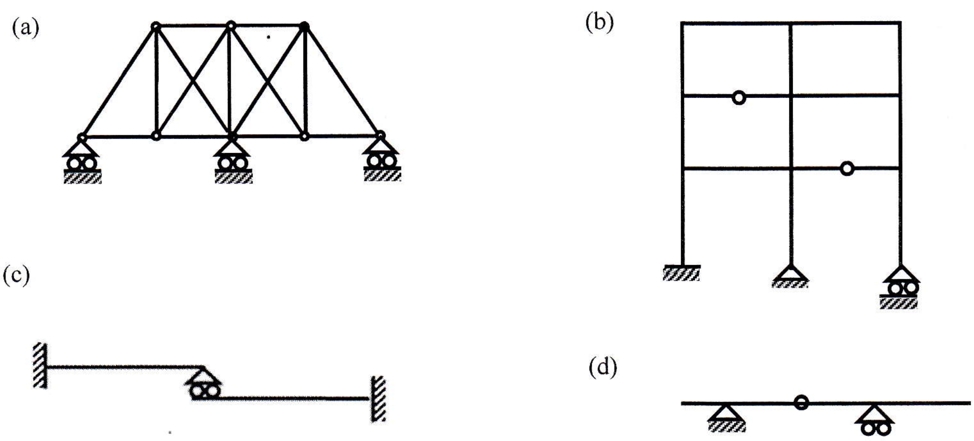
4. Draw the shear force and bending moment diagrams for the frame shown in figure below. C is an internal hinge. [10]



5. Draw influence lines for shear in panel 1-2, moment at panel point 3 of the girder with floor beam system shown in figure below. [10]



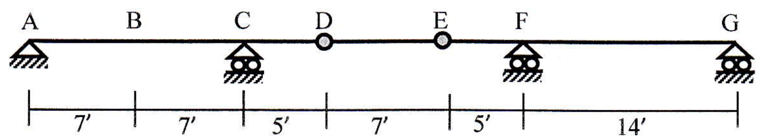
6. Determine whether the following structures are statically and geometrically stable or unstable and also calculate degree of static indeterminacy of each structure. [10]



Part II

*There are **nine (09)** questions in this part. Answer any **six (06)**.*
Assume any missing data reasonably.

7. (a) A car moves over a balanced cantilever bridge shown below. The car produces a loading effect which is equivalent to a point load of 500 kg. Determine maximum reaction at F and maximum moment at B due to the car movement over the bridge. Given: self- weight of the bridge is 20 kg/ft. [10]

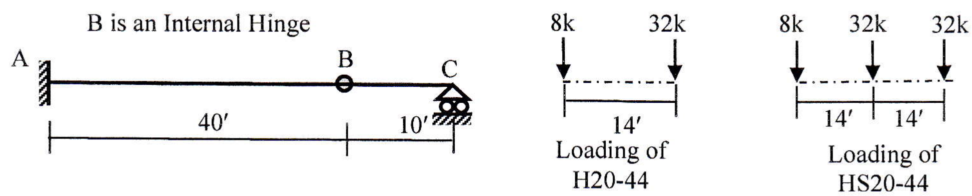


(b) What will be maximum shear force at C (V_{CL}) of the balanced cantilever bridge for a uniformly distributed live load of 50 kg/ft?

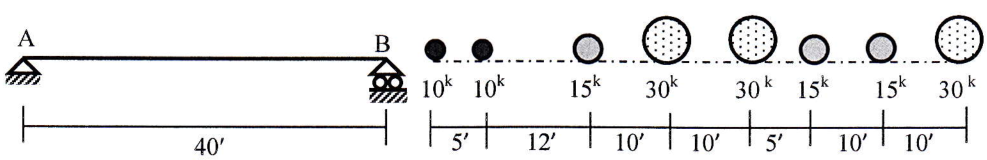
8. The loading effect of H20-44 truck and HS20-44 truck are shown below. Determine [10]

(a) Maximum reaction at A due to H20-44 truck movement from A to B.

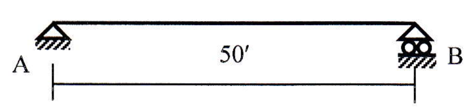
(b) Maximum moment at A due to HS20-44 truck movement from A to C.



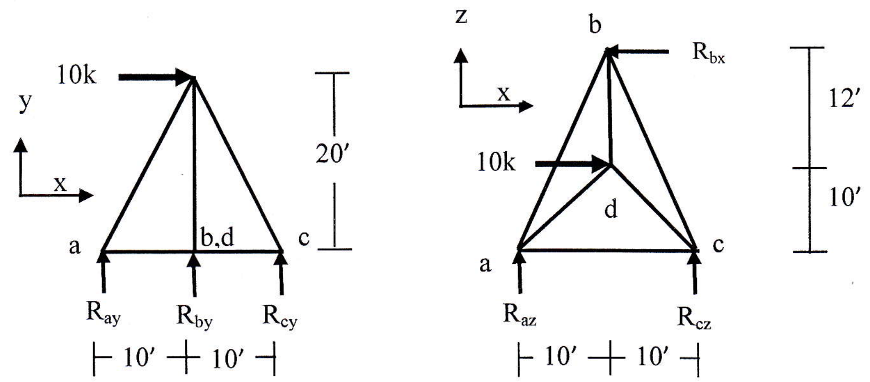
9. Calculate the maximum value of R_A for the wheel load arrangement shown below. [10]



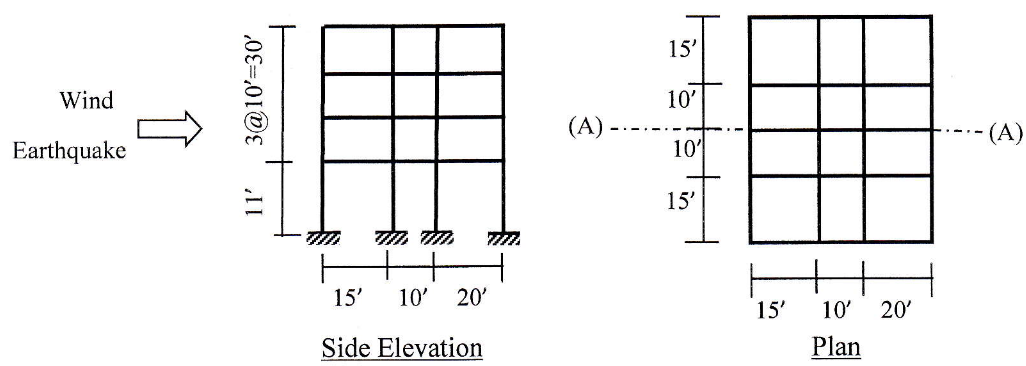
10. Calculate the maximum shear at 15′ right of support A for the following beam and the wheel load arrangement shown in Question 9. [10]



11. Determine the support reactions and bar forces F_{ad} , F_{bd} , F_{cd} of the space truss loaded as shown below. [10]

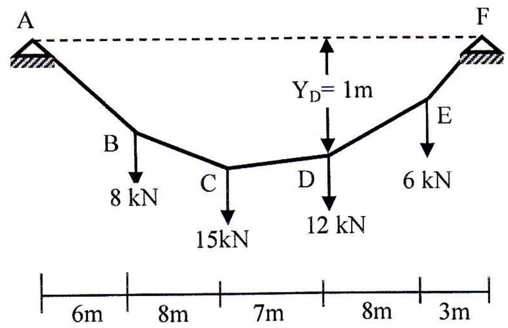


12. Calculate the wind load at each storey of a four-storied concrete made industrial building (shown below) located at a flat terrain in Dhaka (Basic wind speed = 130 mph). Assume the structure to be subjected to Exposure A. [10]

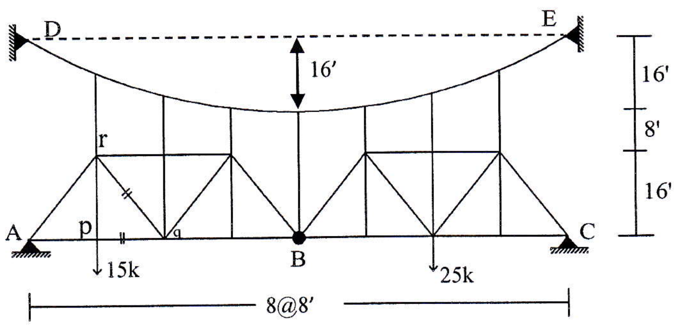


13. Calculate the seismic load at frame A of a four-storied concrete made residential building located in Dhaka (Zone 2). Assume the structure to be an Intermediate Moment Resisting Frame (IMRF) built on soil condition S_1, carrying a Dead Load of 100 lb/ft^2 and Live load of 40 lb/ft^2. Use the same figure for building plan and elevation as of *Question 12.* [10]

