University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2017
Program: B.Sc in Civil Engineering

Course Title: Principles of Management | Course Code: IMG 301
Time: 2 Hours | Full Marks: 50

**Answer any 5 from the following questions**

1. Suppose you are the resource manager of TOMA Construction Ltd. Recently, this company has received some offer from different Institutions to construct apartments. The benefits and problems of each project are given below:

| Projects | Benefits/ Drawbacks |
|---|---|
| **A** | Resources availability-Excellent |
| | Stack resources-Poor |
| | Training for the employees-Satisfactory |
| | Work environment-Good |
| **B** | Resources availability-Average |
| | Stack resources-Good |
| | Training for the employees-Excellent |
| | Work environment-Poor |
| **C** | Resources availability-Excellent |
| | Stack resources-Satisfactory |
| | Training for the employees-Poor |
| | Work environment-Satisfactory |

TOMA Construction Ltd. basically considers the following areas as criteria in order to evaluate a project: Resource availability (35%), Training for the employees (5%), Stack Resources (10%), Work environment (50%).

**Scoring:**

| Type | Score |
|---|---|
| Excellent | 80 |
| Satisfactory | 75 |
| Good | 60 |
| Average | 50 |
| Poor | 40 |

As a resource manager you are to determine:

I. Which project to choose by TOMA construction Ltd.?
II. Why they should choose this? 10

2. A project consists of activities from "A to I" shown in the following table. The immediate predecessors and the duration in Months of each of the activities are given in the same table.

| Activity | Immediate Predecessor | Duration (Months) |
|---|---|---|
| A | - | 4 |
| B | - | 3 |
| C | - | 4 |
| D | A | 5 |
| E | B | 7 |
| F | C | 3 |
| G | D | 2 |
| H | D | 3 |
| I | E,F,G | 2 |

**Requirements:**

a. Construct the Network. 3
b. Determine all possible paths. 2
c. Determine the critical path. 3
d. Determine total floats and free floats for each activity. 2

3. a. "Project manager should be socially responsible." – do you support the statement? Put your arguments for and against social responsibility. 5
b. What are the different degrees of social responsibility? Explain. 5

4. a. What do you mean by psychological contract? List the contributions made by a project manager to a specific project and also list the inducements/benefits that he/she gains from that specific project. 5
b. Explain the following terms:
   i) Lucas of control
   ii) Self efficacy
   iii) Machiavellianism
   iv) Self esteem
   v) Extraversion 5

5. a) Explain the components of Goal Setting Theory. 5
b) Describe the historical perspectives on Motivation. 5

6. a) Define power? Explain its types with proper examples. 6.5
b) In light with the Path Goal Theory answer the following questions by selecting appropriate leader types:
   i) If your perceived ability is low, what type of leader can be helpful?
   ii) If your perceived ability is high, what type of leader can be helpful?
   iii) People believing internal locus of control, prefer what type of leader?
   iv) People believing external locus of control, prefer what type of leader?
   v) If the task structure is complicated, what type of leader is helpful?
   vi) If the task structure is simple, what type of leader is helpful?
   vii) What type of leader prefer work group and which type don't? 3.5

# University of Asia Pacific
# Department of Civil Engineering
# Final Examination Fall 2017
# Program: B.Sc in Civil Engineering

Course Title: Structural Engineering II
Time: 3 Hours

Course Code: CE313
Full Marks: 100

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**QUESTION 1 [20 MARKS]**

A frame of 7 storied reinforced concrete building is shown in **Figure 1**. All beams of the structure are carrying 40 kN/m floor (vertical) load. The lateral load of the structure is shown in **Figure 1**
[Given: Sections of all columns 400 mm x 400 mm, beam 250 mm x 500 mm, shear wall 200 mm x 1600 mm].

a. **Apply** portal and cantilever methods to analyze 6th floor of the frame for lateral load. [12 marks]
b. **Apply** approximate method to analyze 6th floor for vertical load and obtain shear force and bending moment diagrams of beams, columns and shear wall for combined loadings (use cantilever method for lateral load). [8 marks]

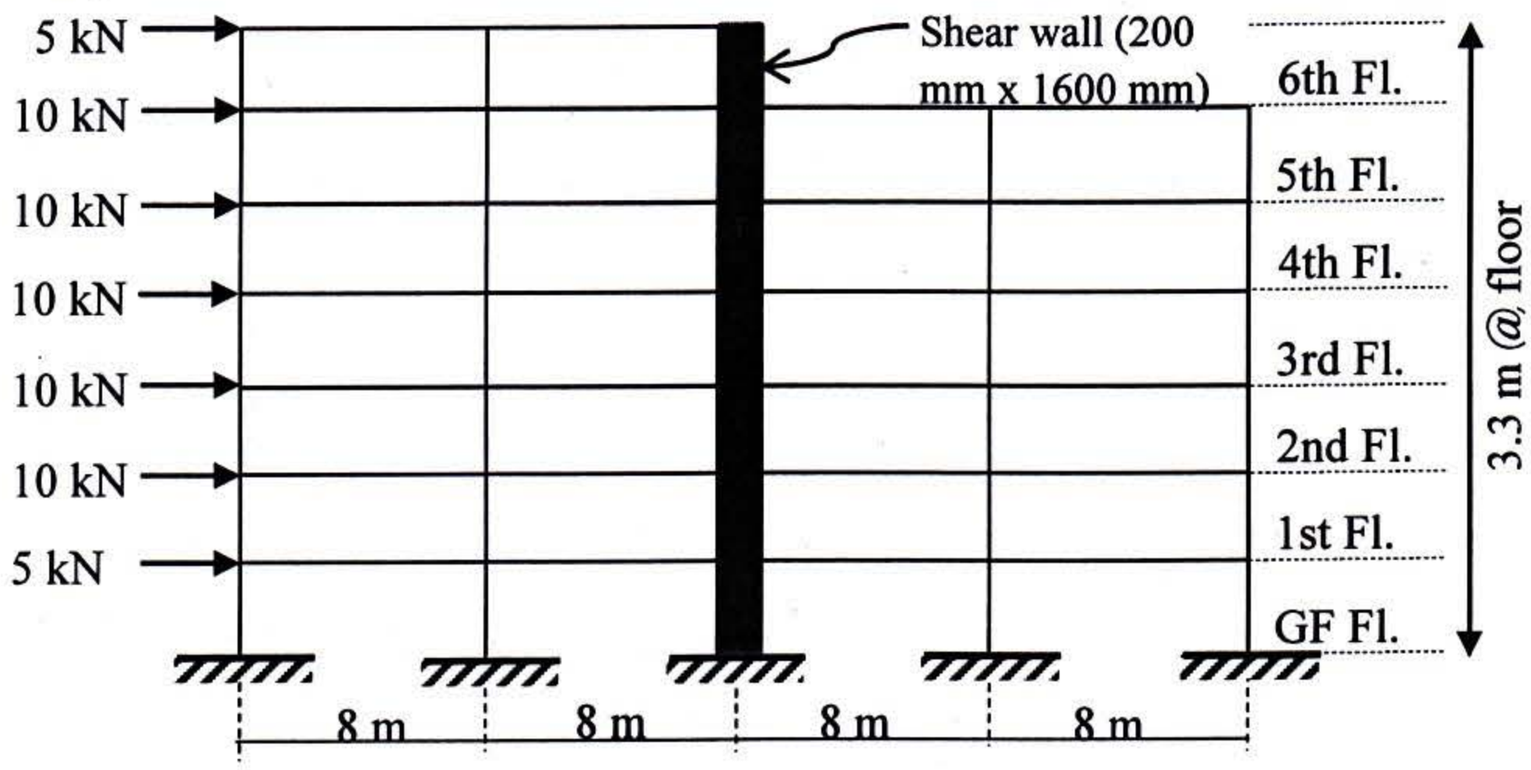



**Figure 1:** Frame of residential building

**QUESTION 2 [20 MARKS]**

A prototype of pedestrian bridge is constructed with two cantilever steel trusses as shown in **Figure 2**.

a. **Evaluate** the differences of maximum deflections of the trusses (between joint c and m)
[Given: Cross-sections of members are 1200 $mm^2$, Modulus of elasticity of steel is 200 GPa]. [15 marks]
b. **Propose a suitable solution with justification** to maintain same deflections between joints c and m
[Length and arrangement of materials cannot be changed, however, section and properties of materials can be changed]. [5 marks]

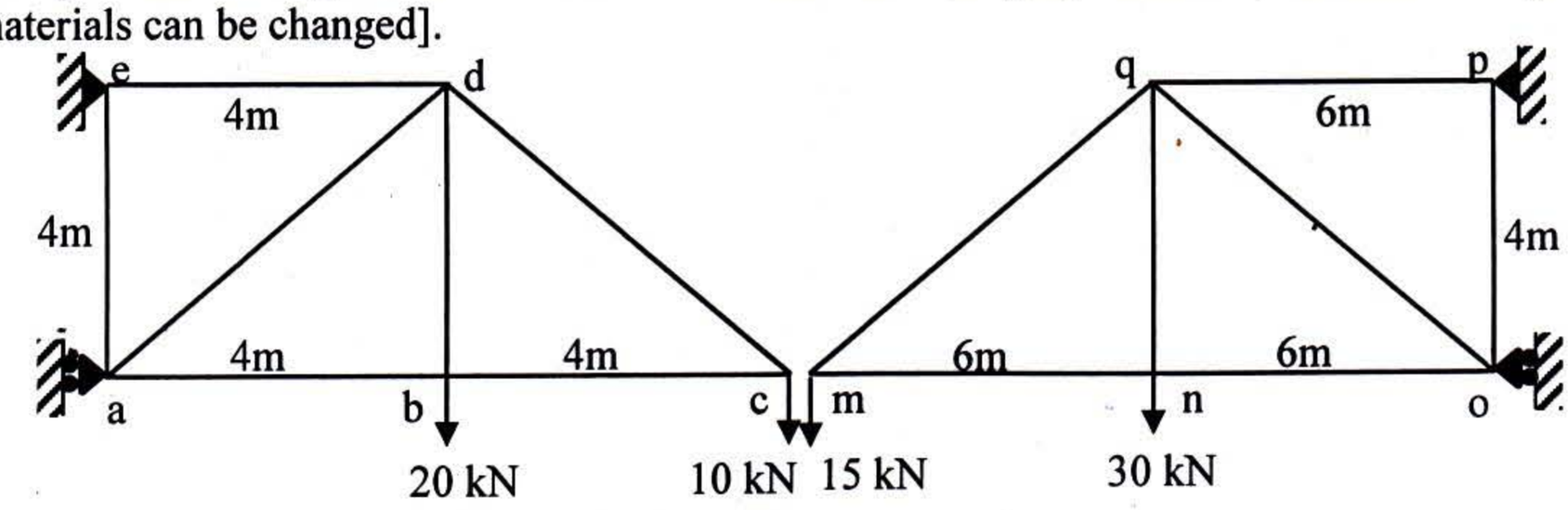



**Figure 2:** Truss of cantilever bridge

**QUESTION 3 [20 MARKS]**

a. A continuous steel beam (ABC) is carrying a 15 kN/m uniformly distributed load as shown in **Figure 3(a)**. **Apply force method** to analyze the structure and draw shear force and bending moment diagrams
[Given: E =200 GPa, I =300x$10^6$ $mm^4$]. [10 marks]

