(4/3)

**B.Sc. Egg. (CEE)/1st Sem.** **2 December, 2022**
**10:00 A.M to 1:00 P.M**

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

**DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING**

**Semester Final Examination** **Winter Semester: 2021 - 2022**

**Course No.: CEE 4101** **Full Marks: 100**

**Course Title: Introduction to Civil Engineering** **Time: 3 Hours**

**There are 6 (Six) questions. Answer all questions. Do not write on this question paper. The figures in the right margin indicate full marks and corresponding CO and PO. The Symbols have their usual meaning.**

| | | |
|---|---|---|
| 1. | a) Define the bearing Capacity of soil. How the bearing capacity of a soil can be improved? | (5) (CO1, PO1) |
| | b) Describe briefly the factors that need to be considered for choosing a foundation. | (5) (CO1, PO1) |
| | c) When should we use pile foundation? Describe its type and function. | (5) (CO1, PO1) |
| 2. | a) Describe the purpose of structural drawings for building construction and the elements addressed in these drawings. | (4) (CO1, PO1) |
| | b) Discuss the role of Structural Engineer in project management. | (5) (CO1, PO1) |
| | c) Structural engineering deals with 'bones and muscles' of man-made structures – please Justify. | (6) (CO2, PO2) |
| 3. | Write Short Notes on: | (5 x 5) |
| | a) Structural Engineer Vs Architect | (CO1, |
| | b) Rigid Pavement Vs Flexible Pavement | PO1) |
| | c) Load Bearing Structure Vs Frame Structure | |
| | d) OPC Vs PCC | |
| | e) Code of Ethics Vs Code of Conduct | |
| 4. | a) Explain why steel is being widely used in construction. | (4) (CO1, PO1) |
| | b) Write down the essential properties of first-class brick. | (6) (CO1, PO1) |
| | c) Define concrete and discuss its advantages in construction work. | (5) (CO1, PO1) |
| 5. | a) Describe the purpose of using Mat/Raft foundation and its principle and function. | (4) (CO1, PO1) |
| | b) State briefly (what and why) the information requires before preparing structural design. | (5) (CO1, PO1) |
| | c) Explain the importance of transportation system towards a nation in view of civil engineer's perspective. | (6) (CO2, PO2) |
| 6. | a) State the difference among code, standard and specification. | (5) (CO1, PO1) |
| | b) Discuss the scope and purpose of BNBC. | (6) (CO1, PO1) |
| | c) Identify the major air pollutants and describe their effects to environment. | (4) (CO1, PO1) |

B. Sc. Engg. (CEE)/ 1st Sem. 30 November, 2022 (Group-A)

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

## DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Semester Final Examination**
**Course No.: CEE 4103**
**Course Title: Surveying**

**Winter Semester: 2021-2022**
**Full Marks: 200**
**Time: 3 Hours**

**There are 5 (Five) questions. Question no. 1, 2, 3 are compulsory. Answer any one from question no. 4 and 5. Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks. The Symbols have their usual meaning. Assume missing value, if any.**

1. **Answer any four questions shown below from (a) to (f) :**

(a) Write a detailed note on applications of remote sensing. (10) (CO1-PO1)

(b) Write a note on the components of a GIS. (10) (CO1-PO1)

(c) Define (i) Celestial poles and Celestial Equator (ii) Celestial Horizon (iii) Zenith and Nadir. Draw necessary sketches. (10) (CO1- PO1)

(d) Describe with the help of sketches the characteristics of contours. (10) (CO1- PO1)

(e) Explain the "closing error'' of a traverse survey? Show how you can adjust it by graphical method. (10) (CO- PO1)

(f) Define (i) Fiducial Marks and Fiducial lines (ii) Ground Control (iii) Drift (iv) Terrestrial Photogrammetry (10) (CO1- PO1)

2(a) The following data are taken from a level book in which some of the readings were found to be missing. Calculate the missing data (indicated by "?") and reduced level of all stations. Apply usual checks and draw necessary diagrams. (20) (CO2- PO2)

| Station | Staff reading(ft) | | | Rise(ft) | Fall(ft) | R. L. | Remarks |
|---|---|---|---|---|---|---|---|
| | Back | Inter | Fore | | | | |
| A | 1.5 | | | | | | |
| B | | 2.1 | | | | | |
| C | 3.3 | | 1.3 | | | | T.P. |
| D | | ? | | | | 10.5 | B.M. |
| E | 4.4 | | 5.9 | 0.4 | | | T.P. |
| F | ? | | 3.3 | | | | T.P. |
| G | | | 3.3 | 0.2 | | | |

R.L. = Reduced level, T.P.= Turning point, B. M.= Bench mark

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(b) The table below displays the field data for a tacheometric survey using a tacheometer survey using a tacheometer fitted with an anallactic lens for a vertically held staff. (20) (CO2- PO2)

| Imstrument station | Height of instrument(m) | Staff station | Vertical angle | Staff Readings |
|---|---|---|---|---|
| O | 1.45 | B | - 5°30' | 1.75, 1.95, 2.15 |
| O | 1.45 | P | 9°30' | 1.50, 1.65, 1.80 |
| P | 1.3 | Q | 12°00' | 1.89, 2.05, 2.21 |

Calculate the horizontal distances OP, OB and PQ. Also, calculate the elevations of Q, P and O if the elevation of B is 500 meter.