14. The cable shown below has supports at A and F that lie at the same elevation. Point D on the cable is 1m below the chord AF. Use the general cable theorem to calculate the sags at B, C and E. Also, calculate maximum cable tension. [10]



15. Calculate the force on each hanger and also determine the truss member force of *pq* and *rq* for the following cable suspension bridge. [10]



Annexure

Wind:

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

$p_z = C_G\, C_p\, q_z$

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

Earthquake:

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

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

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

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

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. $M_{(Max)} = (\sum P/L)\,(L/2 - a/2)^2 - P\, b$

Cable:

i. **General Cable theorem**
$H*y_m$ = Bending Moment of m at the corresponding simply supported beam

ii. **$T_{max} = H(1+16\theta^2)^{(1/2)}$**

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

Course Title: Design of Concrete Structures I | Course Code: **CE 315(A)**
Time: 3 hours | Full Marks: 70

*****Answer Part I and Part II on separate answer scripts*****

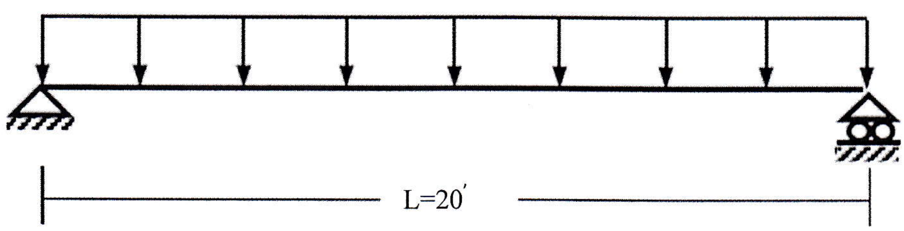
Part I

[Answer any **three** (03) out of following **four** (04) questions]
Full Marks: 30 [=3*(10)]
[Assume reasonable values for any missing data]

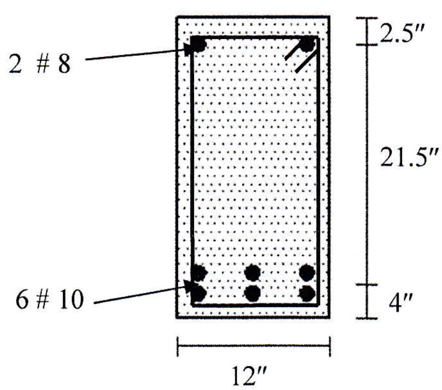
1. (a) Draw stress strain curves of steel and concrete. [2.5]
   (b) Calculate the stresses in concrete and steel of a column section when the section is subjected to an axial force of 100k if the column dimension is 12″x16″ and it contains 6#10 reinforcement bars [Given: $f_c' = 4$ ksi, $f_y = 60$ ksi]. [05]
   (c) What are the maximum and minimum steel ratios used in RC beams? Explain why they are used. [2.5]

2. Use WSD or USD Method to design the simply supported singly reinforced RC beam with working loads as shown in the figure below (for flexure only) [Given: $f_c' = 3$ ksi, $f_y = 60$ ksi, $f_{call} = 1.35$ ksi, $f_{sall} = 24$ ksi.] [10]

W_{DL}=1.2 k/ft (excluding self weight), W_{LL}=0.75 k/ft



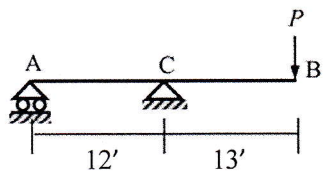
3. Check the adequacy of the beam section shown below to support a positive bending moment of 700 k-ft. Follow USD method [Given: $f_c' = 5$ ksi, $f_y = 50$ ksi]. [10]

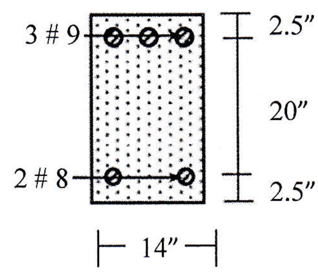


4. (a) Differentiate between USD and WSD method. [02]

(b) Calculate the maximum allowable value of the force P if Section C of the RC beam AB shown in the figure below is to remain uncracked. Neglect the self-weight of the section while calculating the bending moment. [08]

[Given: f_y = 60 ksi and f_c' = 3 ksi].





Part-II

[Answer any **four (04)** out of **Six** (06) questions]

Full Marks: 40 [=4*10]

[Assume reasonable values for any missing data]

5. (a) Explain why temperature and shrinkage reinforcements are required in slabs. (03)

(b) A rectangular beam is to be designed to carry shear force V_u of 45 kips. Given, f_c'= 4 ksi, f_y= 60 ksi and assuming effective beam depth is twice the size of beam width, determine the minimum cross-section of the beam according to ACI code provision- (07)

i. Considering **no web reinforcement.**

ii. With **minimum web reinforcement.**

6. (a) Explain why flexural reinforcement bars are not cut off exactly where they are not theoretically required. (03)

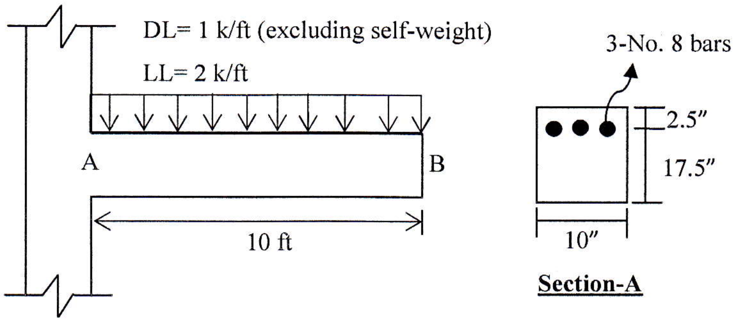
(b) Briefly compare between the development lengths of (04)

i. Bottom and top bars.

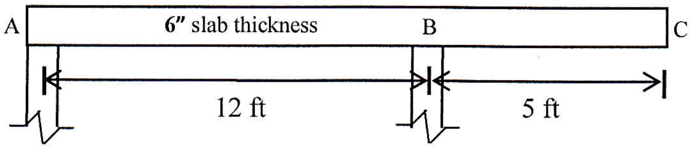
ii. Light weight and normal weight concrete.

(c) Explain when and why maximum shear force considered for design is computed at 'd' distance from support. (03)

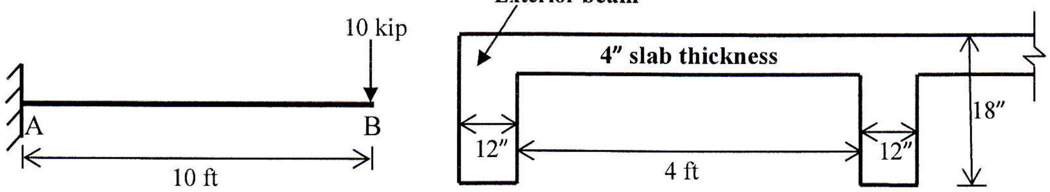
7. Using vertical U stirrup with f_c'= 4 ksi and f_y= 60 ksi, design the web reinforcement of the **beam AB** in the following figures according to **ACI-USD method**. (10)



8. A reinforced concrete slab ABC of **6″ thickness** consists of two spans as shown in the figure below. Service dead load is 50 psf (in addition to slab self-weight) and service live load is 150 psf. Design the one way slab following either WSD or USD method. [Given f_c'= 3 ksi, f_y= 60 ksi, f_{call}= 1.35 ksi, f_{sall}= 24 ksi] (10)