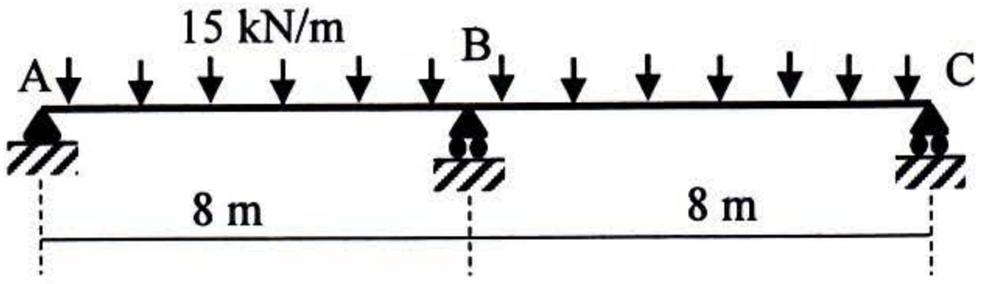



**Figure 3(a):** Integral bridge structure

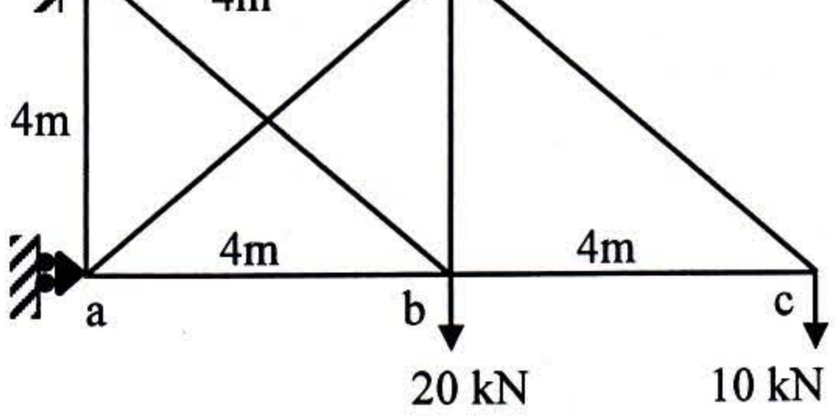



**Figure 3(b):** Indeterminate truss

b. **Apply force method** to analyze the truss shown in **Figure 3(b)** (member force of primary truss could be same as truss shown in Figure 2)
[Given: Cross section of all members is 1200 $mm^2$, Modulus of elasticity of steel is 200 GPa].
[10 marks]

**QUESTION 4 [20 MARKS]**

a. **Draw** the quantitative influence line of reaction at support A of the continuous beam (use 3 m interval) and obtain the reaction at A due to 100 kN moving load at its position shown in **Figure 4(a)**
[Given: E =200 GPa, I =300x$10^6$ $mm^4$]. [10 marks]

b. **Draw** the qualitative influence lines of support reactions $R_A$, $R_B$ shear forces $V_{C(Left)}$, $V_{C(Right)}$ and bending moments $M_A$, $M_B$ of structure shown in **Figure 4(b)**. [10 marks]

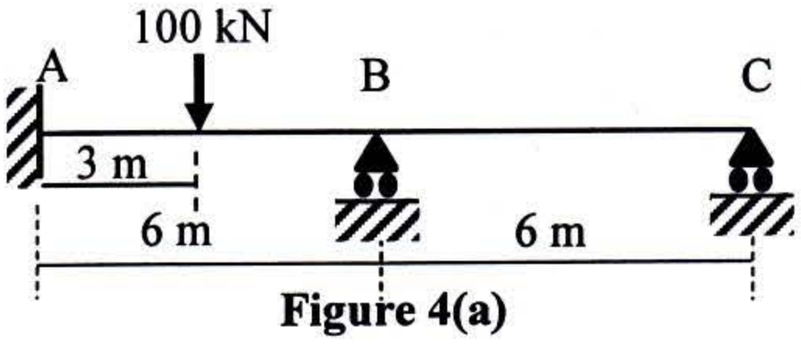



**Figure 4(a)**

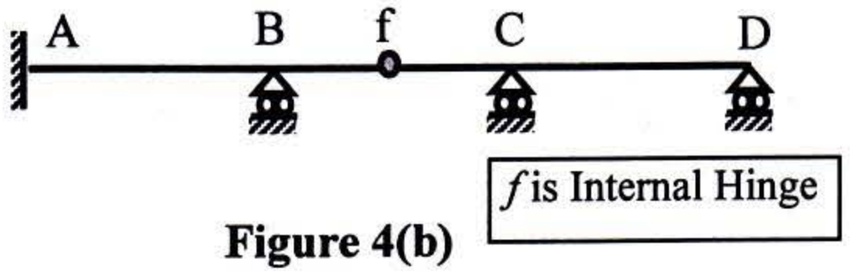



**Figure 4(b)**

**QUESTION 5 [20 MARKS]**

a. A prototype of integral bridge structure is shown in **Figure 5(a)**. The girder ABCD of the structure is carrying 30 kN/m distributed load due to self weight of deck slab and girder. **Analyze the structure using moment distribution method** to obtain joint moments of girder (beam) and pier (column)
[Given: Cross sections of girder is 300 mm x 600 mm, pier is 400 mm x 400 mm, Modulus of elasticity of concrete ($E_c$) is 30000 $N/mm^2$]. [10 marks]

b. The support and loading conditions of a reinforced concrete continuous beam is shown in **Figure 5(b).** However, the support conditions of the structure could be changed. **Propose** a suitable structural system to have lower mid-span moment of beam BC as compared to the existing structure. **Justify** the solution through analysis of structure using moment distribution method
[Given: Cross sections of beam ABC is 300 mm x 800 mm, Modulus of elasticity of concrete ($E_c$) is 30000 $N/mm^2$]. [10 marks]

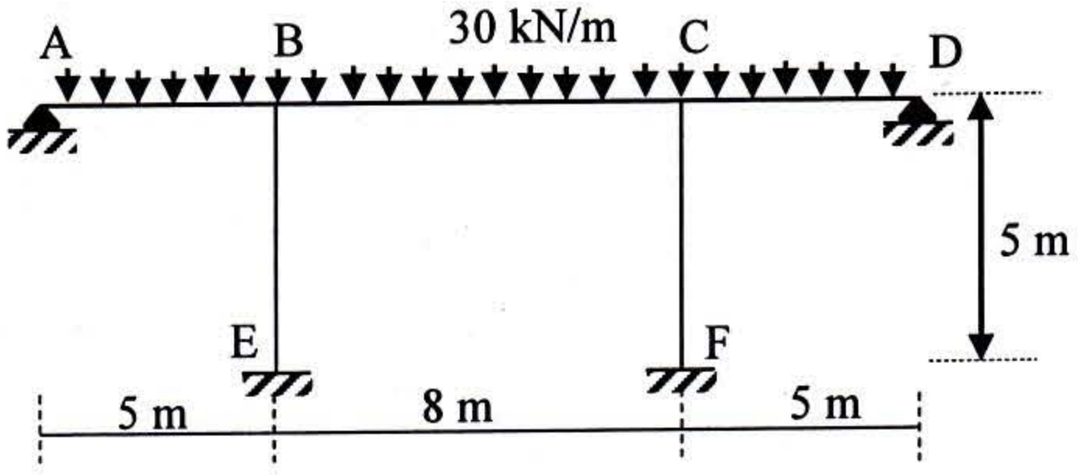



**Figure 5(a):** Integral bridge structure

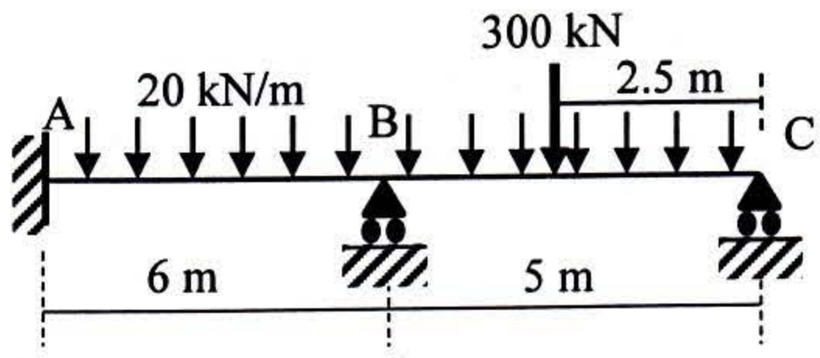
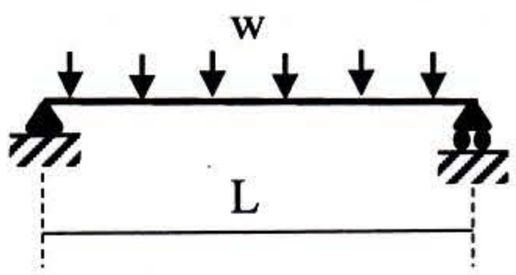