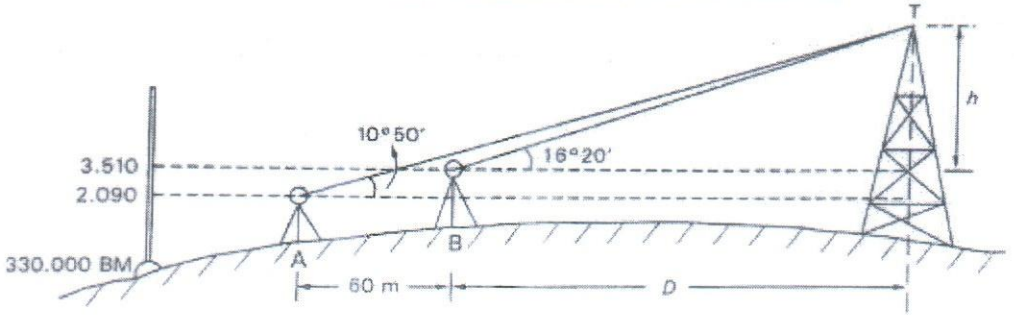
(c) A railway embankment 500 m long is 15 m wide at the formation level and has side slope 3(Horizontal) to 1(Vertical). The ground levels at every 100m along the centre line are as under: (15) (CO2- PO2)

| Distance(m) | 0 | 100 | 200 | 300 | 400 |
|---|---|---|---|---|---|
| R. L.(m) | 204 | 205 | 206 | 206 | 207 |

The formation level at 0 chainage is 215 m and the embankment has a falling gradient of 1 in 200. The ground is level across the centre line. Calculate the volume of earth work by trapezoidal and prismoidal rule.

(d) Determine the RL of the top of a tower from the following observations. Also find its distance from B. The distance AB= 60 m, and stations A and B are in line with the tower. (08) (CO2- PO2)

| Inst. station | Reading on BM(m) | Vertical angle of tower | RL of BM |
|---|---|---|---|
| B | 3.510 | 16°20' | 330.0 m |
| A | 2.090 | 10°50' | |




(e) Find the local apparent time of an observation at a place in longitude 45° E, corresponding to local mean time 10h 10m 10s, the equation of time at G.M.N. being 5m additive to mean time, and decreasing at the rate of 0.32s per hour. (10) (CO2- PO2)

(f) First half of an Engineer's chain measures 48.50 feet while the second half of that particular chain measures 51.00 feet. A certain distance from point 'A' to 'B' has been measured by this defective chain and found to be 2860.40 feet. What is the exact distance between those two points? (07) (CO2- PO2)

3(a) A curve of radius 250 m was to be set by offsets from the long chord. The deflection angle is 50°. Tabulate the offset values at 25 m intervals from the midpoint of the long chord. (10) (CO3- PO2)

(b) Two tangents intersect at chainage 75+50, the deflection angle being 45°. Calculate necessary data for setting out a curve of 10 chains radius to connect the two tangents if it is intended to set out the curve by offsets from chords. Take peg interval equal to 50 links, the length of the chain being equal to 30 metres(100 links). (15) (CO3- PO2)

(c) A sag vertical curve is to be designed with following data: (20) (CO3- PO2)
R. L. of PVI= +8.250 m
Chainage of PVI= 1500 m
Initial grade= - 8%
Final grade= - 4%
Length of curve= 60 m
Determine the elevation of road at chainage 1460 m, 1470 m, 1500 m, 1530 m and 1550 m.

(d) A road bend, which deflect 75°, is to be designed for a maximum speed of 90 km/hr, a maximum centrifugal ratio ¼ and a maximum rate to the change of acceleration of 0.3 $m/sec^3$. The curve consists of a circular arc in combination with two cubic parabolas. Calculate- (15) (CO3- PO2)

(i) Radius of the circular arc.
(ii) The requisite length of transition curve.
(iii) The total length of the composite curve.
(iv) The chainage of the beginning and end of transition curve and of the junctions of the transition curves with the circular arc if the chainage of the P.I is 10000 meters.