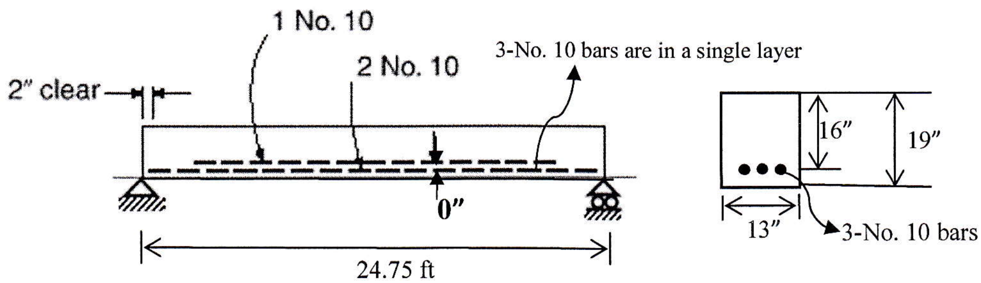


9. Use the WSD or USD method to design the **exterior beam AB** subjected to 10 kip dead load at B (in addition to slab self-weight, FF = 20 psf, PW = 50 psf, beam self-weight and LL = 30 psf). [Given, f_c'= 4 ksi, f_y= 60 ksi, f_{call}= 1.85 ksi, f_{sall}= 24 ksi] (10)



10. A simply supported beam of 24.75 ft span is to carry service dead load of 0.72 k/ft (including self-weight) and service live load of 1.08 k/ft. Reinforcement of the beam consists of **three No. 10** bars **(following USD method)** at 16 in. effective depth. Center bar is to be discontinued where no longer required. (10)

Calculate the point where center bar can be discontinued according to ACI code provision. Given, f'_c= 4 ksi, f_y= 60 ksi.



List of Useful Formulae for CE 315

Fundamentals

* Tensile strength of concrete $f_t' = 7.5\sqrt{f_c'}$ $E_s = 29 \times 10^6$ psi   Modular ratio, $n = E_s/E_c$
* Within elastic limit, Flexural stress $f_c = M\ y/\ I$
* Steel Ratio $\rho_s = A_s/bd$ Minimum Steel Ratio $\rho_{min} = 3\sqrt{f_c'}/f_y$, often taken as $= 200/f_y$

  $Ec = 57000\sqrt{f'c}$(psi)

WSD

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

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

  $M_2 = M - M_1$, $A_{s2} = M_2/[f_s (d-d')]$ and $A_s' = M_2/[f_s'(d-d')]$, where $f_s' = 2f_s(k - d'/d)/(1-k)$

USD

* $\alpha = 0.72 - 0.04\ (f_c' - 4)$, and $0.56 \le \alpha \le 0.72$, while $\beta = 0.425 - 0.025\ (f_c' - 4)$, and $0.325 \le \beta \le 0.425$

$$\rho_{max} = 0.85\beta_1 \frac{f_c'}{f_y} \frac{\epsilon_u}{\epsilon_u + 0.004} \qquad \rho_{max} = 0.85\beta_1 \frac{f_c'}{f_y} \frac{\epsilon_u}{\epsilon_u + 0.005}$$

* Design conditions: $M_u < \phi\ M_n$, $V_u < \phi\ V_n$, $P_u < \phi\ P_n$ [$\phi = 0.483 + 83.3\varepsilon_t$]

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

  $c = a/\beta_1$
* Doubly Reinforced Analysis:

  $a = A_{s1} f_y/(0.85 f_c'\ b)$ [where $A_{s1} = A_s - A_{s2}$, and can be taken as $= A_s - A_s'$ to begin with]

  $A_{s2} = A_s'\ f_s'/f_y$, where $f_s' = E_s \times \varepsilon_t$

  from which A_{s1} can be revised as $= A_s - A_{s2}$ and a can also be revised accordingly

  $M_n = A_{s1} f_y\ (d - a/2) + A_{s2} f_y\ (d - d')$
* Design: Singly Reinforced if $M_n = \rho f_y\ (1 - 0.59\ \rho f_y/f_c')\ bd^2$

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

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

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

  $c = A_{s1} f_y/(\alpha\ f_c'\ b)$ $c/d' = \varepsilon_c/(\varepsilon_c + \varepsilon_t)$ $A_s' = M_2/\{f_s'\ (d - d')\}$
* T-beam b_{eff} is the minimum of L/4, $(16t + b_w)$, and (c/c distance between adjacent beams)

  L-beam b_{eff} is the minimum of $(L/12 + b_w)$, $(6t + b_w)$, and (b_w + half the clear distance between adjacent beams)
* WSD Analysis: $k = \{n\rho_s + (t/d)^2/2\}/\{n\rho_s + (t/d)\}$ where ρ_s (= $A_s/b_{eff}d$) $z = (3kd - 2t)/(2kd - t)\ t/3$

  $M_s = A_s f_s\ (d - z)$ $M_c = f_c\ \{1 - t/(2kd)\}(b_{eff}t)\ (d - z)$

  Design can start with $A_s \cong M_s/\{f_s(d - t/2)\}$ and follow the same equations
* USD Analysis: $A_{sf} = 0.85 f_c'\ (b_{eff} - b_w)t / f_y$ $M_{nf} = A_{sf} f_y (d - t/2)$

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

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

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	$A_{tr} f_{tr}/(1.5Sn)$

$$l_d/d_b = (3/40)\ (f_y/\sqrt{f_c'})\ (\alpha\beta\gamma\lambda)/\{(c + K_{tr})/d_b\}$$

where the term $(c + K_{tr})/d_b$ is ≤ 2.5.

Simplified Equations for <u>Basic</u> Development Length (Tension)

Condition	$(c + K_{tr})/d_b$	l_d
Avoid pullout failure (Experimentally derived limit)	2.5	$0.03\ (f_y/\sqrt{f_c'})d_b$
* Clear cover and Clear spacing ≥ d_b + Code required stirrups * Clear cover and Clear spacing ≥ $2d_b$	1.5	$0.05\ (f_y/\sqrt{f_c'})d_b$ (≥ #7 Bars) $0.04\ (f_y/\sqrt{f_c'})d_b$ (≤ #6 Bars and deformed wires) (?)

Bar Diameter and area

d (No.)	2	3	4	5	6	7	8	9	10
A_s (in²)	0.05	0.11	0.20	0.31	0.44	0.60	0.79	1.00	1.27
d (mm)	8	10	12	16	19	22	25	28	31
A_s (in²)	0.08	0.12	0.18	0.31	0.44	0.59	0.76	0.95	1.17

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

$S = A_v\, f_v\, d\, (\sin\alpha + \cos\alpha)/(V_{ext} - V_c) = A_v\, f_v (\sin\alpha + \cos\alpha)/\{(v_{ext} - v_c)\, b\}$ for inclined stirrups

Summary of ACI Shear Design Provisions (Vertical Stirrups)

	WSD	USD	Additional Provisions
Design Shear Force	V_w	$V_n = V_u/\phi$ [$\phi = 0.75$]	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	$1.1\sqrt{f_c'}$	$2\sqrt{f'c}$	$\sqrt{f_c'} \le 100$ 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 $V_n \ge 4\sqrt{f_c'}b_w d$ OR $V_w \ge 2\sqrt{f_c'}b_w d$ in WSD

Temperature and shrinkage reinforcement

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

Minimum Thickness of One way Slab

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

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

Course Title: Design of Concrete Structures I — Course Code: **CE 315(B)**

Time: 3 hours — Full Marks: 70

*****Answer Part I and Part II on separate answer scripts*****

Part-I

[Answer any **three (03)** out **four** (04) questions]

Full Marks: 30 [=3*10]

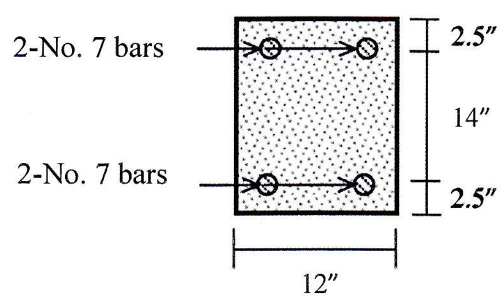
[Assume reasonable values for any missing data]

1. (a) What is a 'transformed' RC section? Show transformed section in sketch for cracked and uncracked section. (04)

   (b) i. Calculate the ultimate (nominal) axial compression and axial tensile force capacity of the RC section shown below. (06)

   ii. Calculate the stresses in concrete and steel when the section is subjected to one-tenth of its ultimate compressive and tensile load.