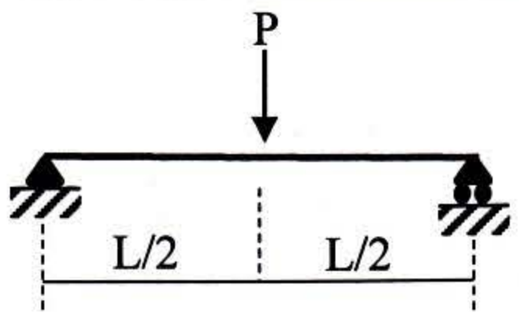

**Figure 5(b)**

## APPENDIX

(Beam deflections and slopes to analyze beam using for force method)




$$v_{max} = \frac{5wL^4}{384EI} \quad \theta_{max} = \pm\frac{wL^3}{24EI}$$




$$v_{max} = \frac{PL^3}{48EI} \quad \theta_{max} = \pm\frac{PL^3}{16EI}$$

# University of Asia Pacific
# Department of Civil Engineering
# Final Examination Fall 2017
# Program: B.Sc. in Civil Engineering

Course Title: Design of Concrete Structures II | Course Code: CE 317
Time: 3 (Three) hours | Full Marks: 140

***There are 9(Nine) questions in this section. Answer any 7(Seven).***

*Assume reasonable values for any missing data. Symbols used have their usual meanings.*
*Marks are shown on right hand side of each question.*

1. A beam-supported interior slab panel is carrying loads from floor finish 30 psf and random wall 50 psf. Calculated reinforcement (in USD) in short span was found to be #3 @8.25″ c/c (bottom), alt ckd + 2#3 extra top as shown in ***Figure 1***. Thickness of the slab was found to be 4.5″. Calculate the live load that can be carried by the slab panel. Use Moment Co-efficient method [Given: $f_c' = 3$ ksi, $f_y = 50$ ksi]. (20)

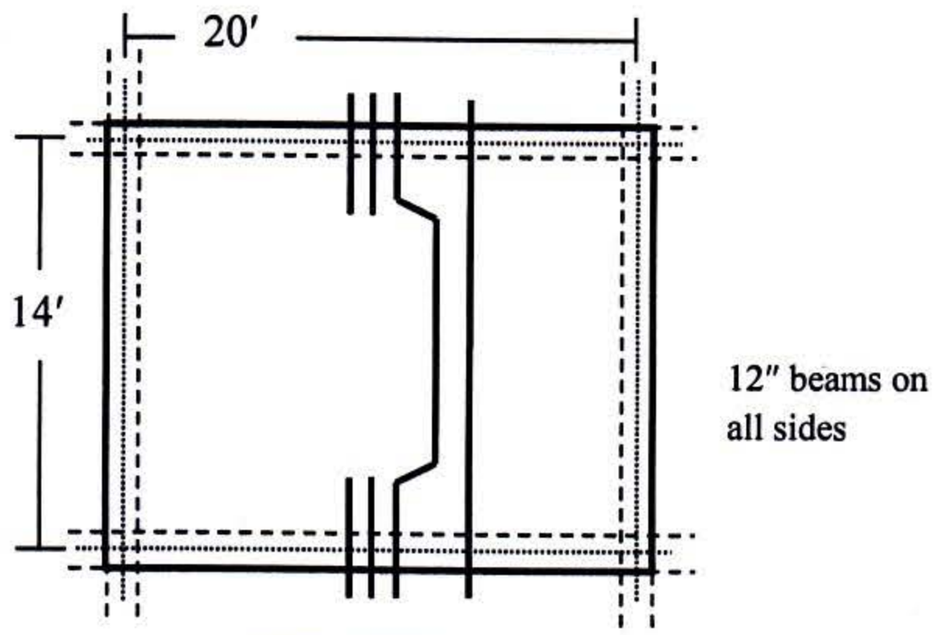



***Figure: 1***

2. Analyze the slab to calculate negative and positive moments in long and short direction by Direct Design Method, required for the design of the exterior panel of the two-way slab with beams as shown in ***Figure 2***. The slab is to support a live load of 120 psf and a dead load of 100 psf including slab weight. Columns are 15″× 15″ [Given: $f_c' = 3$ ksi, $f_y = 60$ ksi]. (20)

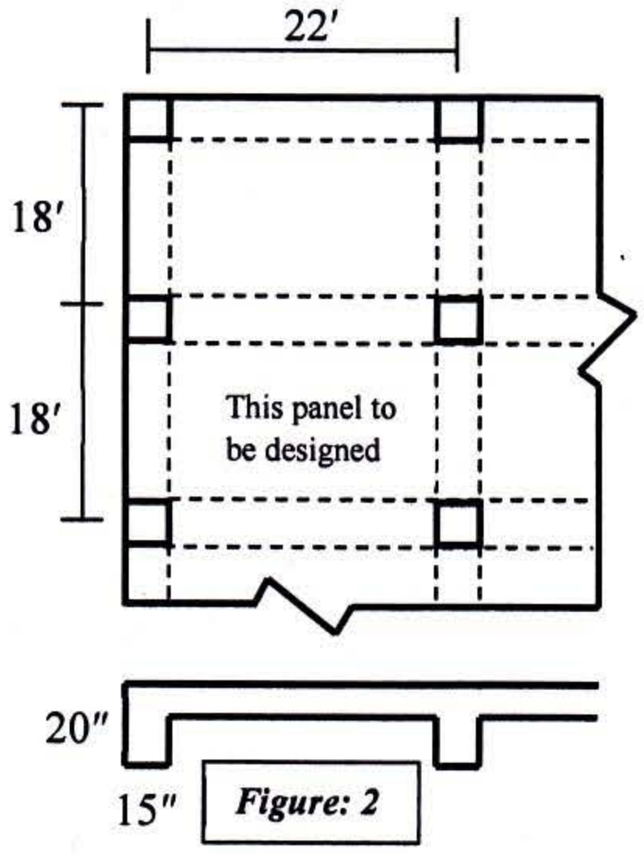



***Figure: 2***

3. (a) Design a circular spiral column to support axial dead load of 180 k and live load of 300 k. Initially assume 2% longitudinal reinforcement. [Given: $f_c' = 4$ ksi, $f_y = 60$ ksi]. (10)

(b) Design a square column to support loads in question 3(a). (10)

4. (a) Explain why the factors $\phi$ and $\alpha$ are used for column design (5)

(b) A 12″ × 18″ column is reinforced with six #9 bars as shown in ***Figure 3***. Determine (i) the load $P_b$, Moment $M_b$ and corresponding eccentricity $e_b$ for balanced failure, (ii) the load and moment for a representative point in the tension failure region of the interaction diagram, (iii) the load and moment for a representative point in the compression failure region of the interaction diagram. The column has 2.5″ cover on all sides. (15)

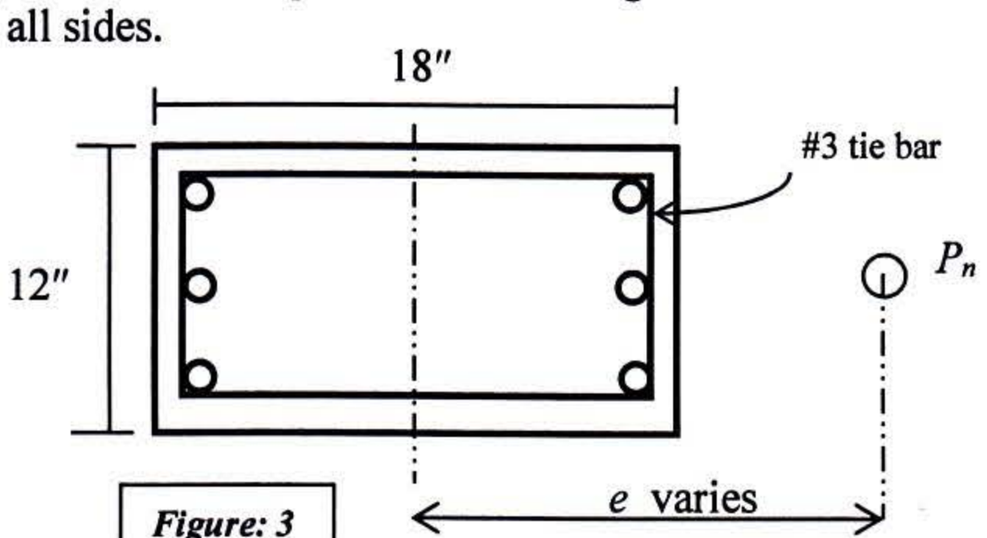



***Figure: 3***

5. (a) A square single footing is to support 18″square interior column. For that column the load of the footing: DL = 245 k and LL = 200 k. The base of the footing is 4 ft below ground level. Design the footing using USD method and also check its thickness for punching and flexural (one-way) shear. Show reinforcement in plan and section with neat sketches. [Given: $f_c' = 4$ksi, $f_y = 60$ ksi, $q_a = 5$ ksf] (18)

(b) What is the function of pile cap in pile foundation? (2)

6. A gravity retaining wall as shown in ***Figure 4*** is to retain a bank of14 ft high. The soil is a sand-gravel mixture with unit weight of 120 lb/ft$^3$ and $\phi$ of 30°. (20)
Check whether the wall has adequate factor of safety against overturning [Given: $f = 0.5$, $q_a = 7000$ psf and $\gamma_{concrete} = 150$ lb/ft$^3$]