4(a) The scale of an aerial photograph is 1cm= 500 m. The photograph size is 20 cm x 20 cm. Longitudinal lap is 60% and side lap is 40 %. Determine the number of photographs required to cover an area of i) 625 sq. km. ii) 50 km x 50 km (10) (CO4- PO2)

(b) Write a note on radiation method and intersection method of plane table surveying with figures. (10) (CO4- PO2)

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5. The bearings of two lines (DE and EF) could not be measured due to field problems. Find these bearings from the remaining data available. (20) (CO4- PO2)

| Line | Length(m) | Bearing |
|---|---|---|
| AB | 151.24 | 160°33' |
| BC | 258.52 | 58°48' |
| CD | 270.32 | 320°47' |
| DE | 121.8 | - |
| EF | 203.7 | - |
| FA | 174.2 | 114°59' |

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## Equations' Table

| | |
|---|---|
| 1. $l = l'.\left(\frac{L'}{L}\right)$ | 18. $\Delta = \left(\frac{O_0+O_n}{2} + O_1 + O_2 + O_3 + \cdots + O_{n-1}\right) d$ |
| 2. $A = A'.\left(\frac{L'}{L}\right)^2$ | 19. $\Delta = \frac{d}{3}[(O_0 + O_n) + 4(O_1 + O_3 + \cdots + O_{n-1}) + 2(O_2 +$ $O4+\ldots+On-2)$ |
| 3. $V = V'.\left(\frac{L'}{L}\right)^3$ | 20. $V = d\left[\frac{(A_0+A_n)}{2} + A_1 + A_2 + \cdots + A_{n-1}\right]$ |
| 4. $C_t = \alpha(T_m - T_o)L$ | 21. $V = \frac{d}{3}[(A_0 + A_n) + 4(A_1 + A_3 + \cdots + A_{n-1}) + 2(A_2 +$ $A4+\ldots+An-2)$ |
| 5. $C_p = \frac{(P-P_o)L}{AE}$ | 22. A=h(nh+b) |
| 6. $C_s = nC_{s1} = \frac{nl_1(wl_1)^2}{24P^2}$ | 23. $C_p = V_T - V_P$ |
| 7. $P_n = \frac{0.204w_1\sqrt{AE}}{\sqrt{P_n - P_0}}$ | 24. $C_c = \frac{d^2}{2R}$ (Subs) |
| 8. Back Bearing = Force Bearing $\pm 180^o$ | 25. $C_R = \frac{1}{7}.\frac{d^2}{2R}$ (add) |
| 9. B.B of AB = F.B of BA | 26. $C_c = \frac{6}{7}.\frac{d^2}{2R}$ |
| 10. include angle=(2N-4)$\times 90^o$ | 27. $H = \frac{1}{2}[(h_a - h_b) + (h_a - h_b)]$ |
| 11. exclude angle=(2N+4)$\times 90^o$ | 28. $D = (b + s\cot\alpha_2)\frac{\tan\alpha_2}{\tan\alpha_1 - \tan\alpha_2}$ |
| 12. $\sum L = l_1\cos\theta_1 + l_2\cos\theta_2 + l_3\cos\theta_3 + \ldots = 0$ | 29. $h_1 = D\tan\alpha_1$ |
| 13. $\sum D = l_1\sin\theta_1 + l_2 sin\theta_2 + l_3\sin\theta_3 + \cdots = 0$ | 30. $D = (KS+C)\cos\theta + h\sin\theta$ |
| 14. $A = \sqrt{s(s-a)(s-b)(s-c)}$ | 31. $H = L\sin\theta = KS\ \sin\theta + C\ \sin\theta$ |
| 15. $A = \lvert\sum M_i L_i\rvert$ | 32. $D = L\cos\theta = KS\,(\cos\theta)^2 + C\ \cos\theta$ |
| 16. $M_i = M_{i-1} + \frac{D_{i-1}+D_i}{2}$ | 33. $H = L\sin\theta = KS\frac{\sin 2\theta}{2} + C\sin\theta$ |
| 17. $\Delta = \frac{O_1+O_2+O_3+\cdots+O_n}{n+1} \times L = \frac{L}{n+1}\sum O$ | 34. $\frac{\text{Map Distance}}{\text{Photo Distance}} = \frac{\text{Map Scale}}{\text{Photo Scale}}$ |