   [Given, f_c' = 4 ksi, f_y = 50 ksi]

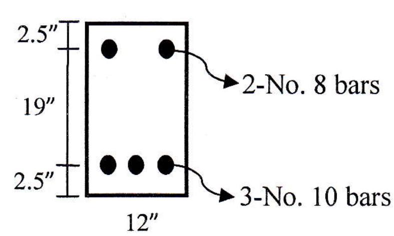


2. (a) A rectangular beam of 14″x30″ is reinforced with **four No.10** bars in two layers. Determine whether failure will be initiated by crushing of concrete or yielding of steel. [Given, f_c' = 4 ksi, f_y = 60 ksi] (03)

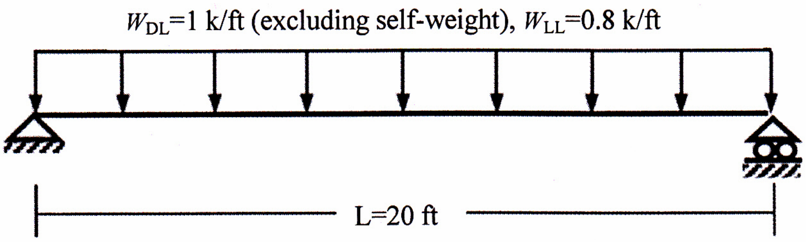
   (b) A rectangular beam of 12″x24″ is reinforced with **three No. 10** tension bars and **two No. 8** compression bars. Using USD or WSD method with f_y = 60 ksi and f_c' = 3 ksi (07)

   i. Check whether compression reinforcement increases beam's moment capacity

   ii. Determine the design moment capacity of the section.

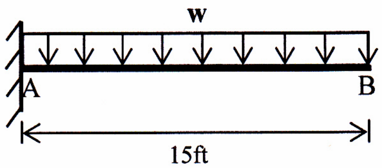


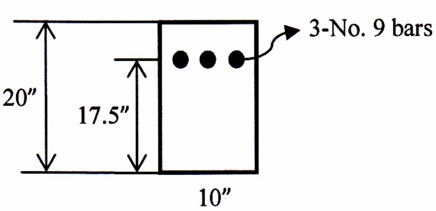
3. Use WSD or USD Method to design for flexure only the simply supported, singly reinforced rectangular RC beam with service loads as shown in the figure below. (10)
[Given $f_c' = 4$ ksi, $f_y = 50$ ksi, $f_c = 1.80$ ksi, $f_s = 20$ ksi]



4. (a) Why does the ACI recommend that in WSD, the value of compressive stress in steel (f'_s) be taken as twice the value calculated from elastic analysis? (04)

(b) Calculate the uniformly distributed load **(w)** that will produce first crack in the cantilever beam (AB) at **section A**. Consider self-weight of the beam. (06)
[Given $f_y = 60$ ksi and $f_c' = 3$ ksi]



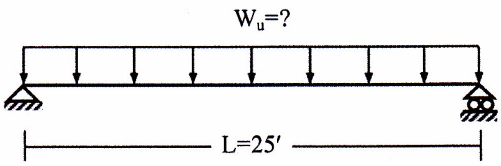


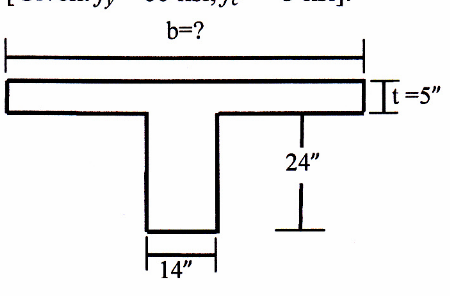
Section A

Part II

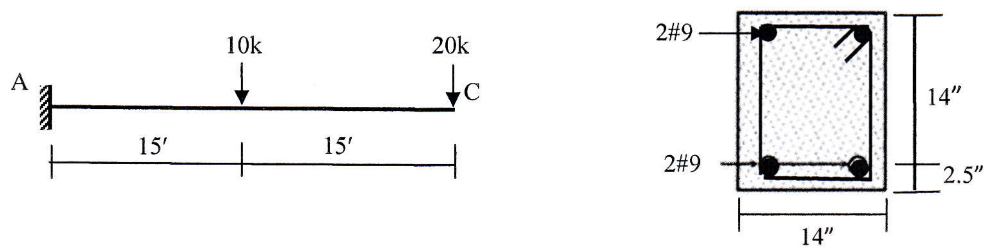
[Answer any **four** (04) out of following **Six** (06) questions]
Full Marks: 40 [=4*(10)]
[Assume reasonable values for any missing data]

5. Use the USD Method to design the simply supported T-beam shown below which carries FF = 30 psf, PW = 80 psf and LL = 40 psf in addition to its self-weight. Distance between two adjacent beams is 10′ c/c [Given: $f_y = 60$ ksi, $f_c' = 3$ ksi]. [10]



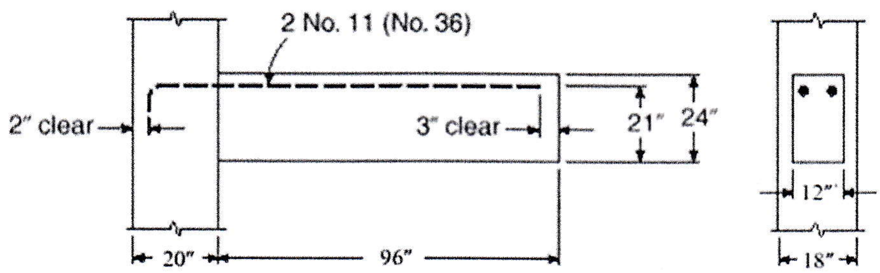


6. Design the web reinforcement for the beam shown below using USD/WSD method. Neglect self weight of the beam [Given: f_c' = 3 ksi, f_y = 60 ksi, f_{call} = 1.35 ksi, f_{sall}= 24 ksi]. [10]

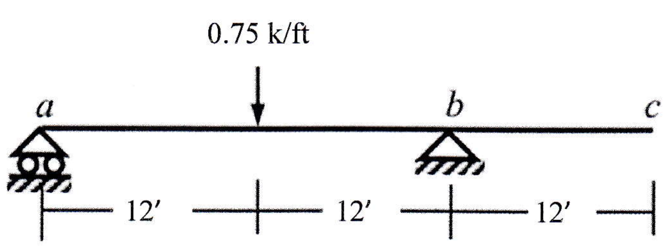


7. (a) Define development Length. Show different bond failures. [03]

(b) The tensile flexural reinforcement required in the cantilever beam shown below is A_s = 2.80 in^2, which is provided by two #11 bars (for d = 21″), while #3 transverse reinforcements with 1.5″ cover are provided starting at 4″ from column face, with 3 @ 8″c/c and 5 @ 10″c/c. Check if the #11 bars (shown in figure below) are provided adequate development length in the beam. [07]



8. Design the RC slab shown below supported on 10″ thick walls a and b (carrying FF = 30 psf, PW = 60 psf + 0.75 k/ft at midspan of ab, LL = 60 psf, in addition to self weight) using design moments. Follow USD or WSD method. [10]
[Given: Thickness of the slab = 9″, f_c' = 3 ksi, f_y = 60 ksi, f_{call} = 1.35 ksi, f_{sall}= 24 ksi, No need to check d_{req} and shear].