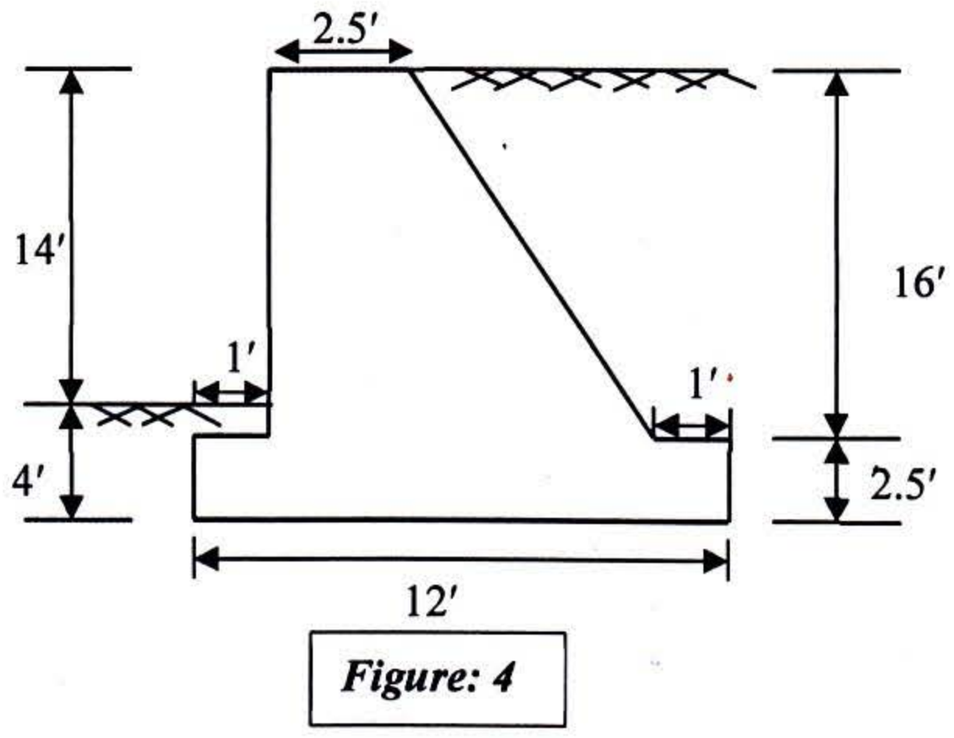



***Figure: 4***

7. (a) Cast -in-situ piles of 18″dia will be provided for a RC column of 24″ x 24″ in section. The column will carry DL= 500 k and LL= 400 k. The allowable load carrying capacity of each pile is 100 k. Pile spacing will be 3 times the pile diameter. Using USD method, (16)

(i) Determine number of piles required.

(ii) Make a layout plan of the pile cap.

(iii) Determine thickness of pile cap checking for punching and flexural (one-way) shear.

[Given, $f_c' = 4$ ksi, $f_y = 60$ ksi. Assume self -weight of pile cap is about 10% of total service load].

(b) What does the term 'Pre-tensioning' mean? Write down some advantages of prestressed concrete. (4)

8. (a) A simply supported pre-stressed concrete T beam is carrying uniform live load of 32 kN/m and 12 kN/m dead load (self- weight). The c.g.s. (center of gravity of steel) profile of tendon is a shown in ***Figure 5.*** The effective prestress force is 2000 kN. (16)

Apply the concept to calculate extreme stresses at mid span section of the beam [Given, $f_c' = 35$ MPa, $I_c$ of the section $37.7 \times 10^9$ mm$^4$, $A_c = 500 \times 10^3$ mm$^2$].

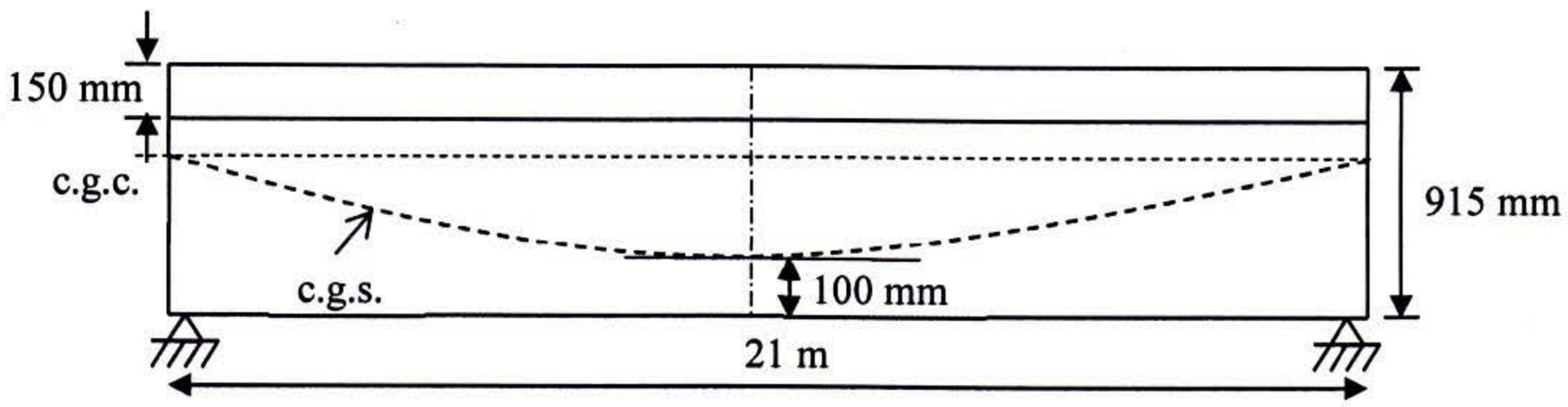



***Figure: 5***

(b) What is retaining wall? Why is it important to allow drainage of water behind a retaining wall? (4)

9. A combined footing has to support an exterior column and an interior column. The loads and dimensions of the columns are shown in ***Figure 6(i)***. (20)

(i) Determine effective depth ($d$) of the combined footing using shear force diagram shown in ***Figure 6(ii).***

(ii) Calculate maximum positive and negative moment ($M$) in long direction of the combined footing.

Allowable soil pressure is 5 ksf. The bottom of the footing is 6 ft below ground level.

[Given, $f_c'$ = 4 ksi, $f_y$ = 50 ksi, $\gamma_{concrete}$ = 150 lb/ft$^3$].

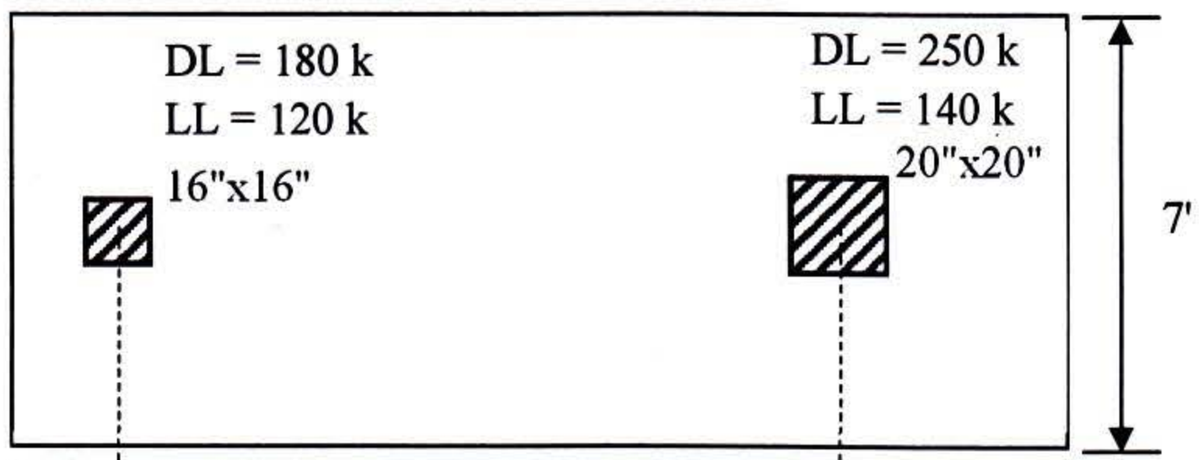
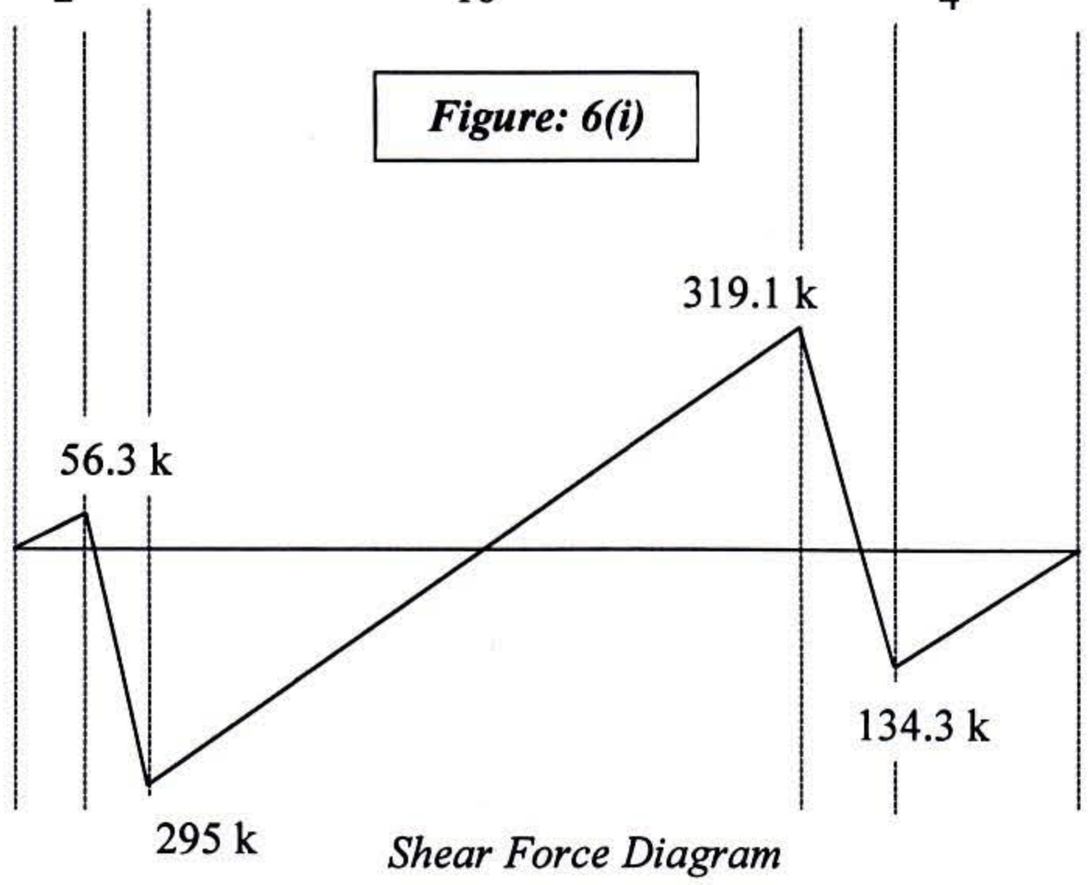