9. (a) Explain different types of lap splice. [04]

(b) Explain effect of axial force on shear strength. [03]

(c) Define one way slab. Differentiate between one way and two way slab. [03]

10. (a) A simply supported rectangular beam 12″ wide having an effective depth of 20″, carries a total factored load of 6 k/ft on a 25 ft clear span. If $f_c' = 4$ ksi and $f_y = 60$ ksi, throughout what part of the beam is web reinforcement required? [06]

(b) A rectangular beam is to be designed to carry a shear force V_u of 35k. No web reinforcement is to be used and f_c' is 3 ksi. What is the minimum cross section if controlled by shear? [04]

List of Useful Formulae for CE 315

Fundamentals

* Tensile strength of concrete $f_t' = 7.5\sqrt{f_c'}$ $E_s = 29 \times 10^6$ psi Modular ratio, $n = E_s/E_c$

* Within elastic limit, Flexural stress $f_c = M\,\bar{y}/\bar{I}$

* Steel Ratio $\rho_s = A_s/bd$ Minimum Steel Ratio $\rho_{min} = 3\sqrt{f_c'}/f_y$, often taken as $= 200/f_y$

$Ec = 57000\sqrt{f'c}$(psi)

WSD

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

Design: $k = n/(n + r)$ [where $r = f_{s(all)}/f_{c(all)}$] $j = 1 - k/3$

* Singly Reinforced Beam: $M_s = A_s f_s jd$ and $M_c = (f_c kj/2)\,bd^2 = R\,bd^2$

* Balanced Stress Steel Ratio $\rho_{sb} = k/2r$, when $M_s = M_c$

* Doubly Reinforced Beam: $M_1 = Rbd^2$, $A_{s1} = M_1/(f_s jd)$

$M_2 = M - M_1$, $A_{s2} = M_2/[f_s(d-d')]$ and $A_s' = M_2/[f_s'(d-d')]$, where $f_s' = 2f_s(k - d'/d)/(1-k)$

USD

* $\alpha = 0.72 - 0.04(f_c' - 4)$, and $0.56 \le \alpha \le 0.72$, while $\beta = 0.425 - 0.025(f_c' - 4)$, and $0.325 \le \beta \le 0.425$

$$\rho_{max} = 0.85\beta_1 \frac{f_c'}{f_y}\frac{\epsilon_u}{\epsilon_u + 0.004} \qquad \rho_{max} = 0.85\beta_1 \frac{f_c'}{f_y}\frac{\epsilon_u}{\epsilon_u + 0.005}$$

* Design conditions: $M_u < \phi M_n$, $V_u < \phi V_n$, $P_u < \phi P_n$ [$\phi = 0.483 + 83.3\varepsilon_t$]

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

$c = a/\beta_1$

* Doubly Reinforced Analysis:

$a = A_{s1} f_y/(0.85 f_c' b)$ [where $A_{s1} = A_s - A_{s2}$, and can be taken as $= A_s - A_s'$ to begin with]

$A_{s2} = A_s' f_s'/f_y$, where $f_s' = E_s \times \varepsilon_1$

from which A_{s1} can be revised as $= A_s - A_{s2}$ and a can also be revised accordingly

$M_n = A_{s1} f_y(d - a/2) + A_{s2} f_y(d - d')$

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

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

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

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

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

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

L-beam b_{eff} is the minimum of $(L/12 + b_w)$, $(6t + b_w)$, and (b_w + half the clear distance between adjacent beams)

* WSD Analysis: $k = \{n\rho_s + (t/d)^2/2\}/\{n\rho_s + (t/d)\}$ where $\rho_s (= A_s/b_{eff}d)$ $z = (3kd - 2t)/(2kd - t)\,t/3$

$M_s = A_s f_s(d - z)$ $M_c = f_c\{1 - t/(2kd)\}(b_{eff}t)(d - z)$

Design can start with $A_s \cong M_s/\{f_s(d - t/2)\}$ and follow the same equations

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

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

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

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	$A_{tr}f_{tr}/(1.5Sn)$

$$l_d/d_b = (3/40)\,(f_y/\sqrt{f_c'})\,(\alpha\beta\gamma\lambda)/\{(c + K_{tr})/d_b\}$$

where the term $(c + K_{tr})/d_b$ is ≤ 2.5.

Simplified Equations for <u>Basic</u> Development Length (Tension)

Condition	$(c + K_{tr})/d_b$	l_d
Avoid pullout failure (Experimentally derived limit)	2.5	$0.03\,(f_y/\sqrt{f_c'})d_b$
* Clear cover and Clear spacing $\geq d_b$ + Code required stirrups * Clear cover and Clear spacing $\geq 2d_b$	1.5	$0.05\,(f_y/\sqrt{f_c'})d_b$ (≥ #7 Bars) $0.04\,(f_y/\sqrt{f_c'})d_b$ (≤ #6 Bars and deformed wires) (?)

<u>Bar Diameter and area</u>

d (No.)	2	3	4	5	6	7	8	9	10
A_s (in^2)	0.05	0.11	0.20	0.31	0.44	0.60	0.79	1.00	1.27

d (mm)	8	10	12	16	19	22	25	28	31
A_s (in^2)	0.08	0.12	0.18	0.31	0.44	0.59	0.76	0.95	1.17

<u>Shear Design</u>

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

$S = A_v f_v d\,(\sin\alpha + \cos\alpha)/(V_{ext} - V_c) = A_v f_v(\sin\alpha + \cos\alpha)/\{(v_{ext} - v_c)\,b\}$ for inclined stirrups

Summary of ACI Shear Design Provisions (Vertical Stirrups)

	WSD	USD	Additional Provisions
Design Shear Force	V_w	$V_n = V_u/\phi$ [$\phi = 0.75$]	Calculated at d from Support face
Min^m Section Depth	$V_w/5\sqrt{f_c'}b_w$	$V_n/8\sqrt{f_c'}b_w$	$f_y \leq 60$ ksi
Concrete Shear Strength v_c	$1.1\sqrt{f_c'}$	$2\sqrt{f'c}$	$\sqrt{f_c'} \leq 100$ psi $Vd/M \leq 1.0$
No Stirrup	$V_w \leq V_c/2$	$V_n \leq V_c/2$	
Max^m Spacing	d/2, 24″ $S = A_vf_y/50b_w$	d/2, 24″ $S = A_vf_y/50b_w$	To be halved if $V_n \geq 4\sqrt{f_c'}b_wd$ OR $V_w \geq 2\sqrt{f_c'}b_wd$ in WSD

Temperature and shrinkage reinforcement

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

Minimum Thickness of One way Slab

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

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

Course Title: Environmental Engineering I — Course Code: CE 331
Time- 3 hours — Full marks: 120

There are **FOUR** questions in each section. Answer any **THREE** from each section. *(20*6= 120)*

SECTION – A

1. (a) Write the names of certain common coagulants. Describe the mechanism of coagulation and flocculation (2+4)

(b) What problems will you face if you do not have a storage reservoir in your water distribution system? What option would you choose for water distribution if there pumping system cannot be afforded and there is a difference in elevation? Explain with advantages and disadvantages. (3+4)

(c) The table below shows the properties of four types of soil. Mention which type of soil is capable of retaining most of the water and which one is capable of discharging most of the water. Also calculate the maximum amounts retained and discharged respectively if the aquifer bearing the soil layer has a total volume of 1000 m^3. (7)

Soil type	Porosity (%)	Specific yield (%)
Clay	45	3
Gravel and sand	20	16
Sand	35	25
Gravel	25	22

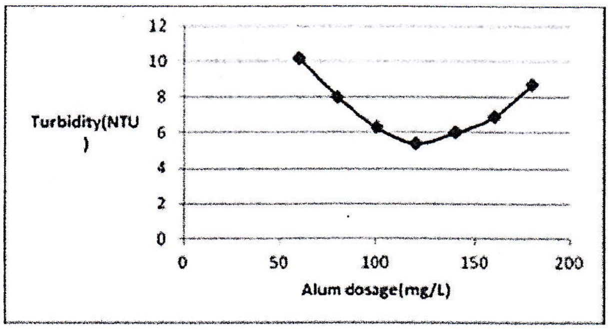
2 (a) Show the "Bayliss curve" in a figure. Compare between "Corrosive water" and "Scale forming water". (6)

(b) Show different configurations of roughing filters. Discuss any two mechanisms of filtration. (6)

(c) A community upgraded their drinking water treatment plant by introducing coagulation/flocculation basins. The plant maintains a flowrate of 1 MGD and intends to use alum as a coagulant. Determine the optimum dose of the coagulant from the given figure. Also calculate the annual requirement of alum for the plant in pounds. (8)

Calculate the annual production of aluminium hydroxide [lbs/year]

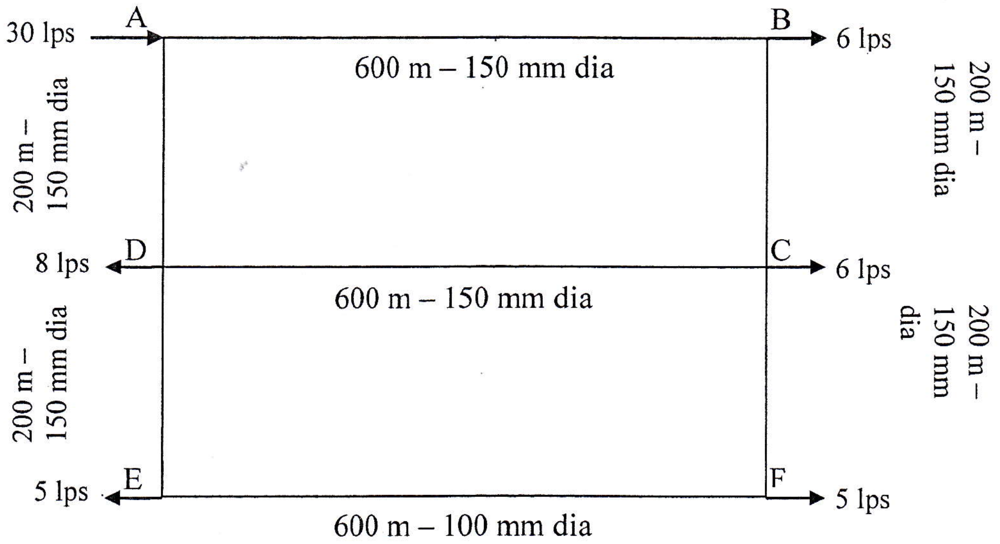
$$Al_2(SO_4)_3 + 3\,Ca(HCO_3)_2 = 2\,Al(OH)_3 + 3CaSO_4 + 6\,CO_2$$



3. (a) You are designing a water distribution network for your city and you want it to be easily expandable in future so that newly developed areas could be covered. Which network system would you choose? Compare between branch network and looped network (4)

(b) Explain Groundwater Recharge and Discharge and show the processes in a schematic. (5)

(c) Calculate the flow in each of the pipes in the following looped pipe network (using Hardy Cross method and two trials are required): (11)



(6)

4. (a) Define specific retention, specific yield and porosity (with expressions) and show the relationship among them.

(b) How can an operator tell when to backwash a rapid sand filter? Show the equations (separately for each case) for softening of water (hardness removal) if the water has the following forms of hardness: (3+6)

i) $Ca(HCO_3)_2$ ii) $Mg(HCO_3)_2$ iii) $MgSO_4$

(c) Why is maintenance of a tubewell necessary? Mention certain chemicals that can be utilized for tubewell maintenance. (5)

SECTION – B

5 (a) Explain the phenomenon of saltwater intrusion and the effect of groundwater abstraction in coastal areas with figure. Write a short note on "Shallow Shrouded Tubewell" (6)

(b) When is filter packing required in a well? What is a sand trap and what is its function in a well? (5)

(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. (9)

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, $K_{entrance} = 0.03$, $K_{bend} = 0.35$, $K_{exit} = 1$

6 (a) What are the ways that the "Net Positive Suction Head" that is available in a pump could be adjusted/raised so that it is higher than the "Net Positive Suction Head" that is required? Show with a figure how the operating range for a pump can be obtained if the system head curves are given for minimum and maximum heads? (3+3)

(b) Explain the importance/relevance of mixing/stirring in both coagulation and flocculation process. (5)

(c) Design (indicate diameter and depth in meters) a circular settling basin for a plant with a flow rate of 45 m^3/hr using an overflow rate of 0.5m^3/m^2-hr. The detention time is 3 hours. What percent of particles with a settling velocity of 0.8 m/hr will settle out in this tank? (9)

7 (a) Show the set of equations for the formation of combined chlorine residuals (when water contains ammonia). (5)

(b) Discuss the ways that "Failure of Tubewell" might take place. (4)

(c) Determine the storage volume of an overhead tank to balance the treatment plant output (Demand line) of 120000 m^3/day with the high service pumping (Supply line) with the following schedule: (11)

12 Midnight – 6 A.M. = 2.00 m^3/hr
6 A.M. – 10 P.M. = 5.00 m^3/hr

10 P.M. – 12 Midnight = 2.00 m^3/hr
(Utilize graph paper for the plot of cumulative demand and supply with time)

8 (a) Show the flow diagram of a typical drinking water treatment plant with all the treatment units. (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. (5)

(c) Design the appropriate details of a well following the given steps and according to the data provided below:

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	0.19 5	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. (4)

ii) Find out the length of the casing pipe, considering static water level at 200 ft, drawdown of 20 ft with water level declination of 2.5 ft per year, design life of 20 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. (2)

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? (3)

iv) If the well has to serve a community with 1 Million people with water demand of 50 liter per capita per day, how many wells will be required to be installed? (2)

Useful Equations:

I. Water Horse Power of pump = (W. Q. H) / 75
Where, W = Specific weight of water in kg/m^3
Q = Pump discharge in m^3/ sec

II. Brake Horse Power of pump = Water Horse Power / (efficiency of pump) x (efficiency of motor)

III. $Q = \pi D L(0.01p) v_c$

IV. $t_d = V/Q$

V. $v_o = Q/As$

VI. $$h_L = 1.39 \times 10^6 Q^{1.85} D^{-4.87}$$ *(when C = 130)*

$$\Delta = -\frac{\sum H}{x \sum H / Q_a}$$

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2015
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. **(4x13=52 marks)**

1. (a) Three direct shear tests were conducted on a dense sand for three different normal stresses of 80 kPa, 150 kPa and 220 kPa. Given that peak shear strengths are obtained 60 kPa, 112 kPa and 165 kPa, respectively. (i) Draw typical shear stress vs shear displacement curves (on the same plot) for the tests conducted under each normal stress. (ii) On each curve, mark the peak shear strength (τ_f) and ultimate shear strength (τ_u). (iii) Plot the Mohr-Coulomb failure envelop and calculate φ value of the soil samples. 6

   (b) Identify the differences between consolidation and compaction. 3

   (c) Consider a soil element existing at a depth of 5 m below the ground level within a 7 m thick deposit of homogeneous sand (γ = 16.5 kN/m^3 and φ = 30°). Draw Mohr circles (with co-ordinates on the x axis) for at-rest, active and passive earth pressure conditions, and also the Mohr-Coulomb failure envelope of this soil element. 4

2. (a) In an unconfined compressive strength test, a clay sample failed under an axial compressive force of 50 N. Area of cross-section at failure is obtained 1327 mm^2. Calculate unconfined compressive strength. Also draw the Mohr circle and the Mohr-Coulmb failure envelop. 4

   (b) Derive two expressions of settlement calculation for a normally consolidated clay, utilizing compression index and coefficient of volume compressibility. 6

   (c) Briefly discuss on the drainage conditions of three types of triaxial tests during application of cell pressure and deviator stress. 3

3. (a) In a laboratory test, a 2 cm thick soil sample takes 25 minutes time to reach 30% degree of consolidation. Find the time taken for a 5 m thick clay layer in field to reach 40% consolidation. Assume one way drainage in field condition. 4

   (b) Compute OCR and pre-consolidation pressure at point A in each of the following timeline. 5

   (a) In the year 2007,
   $\sigma_{present}'$ = 400 kPa
   maximum pressure (in its life history till 2007) = 600 kPa

   (b) In 2010, due to partial demolition, $\sigma_{present}'$ = 250 kPa.

   (c) In January 2011, due to re-construction, $\sigma_{present}'$ = 340 kPa.

   (d) In 2014, due to further expansion project, $\sigma_{present}'$ = 780 kPa.

   (c) Calculate the maximum dry unit weight of the soil, if it has bulk unit weight of 17.5 kN/m^3 at optimum moisture content. From a laboratory compaction test on a sample of the soil, the optimum moisture content is found to be 13.28%. 4

   Also calculate the dry unit weight at optimum moisture content for zero air void condition.

4. (a) Write a short note on 'Atterberg's Limits' 4

(b) Different projects demand the shear strength parameters obtained from different types of triaxial tests (CU, CD and UU) in order to simulate actual field condition. Give examples of projects for each type of the tests. 3

(c) Determine compression index, swelling index, coefficient of compressibility, coefficient of volume compressibility, coefficient of permeability and coefficient of consolidation for the following records. 6

In a consolidation test, the pressure on a sample was increased from 150 to 350 kN/m^2. The void ratio after 100% consolidation under 150 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. A mathematical relation that you may need is given below.

$$k = c_v \, . \, m_v \, . \, \gamma_w$$

5. (a) Write the expression of Bernoulli's equation for soil media. 1

(b) Why can Darcy's law be applied for a soil media? 2

(c) Derive the following relation of total flow rate utilizing the concept of flownet: 5

$$q = k.H. \, N_f/N_d$$

All the symbols carry usual meaning.