***Figure: 6(i)***




*Shear Force Diagram*

***Figure: 6(ii)***

# Appendix

## Co-efficient Method:

$Ma = C_a\, w_u\, la^2$
$Mb = C_b\, w_u\, lb^2$
Thickness h =P/180 ≥ 3.5, P = panel perimeter
Shear strength of the slab, $\varphi V_c = 2\sqrt{f_c'}bd$

$$d = \sqrt{\frac{M_u}{\phi\rho f_y(1-0.59\rho\frac{f_y}{f_c'})}} \qquad \text{Here } \rho = \rho_{max} = 0.75\rho_b = 0.75 * 0.85*\beta_1 \frac{f_c'}{f_y} * \frac{87000}{87000+f_y}$$

$As = (f_c/f_y)\,[1-\sqrt{\{1-2\,M_n/(f_c\,bd^2)\}}]\,bd$

## Direct Design Method:

Minimum thickness of Flat Slab

| Exterior Panels without Edge Beams | Exterior Panels with Edge Beams | Interior Panels |
|---|---|---|
| $L_n/33$ | $L_n/36$ | $L_n/36$ |

For reinforcements with fy ≠ 40 ksi, the tabulated values are to be multiplied by (0.8 + fy/200).

$$M_o = w_n L_2 L_n^2/8;\ M_u^{(-)} = 0.65M_o;\ M_u^{(+)} = 0.35M_o$$

Distribution Factors applied to Static Moment $M_0$ for Positive and Negative Moments

| Position of Moment | Ext Edge unrestrained (a) | Slab with beams between all supports (b) | No beam between interior supports | | Exterior Edge fully restrained (e) |
|---|---|---|---|---|---|
| | | | Without edge beam (c) | With edge beam (d) | |
| Exterior $M^{(-)}$ | 0.00 | 0.16 | 0.26 | 0.30 | 0.65 |
| Interior $M^{(-)}$ | 0.75 | 0.70 | 0.70 | 0.70 | 0.65 |
| $M^{(+)}$ | 0.63 | 0.57 | 0.52 | 0.50 | 0.35 |

$\alpha = E_{cb}I_b/E_{cs}I_s \quad \beta_t = E_{cb}C/2E_{cs}I_s \quad C = \sum(1-0.63\ x/y)\ x^3y/3$

% of Exterior $M^{(-)}$ supported by Column Strip = $100 - 10\beta_t + 12\,\beta_t\,(\alpha_1\,L_2/L_1)\,(1-L_2/L_1)$

% of $M^{(+)}$ supported by Column Strip = $60 + 30\,(\alpha_1\,L_2/L_1)\,(1.5-L_2/L_1)$

% of Interior $M^{(-)}$ supported by Column Strip = $75 + 30\,(\alpha_1\,L_2/L_1)\,(1-L_2/L_1)$

For slabs without beams between supports ($\alpha_1 = 0$) and without edge beams ($\beta t = 0$), the portion of negative moments in column strip is simply 100% and 75% for exterior and interior supports, respectively, and portion of positive moment in column strip is simply 60%.

Punching shear capacity $V_c = 4\sqrt{f'_c}\,b_o\,d$

Short Column:
Axial Capacity $P_u = \alpha\,\phi\,A_g\,[0.85f_c' + \rho_s\,(f_y - 0.85f_c')]$

$$c = c_b = d\,\frac{\epsilon_u}{\epsilon_u + \epsilon_y} \qquad f_s = \epsilon_u E_s\,\frac{d-c}{c} \le f_y \qquad f_s' = \epsilon_u E_s\,\frac{c-d'}{c} \le f_y \qquad C = 0.85f_c'ab$$

$$P_n = 0.85f_c'ab + A_s'f_s' - A_sf_s$$

$$M_n = P_ne = 0.85f_c'ab\left(\frac{h}{2}-\frac{a}{2}\right) + A_s'f_s'\left(\frac{h}{2}-d'\right) + A_sf_s\left(d-\frac{h}{2}\right)$$

$$K_n = \frac{P_u}{\phi f_c'A_g} \qquad R_n = \frac{M_u}{\phi f_c'A_g h}$$

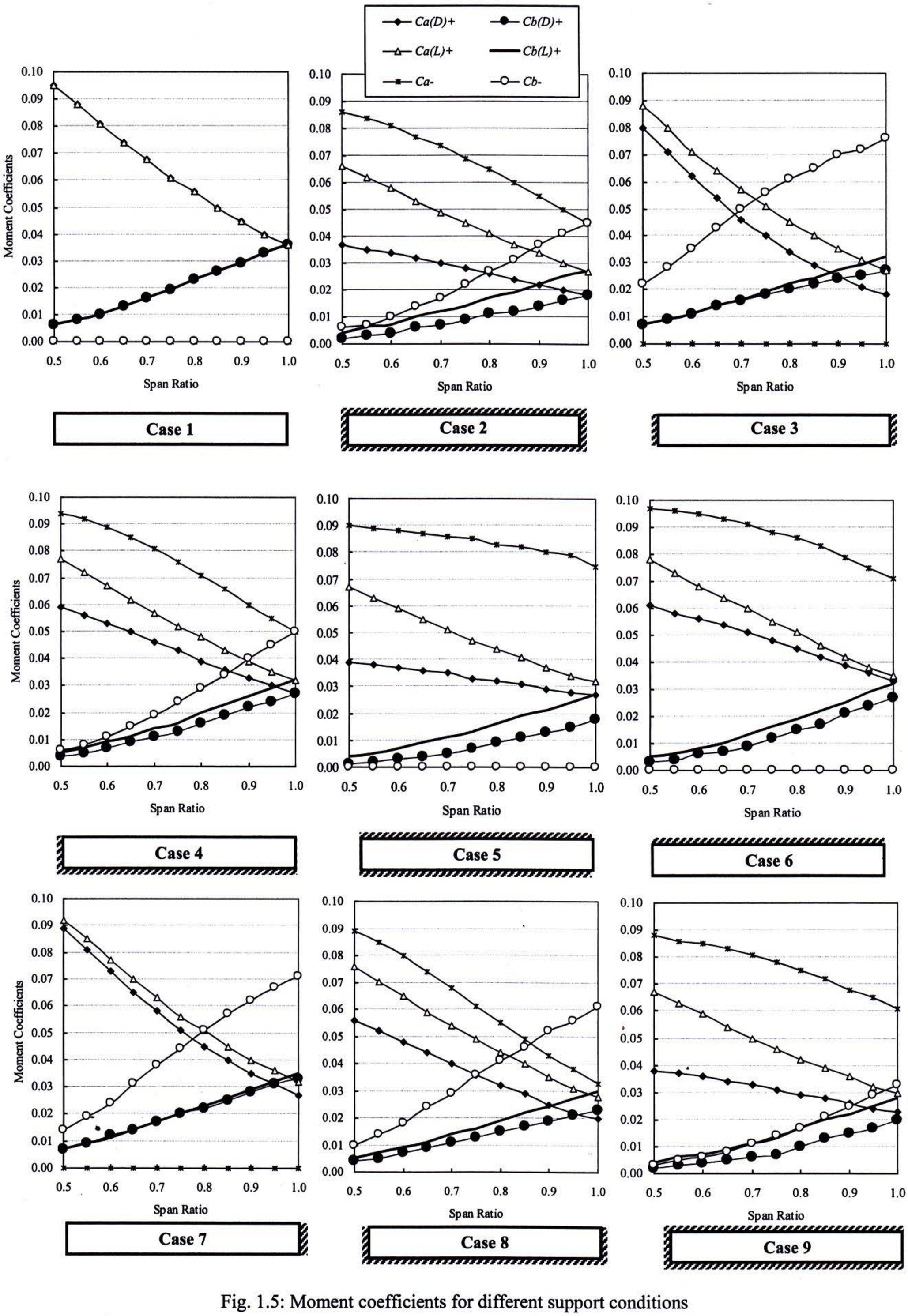



Fig. 1.5: Moment coefficients for different support conditions

# Appendix

Footing

$$A_{req} = \frac{D + L}{q_a}$$

$$q_u = \frac{1.2D + 1.6L}{A}$$

$$A_{s(\min)} = \frac{3\sqrt{f_c'}}{f_y} b_w d \geq \frac{200\, b_w d}{f_y}$$

$$\emptyset\, V_c = \emptyset * 2\lambda\sqrt{f'_c} bd$$

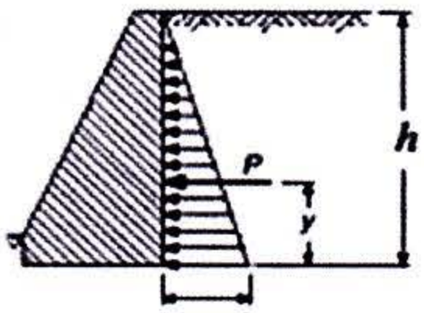
$$\emptyset\, V_c = \emptyset * 4\lambda\sqrt{f'_c} b_0 d$$

Pile Cap

$$n = \frac{D + L}{R_e}$$

$$R_u = R_e \times \frac{1.2\, D + 1.6\, L}{D + L}$$

Retaining Wall




$$P_a = \frac{1}{2} K_{ah} \gamma_s h^2$$

$$K_{ah}\gamma_s h$$

$$K_a = \frac{1 - sin\emptyset}{1 + sin\emptyset}$$

$$K_p = \frac{1 + sin\emptyset}{1 - sin\emptyset}$$

Prestressed concrete

$$f = -\frac{F}{A_c} \pm \frac{Fey}{I} \pm \frac{My}{I}$$

# University of Asia Pacific
# Department of Civil Engineering
# Final Examination Fall 2017
# Program: B.Sc. Engineering (Civil)

Course Title: Environmental Engineering II
Time: 3 hours

Course Code: CE 333
Full Marks: 100

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**There are SIX (6) questions. <u>Question No. 6 is compulsory</u>. Answer Question No. 6 and any FOUR (4) from the rest (Marks distribution= 20+20×4 =100). Assume any missing data.**

1. (a) Explain the mechanisms of VIP and ROEC latrines for human excreta management. **[3+3=6]**
   (b) Why Fossa Alterna latrines are referred as ecosan systems? **[4]**
   (c) Describe the major types of sewers often found in a sewerage network. What are the advantages of combined sewers? **[3+2=5]**
   (d) Write short notes on "sheeting" and "bracing" that are often employed during excavation of sewers. **[2.5+2.5=5]**

2. (a) With necessary diagrams explain the principles of aerated grit chambers. What are the roles of SOR and scour velocity for designing primary sedimentation tanks? **[3+3=6]**
   (b) Which kinetics (between first order and Monod kinetics) describes bacterial growth curve more precisely in a biological reactor? **[4]**
   (c) Why does biomass sloughing occur in attached growth systems? What is the impact of pollutant overloading on RBC systems? **[3+2=5]**
   (d) Explain "contact stabilization" and "pure oxygen activated sludge" systems. **[2.5+2.5=5]**

3. (a) Calculate the volume of first and second stage units of a two stage trickling filter system using NRC formula from the following dataset. **[6]**

- Water temperature= 32°C
- Incoming wastewater= 3000 $m^3/d$
- Influent BOD=250 mg/L
- Expected effluent BOD=15 mg/L
- Depth of each filter=2 m
- Recirculation for filter 1 and 2 ($r_1$=$r_2$)=1.5
- Assume both filters will have equal BOD removal efficacy

Use the following equations if required.

$$E_1 = \frac{100}{1+0.532\sqrt{\frac{W}{VF}}} \qquad E_2 = \frac{100}{1+\frac{0.532}{1-E_1}\sqrt{\frac{W'}{VF}}} \qquad E = 100-(1-\frac{35}{100})(1-\frac{E_1}{100})(1-\frac{E_2}{100})$$

$$F = \frac{1+r}{(1+0.1r)^2}$$

   (b) Explain the parameters that influence denitrification process in a biological reactor. **[4]**
   (c) Why should nutrients be removed from wastewater prior to disposal into open water bodies? Enlist the advantages of biological phosphorus removal process over chemical technologies. **[3+2=5]**

(d) Describe Bardenpho process for nitrogen removal and pre-precipitation process for phosphorus removal from wastewater. **[2.5+2.5=5]**

4. (a) Explain the concept of central effluent treatment plant to treat industrial wastewaters. Why does an environmental engineer need to go through the flow diagram process of industrial manufacturing process before designing wastewater treatment plant? **[3+3=6]**

(b) How can organic media support denitrification in a vertical flow wetland? **[4]**

(c) Why is it difficult to achieve sedimentation and anaerobic digestion in a single stage sludge treatment digester? How does shock loading influence performance of sludge treatment digesters? **[3+2=5]**

(d) Write short notes on: (i) continuous belt filter presses and (ii) sludge drying bed. **[2.5+2.5=5]**

5. (a) Wastewater flow from an area averages 5000 $m^3/d$ during December (winter) and 8000 $m^3/d$ during July (summer). The average temperature of winter is $8^0C$, and in summer average temperature is $32^0C$. The mean concentration of influent $BOD_5$ is 400 mg/L. Reaction coefficient K is 0.23 $d^{-1}$ at $20^0C$, and $\theta$ is 1.06. Design a facultative pond treatment system for the area to remove 90% of the incoming $BOD_5$. Use the following graph if required. **[6]**

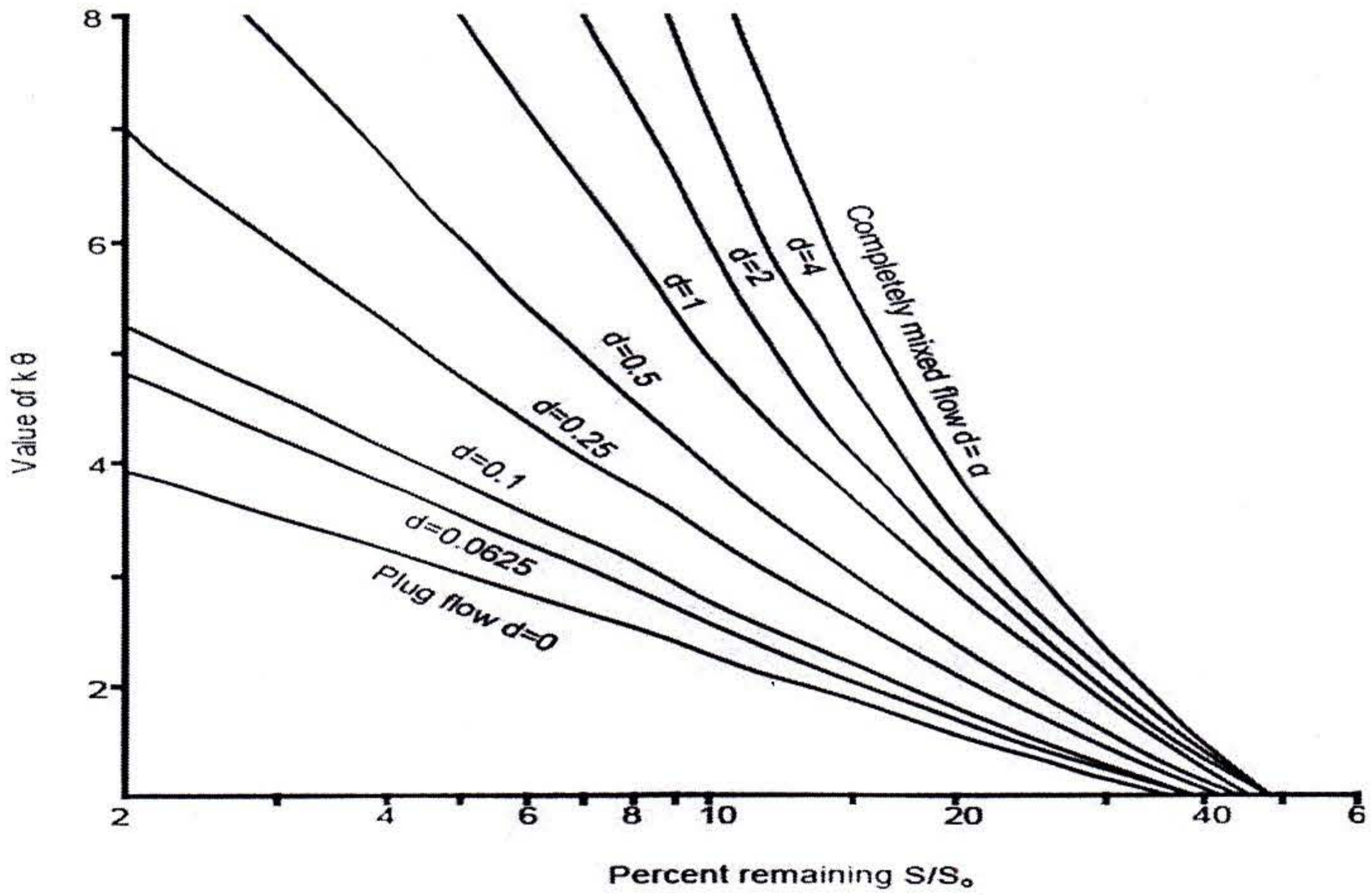



**Figure 1.** Graphical plot of the Thirumurthi equation.

(b) With a schematic diagram explain pollutant removal mechanisms in a facultative pond. **[4]**

(c) What is the impact of polluted lakes on ecological system of Dhaka city? How could the water quality of Hatirjhil lake be improved? **[3+2=5]**

(d) Explain the operating principles of siphon jet and reverse trap water closets. **[2.5+2.5=5]**

6. You have been assigned to propose wastewater treatment plants for two industries namely A and B. Pollutant concentration values in wastewaters generated from these industries are given in the following table. Propose: (i) natural treatment plant (constructed wetlands/ponds) diagram for industry A and (ii) activated sludge process diagram for industry B. **[10+10=20]**

| Parameter | Unit | Concentration | |
|---|---|---|---|
| | | *Industry A* | *Industry B* |
| pH | --- | 5.0 | 7.3 |
| DO | mg/L | 0.5 | 1.1 |
| $NH_4$-N | | 200.0 | --- |
| $NO_3$-N | | 12.0 | 280.0 |
| TN | | 230.0 | 290.0 |
| $BOD_5$ | | 4000.0 | 94.0 |
| COD | | 9000.0 | 200.0 |
| TP | | --- | 15.0 |
| TSS | | 3000.0 | --- |

**University of Asia pacific**
**Department of Civil Engineering**
**Final Examination Fall 2017**
**Program: B.Sc. Engineering (Civil)**

Course Title: Transportation Engineering I (Transport and Traffic Design) Course Code: CE 351
Time: 3 Hours Full Marks: 150

There are **six** questions. Answer **five** of them

1. a) Animate briefly the different components of Passing Sight Distance for a two-lane highway. 12
   b) An urban primary road with 70 ft pavement width having a reflectance of 11% carries a maximum of 1850 vph at night-time. Design the lighting system considering Sodium source with mounting height of 50 ft and a maintenance factor of 0.88. Draw the lighting layout. 13
   c) Combine the factors that affect the choice of specific type of mode? 5

2. a) Discriminate between parallel and angular method of parking. 8
   b) Design the offsets at some interval for a transition curve which is to be employed to join the ends of a $6^0$ circular curve with the straight. The length of transition curve is 300 m. Draw the transition curve. 12
   c) Compile different types of vertical deflection measures for traffic calming. 10

3. a) Design a two-phase signal at an isolated cross-junction for the following data: 12
   Intergreen for N-S: 6 sec and E-W: 7 sec.
   Lost time due to starting and end delays : 3 sec (N-S) and 4 sec (E-W)

| | N | S | E | W |
|---|---|---|---|---|
| Flow(q), veh/hr | 850 | 640 | 870 | 790 |
| Saturation flow(s) veh/hr | 2350 | 1950 | 2470 | 2350 |

   Assume any missing data. Draw bar diagram.
   b) Document the constraints of transportation sector in Bangladesh. 12
   c) Categorize traffic signs along with examples. 6

4. a) Write short notes on any **four**: 12
   i) Color vision ii) Origin Destination survey
   iii) Glare recovery v) Skid resistance
   iv) Park and Ride system
   b) Illustrate the requirements of a bus terminal. 8
   c) A vehicle initially traveling at 52 km/h skids to a stop on a 6% downgrade, where the pavement surface provides a coefficient of friction equal to 0.35. Determine the distance the vehicle travel before coming to a complete stop. 10

5. a) A sag vertical curve is to be designed to join a -6% grade with a +5% grade at a section of a two-lane highway. The design speed of the highway is 55 mph. Determine the minimum length of the curve. Assume the stopping sight distance is 540 ft. 12
   b) Mayor of Dhaka North city corporation is planning to erect a billboard at a distance 70 ft from the centerline of the inside lane near the Kuril flyover. The safe stopping sight 18

distance of the road is 60 ft. The inside lane in 12 ft wide. Compute the speed limit of that section of the roadway. Assume reaction time as 2.5 second and friction factor as 0.348.