(d) From a standard Proctor test, maximum dry unit weight is obtained 17 kN/m^3. After compaction, dry unit weight in field condition is determined 16.3 kN/m^3. Calculate relative compaction. 5

What changes do you recommend in calculation relative compaction, if a dry unit weight (in field condition) of 18 kN/m^3 is targeted after compaction.

Section B

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

6. A 4 m thick clay layer is sandwiched between two sand layers, as shown in Figure 1. Calculate saturated unit weights of the soil layers existing below the ground water table. Draw the effective stress, total stress and pore water pressure diagrams up to a depth of 14 m below the ground level.

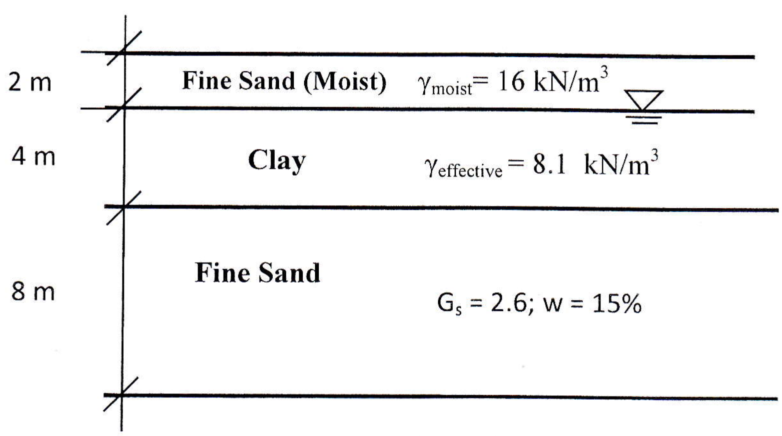


Figure 1

7. A rectangular flexible footing (4 m x 3 m) transmits a pressure of 205 kN/m2. Determine the vertical stress at a depth of 5 m below the centroid (C) and the corner (A) of the footing.

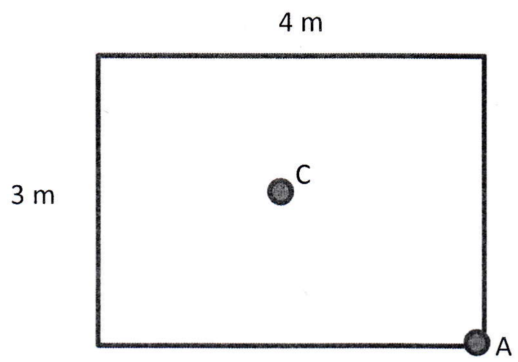


Figure 2

Table: Influence factor chart

n	m							
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
0.3	0.01323	0.02585	0.03735	0.04742	0.05593	0.06294	0.06858	0.07308
0.4	0.01678	0.03280	0.04742	0.06024	0.07111	0.08009	0.08734	0.09314
0.6	0.02223	0.04348	0.06294	0.08009	0.09473	0.10688	0.11679	0.12474
0.8	0.02576	0.05042	0.07308	0.09314	0.11035	0.12474	0.13653	0.14607

8. Classify the following soils:

(a) The properties of a subgrade soil (A) are found as follows:
Percent finer than 0.075 mm = 10%
Percent finer than 0.425 mm = 18%
Percent finer than 0.6 mm = 30%
Percent finer than 1 mm =60 %
Percent finer than 4.75 mm = 62%
Liquid limit = 52% & Plastic limit = 35%

(b) The properties of a subgrade soil (B) are found as follows:
Percent of soil material in the pan = 63%
60% of the total soil material having a diameter less than 4.75 mm
30% of the total soil material having a diameter less than 0.425 mm
10% of the total soil material having a diameter less than 0.3 mm
Liquid limit = 40% & Plastic limit = 20%

9. Find the magnitude of the active force (per unit width) on the retaining wall, shown in Figure 3, for the Rankine state. Consider up to the dredge line. The wall penetrates 2.5 m below the dredge line. Calculate the change in active force if both the layers have 10 kPa cohesion. Also calculate the depth of tension crack.

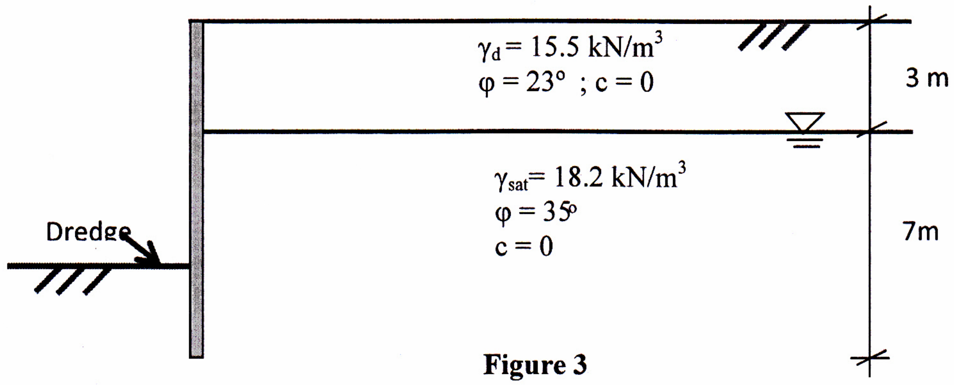


Figure 3

10. A consolidated undrained test was conducted on a clay sample and the following results were obtained.

Cell pressure (kN/m²)	Deviator stress at failure (kN/m²)	Pore water pressure at failure (kN/m²)
110	95	80
225	195	190
340	294	240

Determine the shear strength parameters with respect to total stresses and effective stresses. Use graphical method.

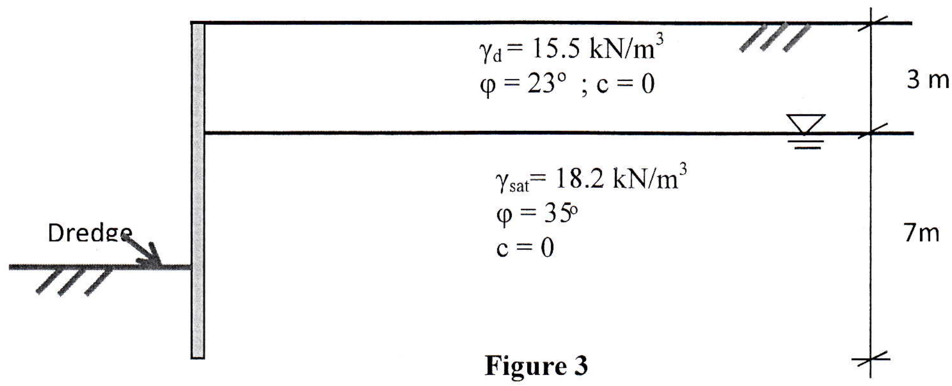
11. Calculate the following for the seepage flow shown below:

(a) Heights of water in the piezometer, if installed at a and b.

(b) Average hydraulic gradient, i for the flownet. On an average, size of the flow element is found 1.2 m x 1.2 m.

(c) Flow rate through the flow channels between point a and point b. In this calculation, what value have you used for N_f.

9. Find the magnitude of the active force (per unit width) on the retaining wall, shown in Figure 3, for the Rankine state. Consider up to the dredge line. The wall penetrates 2.5 m below the dredge line. Calculate the change in active force if both the layers have 10 kPa cohesion. Also calculate the depth of tension crack.