6. a) Spot speeds (km/hr) of 50 vehicles navigating a section of an major road are as below: 25
53, 77, 55, 38, 55, 56, 39, 36, 53, 45, 73, 56, 43, 37, 47, 44, 68, 53, 67, 64, 66, 46, 49, 57, 44, 33, 65, 76, 26, 58, 57, 70, 59, 88, 58, 37, 53, 75, 39, 46, 48, 42, 45, 63, 62, 48, 76, 42, 83, 37.
Estimate the design speed, average speed, safe speed, median speed, and upper limit of speed. (Consider pace as **10-19, 20-29** and so on)

b) Explain time-mean and space-mean speeds. 5

**Necessary equations:**

$$S < L: \quad L = \frac{AS^2}{100(\sqrt{2h_1} + \sqrt{2h_2})^2}$$

$$S > L: \quad L = 2S - \frac{200(\sqrt{h_1} + \sqrt{h_2})^2}{A}$$

$$S < L: \quad L = \frac{AS^2}{200[2.0 + S(\tan 1^\circ)]}$$

$$S > L: \quad L = 2S - \frac{200[2.0 + S(\tan 1^\circ)]}{A}$$

## Table for Question 1a)

TABLE 1 RECOMMENDED AVERAGE ILLUMINATION (LUMENS/FT$^2$)

| Pedestrian traffic[1] | Vehicular traffic[2] (vph) | | | |
|---|---|---|---|---|
| | Very light (<150 vph) | Light (150 – 500 vph) | Medium (500 – 1,200 vph) | Heavy (>1,200 vph) |
| Heavy | - | 0.8 | 1.0 | 1.2 |
| Medium | - | 0.6 | 0.8 | 1.0 |
| Light | 0.2 | 0.4 | 0.6 | 0.8 |

Notes: (1) Heavy: As on main business street
Medium: As on secondary business streets
Light: As on local streets
(2) Night hour flow in both directions

TABLE 2 ADJUSTMENT FACTORS FOR RECOMMENDED AVERAGE ILLUMINATION VALUES

| Surface Reflectance | Adjustment Factors |
|---|---|
| 3 % or less | 1.5 |
| 10% | 1.0 |
| 20% or more | 0.75 |

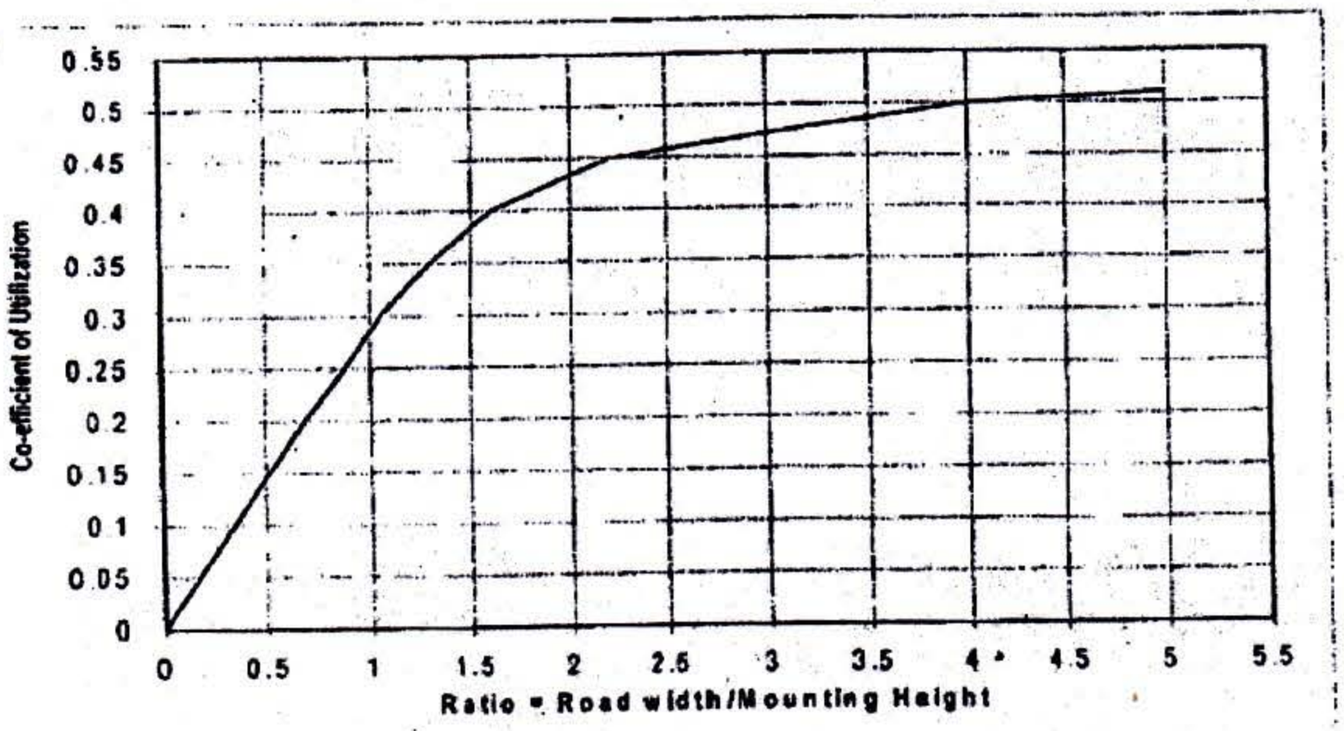
TABLE 3 LIGHTING SOURCE CHARACTERISTICS

| Source Types | Expected Life (hrs) | Lighting Efficiency (Lumens/Watt) | Wattage (Watt) |
|---|---|---|---|
| Tungsten | 1000 | 8 – 14 | Up to 1000 |
| Fluorescent | 6000 | 50 – 75 | Up to 250 |
| Sodium | 6000 | 100 – 120 | Up to 160 |
| Mercury | 7500 | 20 – 60 | Up to 400 |

TABLE 4 RECOMMENDED ARRANGEMENT OF STREET LIGHTING

| Type of Arrangement | Pavement Width |
|---|---|
| One side | Width <= 30ft |
| Both sides – Staggered | 30ft > Width <= 60ft |
| Both sides – Opposite | Width > 60ft |

FIGURE 1 CO-EFFICIENT OF UTILIZATION CURVES (FOR LIGHT DISTRIBUTION TYPE III)




Note: Due to poor maintenance, the actual co-efficient of utilization is reduced by a factor usually 0.8 (i.e. taken as 80%).

# University of Asia Pacific
# Department of Civil Engineering
# Final Examination Fall 2017
# Program: B.Sc. Engineering (Civil)

Course Title: Engineering Hydrology
Time: 3 hours

Course Code: CE 363
Full marks: 150

Assume any reasonable value, if not given

## Part A

**There are FOUR questions. Answer any THREE.**

1(a). Write short notes on (any four): (10)

i. Dalton's law of evaporation
ii. Hadley Circulation
iii. Recurrence Interval
iv. Front
v. Intensity-Duration-Frequency relationship

1(b). Calculate the volume of precipitable water in a 10 km high saturated atmospheric column over an area of 200 $km^2$, if the surface conditions are as follows: temperature = 20 °C, pressure = 101.1 kPa and lapse rate 6.5 °C/km. (15)

2(a). The normal annual precipitation of five raingauge stations *P, Q, R, S* and *T* are respectively 100.3 cm, 109.5 cm, 93.5 cm, 125.7 cm and 117.5 cm. During a particular storm the precipitation recorded by stations *P, Q, S* and *T* were 9.7 cm, 8.3 cm, 11.7 cm and 8.0 cm respectively. The instrument at station *R* was inoperative during that storm. Estimate the rainfall at station R during that storm. (5)

2(b). There are 5 rain gauges in Comilla, as shown in the Figure 1 (see page 5). Annual rainfall recorded in *A, B, C, D and E* gauge are 58 cm, 63 cm, 62 cm, 68 cm and 68.5 cm respectively. Calculate average annual rainfall in the area applying Thiessen Polygon where 1 small square = 10 $km^2$. (15)

2(c). Explain Water – Budget method to estimate evaporation. (5)

3(a). The precipitation over a 15 $km^2$ catchment produced a direct runoff of 5.8 cm. The time distribution of the storm is as follows: (10)

| Time from start (hrs) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Incremental rainfall in each hour (cm) | 0.4 | 0.5 | 1.5 | 2.3 | 1.8 | 1.6 | 1 | 0.5 |

Calculate Φ index and the discharge at the outlet.

3(b). The initial rate of infiltration of a watershed is estimated as 2.1 cm/hr, the final capacity is 0.2 cm/hr, and the time constant, k is 0.4 $hr^{-1}$. Use Horton's Equation to determine the infiltration capacity at t = 2 hrs and t = 6 hrs. (10)

3(c). Explain diagrammatically storage in a channel reach during a flood event. (5)

4(a). Estimate the daily potential evapotranspiration from the following data using Penman's formula. (15)

Slope of the saturation vs. temperature at the mean air temperature = 1.00 mm/°C

Net radiation = 1.990 mm of water per day

Relative humidity = 75%

Atmospheric air temperature, $t_a = 14.485$ °C
Wind velocity at 2 m height = 85 km/day
Psychometric constant = 0.49 mm of Hg.