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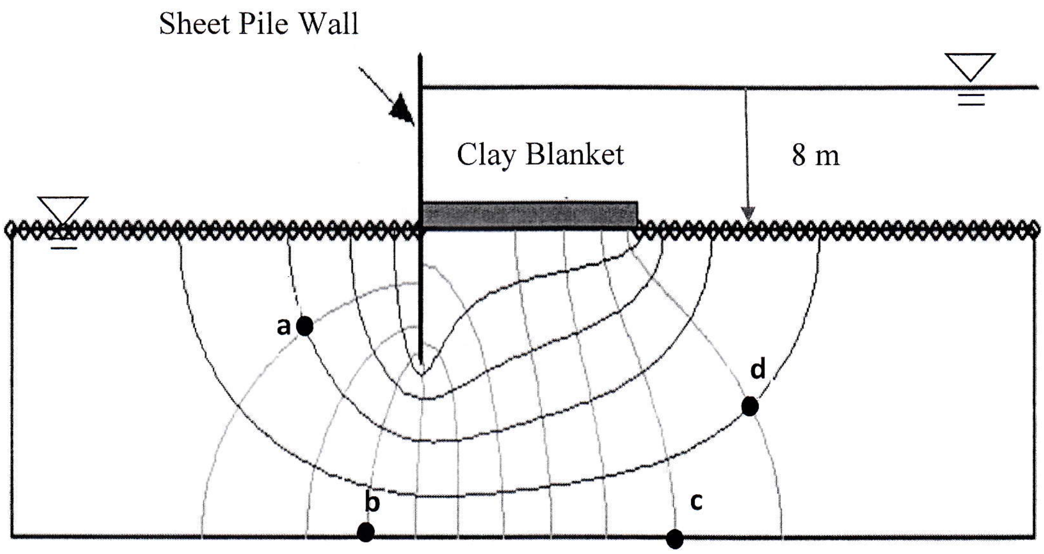


Figure 4

12. Calculate the primary consolidation settlement for the 15 ft thick clay layer (as shown below) due to the load carried by a square footing of size 6 ft x 6ft. The clay is normally consolidated. Use Boussinesq analysis $\Delta\sigma = \frac{3Q.z^3}{2\pi.(r^2+z^2)^{5/2}}$] to calculate the increase in stress at the mid-depth of the clay layer. Assume the load as point load.

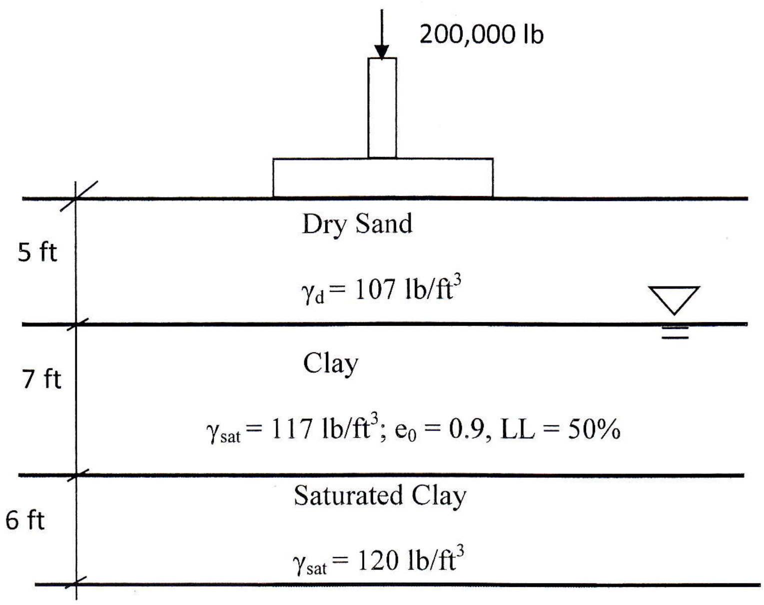


Figure 5

Given that: Cc = 0.009(LL – 10);

3-1

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2015
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 (25×3=75)

1. (a) What is the basic difference between open channel flow and pipe flow? In which condition pipe flow is called open channel flow? (05)

   (b) Write down the classifications of open channel flow. (05)

   (c) In a wide channel velocity varies along a vertical as $u = 4\,(z/h)^{1/2}$, where h is the total depth and u is the velocity at a distance z from the channel bottom. Calculate the depth average velocity (U) and momentum co-efficient (β) if the total depth is 10 m. (15)

2. (a) Write momentum equation with explanation of all notations. (05)

   (b) Derive the expression of energy coefficient (α) and momentum coefficient (β). (05)

   (c) A compound channel is shown in figure (1). Compute the discharge and determine the state of flow in this channel if the depth of flow is 1.5 m and the mean velocity of flow is 2.3 m/s. If elementary waves are created in this channel, determine the speed of the wave fronts upstream and downstream. (15)

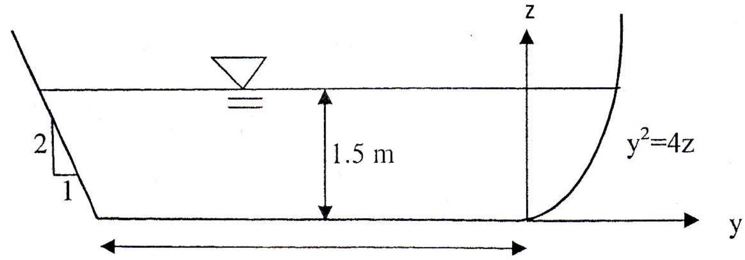


Figure (1)

3. (a) Prove that, for a rectangular channel specific energy is 1.5 times of critical depth. (05)

   (b) Write short notes on laminar viscous sublayer. (05)

(c) For a compound channel shown in figure (2), Compute the critical depth and velocity if discharge is 50 m^3/s. Assume $\alpha = 1.12$ (15)

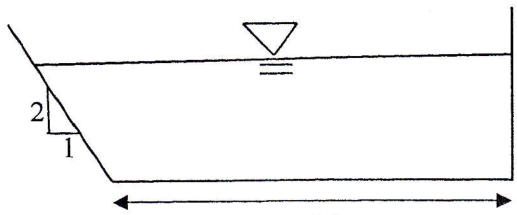


Figure (2)

4. (a) Design a stable alluvial channel using Lacey's theorem. The channel is to carry 15 m^3/s discharges through 0.15 cm sand. (15)

(b) What is shear stress? Derive an expression of drag velocity of a channel. (10)

Section B

Answer any 3 (Three) out of 4 (Four) questions (25×3=75)

5. (a) An open channel lined with concrete (D_{50}=1.5 mm) is laid on a slope of 0.001. The channel is trapezoidal with b= 6 m and s=2. Compute the uniform flow discharge in the channel based on Darcy- Weisbach formula if the depth of flow is 2 m. (08)

(b) Prove that in best hydraulic trapezoidal section, hydraulic radius is one half of the depth. (12)

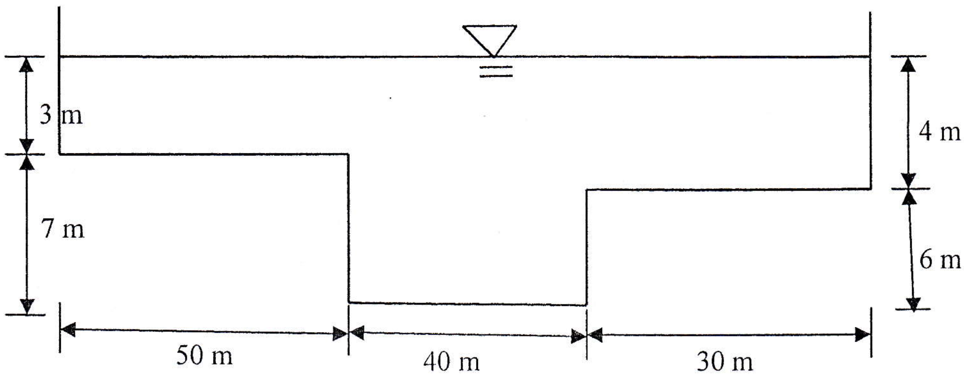
6. (a) What do you mean by maximum and minimum permissible velocity in an open channel? Explain. (05)

(b) 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)

(c) Show relationship between Chezy's C, Darcy-Weisbach friction factor f and Manning's n. (05)

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

(b) A channel consists of a main section and two side sections as show in figure (3). Compute the total discharge, the mean velocity of flow and the Manning's n for the entire section when n= 0.025 for the main channel, n= 0.045 for the side channel and S_0=0.0002. (20)



8. (a) Write down the practical applications of hydraulic jump in an open channel flow. (05)

(b) Classify the hydraulic jump in sloping channel. (05)

(c) 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 (15)

i. Type of jump
ii. Efficiency of the jump
iii. Relative height of the jump

Formulas:

For parabolic channel:

$$A = \frac{4\,h^{\wedge}(3/2)}{3\sqrt{c}}, \quad P = B + (8h^2/3B), \quad B = \frac{2\sqrt{h}}{\sqrt{c}}$$

$$Lj = 9.75 \times (Fr_1 - 1)^{1.01} \times h_1$$