4(b). The ordinates of a 2-hr unit hydrograph are given below: (10)

| Time | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|
| UH ordinate (cumec) | 0 | 60 | 120 | 90 | 50 | 30 | 20 | 10 | 5 | 0 |

If two storms occur, each of 2-hr duration and having rainfall excess values of 2.0 cm and 4.0 cm respectively, then compute the Direct Runoff Hydrograph.

## Part B

**There are THREE questions. Answer any TWO.**

5(a). Define unit hydrograph? List the assumptions involved in the unit hydrograph theory? (5)

5(b). A spillway crest is at elevation 100.50 m, the following hydrograph entered the reservoir. (10)

| Time (hrs) | 0 | 6 | 12 | 18 | 24 | 30 | 36 |
|---|---|---|---|---|---|---|---|
| Discharge ($m^3/s$) | 10 | 20 | 55 | 80 | 73 | 47 | 46 |

Formulate outflow hydrograph using flood routing.
Storage-Elevation and Discharge-Elevation data for the reservoir are given in Page 6 (Figure 2).

5(c). Route the following flood hydrograph and generate outflow hydrograph through a channel reach for which Muskingum coefficient $K = 8$ hrs and $x = 0.25$. (10)

| Time (hrs) | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 28 |
|---|---|---|---|---|---|---|---|---|
| Inflow ($m^3/s$) | 8 | 16 | 30 | 30 | 25 | 20 | 15 | 10 |

The initial outflow discharge from the reach is 8 $m^3/s$.

6(a). Describe the roles of drainage density and shape of basin on hydrograph. (10)

6(b). Observed flows from a 6-hrs storm on a stream with a catchment area of 10.37 $km^2$ are given below: (10)

| Time (hrs) | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Discharge ($m^3/s$) | 10 | 100 | 250 | 200 | 150 | 100 | 70 | 50 | 35 | 25 | 12 |

Derive the ordinates of 6-hrs unit hydrograph

6(c). Explain the followings: (5)

i. Potential Evapotranspiration;
ii. Infiltration Capacity.

7(a). Flood-frequency computations for the river Ganges at *Hardinge bridge*, by using Gumbel's method, yielded the following data: (15)

| Return period, T (yrs) | Peak flood (cumec) |
|---|---|
| 100 | 40,809 |
| 150 | 46,300 |

Data covering a period of 90 years, yielded the mean and standard derivation of the annual flood series as 6437 $m^3/s$ and 2951 $m^3/s$ respectively.
Predict the design discharge in the river for recurrence interval of 200 years and determine 95% confidence limits for the estimate?

[Assume, $\bar{y}_n = 0.5589$, f(c) = 1.96 and $S_n = 1.2020$]

7(b). The following data are collected for a 25 m wide stream at a gauging station. Compute the discharge. (10)

| Distance from left water edge (m) | Depth, d (m) | Revolutions of current meter kept at | | Duration of observation (s) |
|---|---|---|---|---|
| | | 0.2 depth | 0.8 depth | |
| 0 | 0 | 0 | 0 | 0 |
| 3 | 0.8 | 30 | 17 | 50 |
| 6 | 1.0 | 36 | 24 | 50 |
| 9 | 1.3 | 45 | 35 | 50 |
| 12 | 1.7 | 62 | 51 | 50 |
| 15 | 2.2 | 102 | 87 | 50 |
| 18 | 2.8 | 120 | 103 | 50 |
| 21 | 2.3 | 67 | 53 | 50 |
| 24 | 1.9 | 35 | 22 | 50 |
| 27 | 1.2 | 24 | 15 | 50 |
| 30 | 0 | 0 | 0 | 50 |

Calibration equation of current meter: $v = 0.35N_s + 0.05$; $N_s$ = revolutions per second, v = velocity, m/s.

## Part C

**This part is Compulsory.**

8(a). In a catchment of 1 $km^2$, the following data has been recorded: (25)

| Month | Average Precipitation (cm) | Average Evaporation (cm/h) | Average Evapotranspiration (cm/h) | Average Other Losses (cm) |
|---|---|---|---|---|
| January | 15 | 0.07475 | 0.017167 | 12 |
| February | 27 | 0.07475 | 0.017167 | 7.2 |
| March | 35 | 0.07475 | 0.017167 | 6.4 |
| April | 40 | 0.07475 | 0.017167 | 5.6 |
| May | 50 | 0.07475 | 0.017167 | 4.8 |
| June | 60 | 0.07475 | 0.017167 | 4 |
| July | 70 | 0.07475 | 0.017167 | 3.2 |
| August | 75 | 0.07475 | 0.017167 | 2.4 |
| September | 90 | 0.07475 | 0.017167 | 1.6 |
| October | 95 | 0.07475 | 0.017167 | 1 |
| November | 98 | 0.07475 | 0.017167 | 0.5 |
| December | 102 | 0.07475 | 0.017167 | 0.35 |

Formulate mathematical model for the catchment by plotting runoff-rainfall relationship.

## List of Equations

1. $E_L = K_M(e_w - e_a)(1 + \frac{u_9}{16})$
2. $x_T = \bar{x} + K_T\sigma_{n-1}$
3. $K_T = \frac{y_T - \overline{y_n}}{S_n}$
4. $y_T = -[\ln.\ln(T/(T-1))]$
5. $i_{tc,p} = \frac{KT_x}{(t_c + a)^m}$ ,
6. $S_e = b\frac{\sigma_{n-1}}{\sqrt{N}}$
7. $B = \sqrt{1 + 1.3K + 1.1K^2}$
8. $Q_2 = C_0 I_2 + C_1 I_1 + C_2 Q_1$

   Where,

   a) $C_0 = \frac{-Kx + 0.5\Delta t}{K - Kx + 0.5\Delta t}$

   b) $C_1 = \frac{Kx + 0.5\Delta t}{K - Kx + 0.5\Delta t}$

   c) $C_2 = \frac{K - Kx - 0.5\Delta t}{K - Kx + 0.5\Delta t}$

**Figure 1: Question 2(b). Enclose the figure with your answer script:**

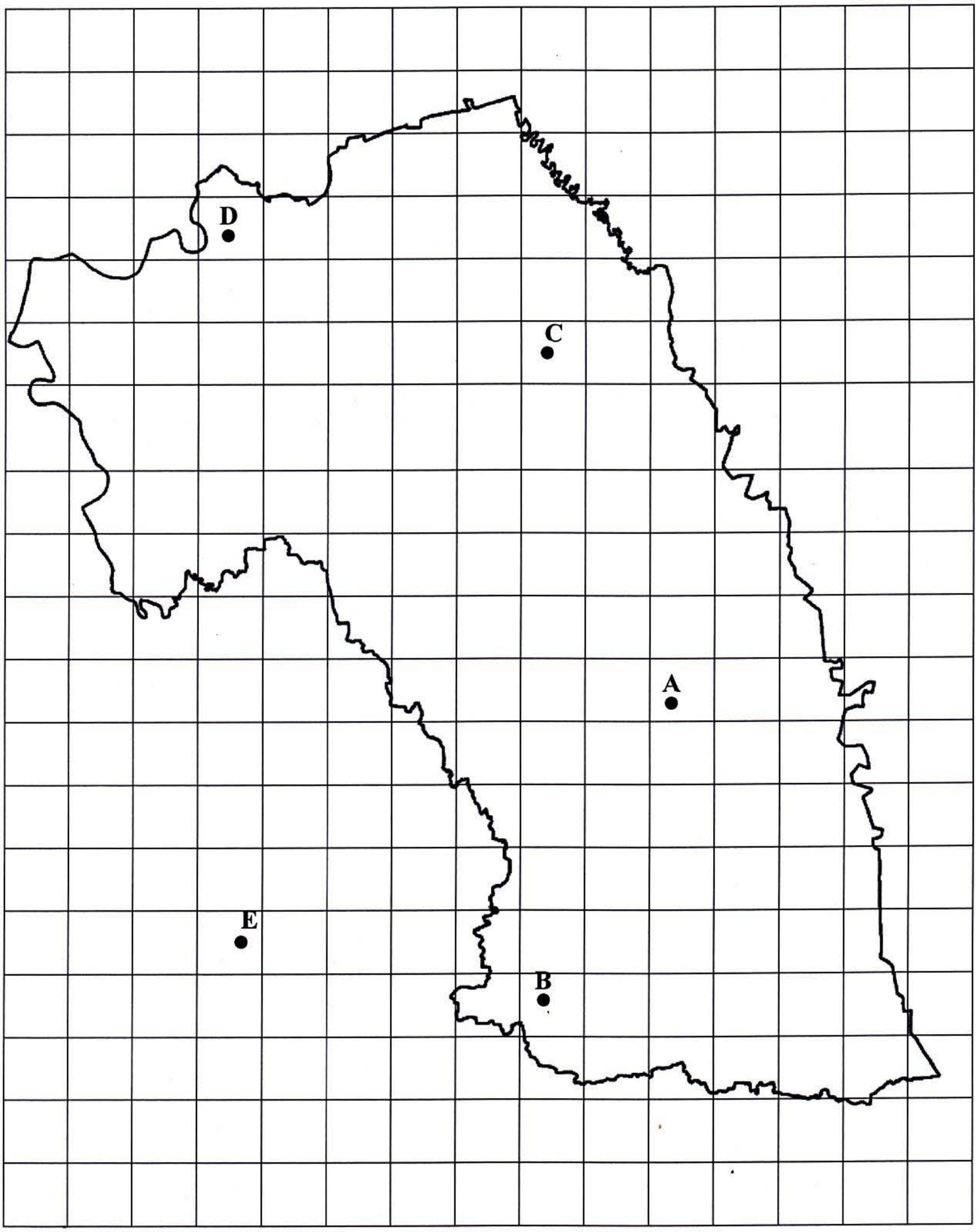


**Figure 2: Question 5 (b). Enclose the figure with your answer script:**