| | |
|---|---|
| 35. $R = \frac{5730}{D} = \frac{50}{\sin(\frac{1}{2}D)}$ | 49. $\delta \cong 1718.9\frac{C}{R}$ |
| 36. $l = \frac{\Pi R}{180^0}\Delta$ | 50. $e = \frac{B\vartheta^2}{gR}$ |
| 37. $L = 2R\sin\frac{\Delta}{2}$ | 51. $\tan\theta = \frac{v^2}{gR}$ |
| 38. $T = R\tan\frac{\Delta}{2}$ | 52. $\Delta = \Delta_c + 2\Delta_s$ |
| 39. $E = R(\sec\frac{\Delta}{2} - 1)$ | 53. $L = \frac{\vartheta^3}{\alpha R}$ |
| 40. $M = R(1-\cos\frac{\Delta}{2})$ | 54. Total Tangent Length $= (R+S)\tan\frac{\Delta}{2} + \frac{L}{2}$ |
| 41. $O_o = R - \sqrt{R^2 - (\frac{L}{2})^2}$ | 55. Length of Circular Curve $= \frac{\Pi R\Delta_c}{180}$ |
| 42. $O_x = \sqrt{R^2 - x^2} - (R - O_0)$ (exact) | 56. Length of Combined Curve $= \frac{\Pi R(\Delta - 2\Delta_s)}{180} + 2L$ |
| 43. $O_x = \frac{x(L-x)}{2R}$ (app) | 57. $y = HT_2(\frac{x}{L})^2$ |
| 44. $CD = R(1-\cos\frac{\Delta}{2}) = R - \sqrt{R^2 - (\frac{L}{2})^2}$ | 58. $L = \frac{(g_1 - g_2)}{r}$ |
| 45. $C_1D_1 = R(1 - \cos\frac{\Delta}{4})$ | 59. $\Delta_s = 1719\frac{L}{R}$ |
| 46. $O_x = \sqrt{R^2 + x^2} - R$ (exact) | 60. $s = \frac{L^2}{24R}$ |
| 47. $O_x = \frac{x^2}{2R}$ (app) | 61. $O_n = \frac{C_n}{2R}(C_{n-1} + C_n)$ |
| 48. $O_x = R - \sqrt{R^2 - x^2}$ (exact) | |

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B.Sc. Engg. (CEE)/ 3rd Sem.

15 December, 2022 (Group-B)

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
## ORGANISATION OF ISLAMIC COOPERATION (OIC)
## DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Semester: Semester Final Examination** — **Winter Semester: 2021-2022**
**Course No.: GS 4351** — **Full Marks: 150**
**Course Title: Geology and Geomorphology** — **Time: 3 hours**

There are 7 **(Seven)** Questions. **Question 1 is compulsory. Answer any 5 (Five) of the remaining 6 (Six)** questions. Programmable calculators are not allowed. Do not write on this questions paper except when using provided graphs. The symbols have their usual meaning. Assume reasonable values for any missing information. Assigned marks, along with CO-PO for each question, is shown at the right margin.

**1(a)** Why Iceland is a unique geological subject? Discuss its geology using plate tectonic theory. **(6)** [CO1 PO1]

**1(b)** Describe the process of cementation of sedimentary rock. Distinguish between Decompression melting and Flux melting. **(9)** [CO1 PO1]

**1(c)** Write down different types of silicate structures along with at least one example mineral. **(7)** [CO2 PO1]

**1(d)** Discuss briefly: i) Mass wasting, ii) Exogenic process, iii) Extrusive vs. Intrusive magma, iv) Olivine. **(8)** [CO2 PO1]

**2(a)** What is S and P waves? Explain, with sketches, how the earthqauke epicenter is located using multiple seismic stations. **(4+5)** [CO3 PO2]

**2(b)** A river is carrying significant amount of suspended load of different sizes. During dry season, a section of river flows 32 cubic meter per second through 320 sq. meter cross section. *Find the minimum size of the deposited particles*. However, during moonson, the flow increases significantly but the channel cross section only increases 1 sq. meter for each 10 cubic meter flow increase. *What would be the flow rate (in cubic meter per second) when the minimum sized particles, deposited during dry season, will be eroded away?* Use curves shown in Figure 1. **(15)** [CO4 PO2]

**3(a)** Write down different types of drainage pattern. What types of drainage pattern will you anticipate on the outside and inside (caldera) of a volcano? **(5+4)** [CO3 PO2]

**3(b)** Grade the stream network covering 10 sq. km area shown in Figure 2 using Horton's method (separate the page from the question and staple to your script). Find bifurcation ratio, length ratio, drainage density, and stream frequency. Length of stream can be estimated using the following formula: $(n+1)^{(0.5+n)}$ km, where 'n' is the stream order. **(15)** [CO4 PO2]

**4(a)** Identify different types of sediment tranportation with neat sketches. Also, explain that Richter scale magnitude of an earthquake is same for all seismic stations. **(5+4)** [CO3 PO2]

**4(b)** A seismic survey was conducted at a site to measure subsoil condition. Time-distance information obtained through this survey was used to construct the graph shown in Figure 3. Identify layer materials and measure layer thickness using information in Figure 3 and 4. **(15)** [CO4 PO2]

**5(a)** Discuss the effect of i) urbnization, ii) soil moisture, iii) elongated basin and iv) vegitation on drainage of a basin with corresponding qualitative sketches of flood hydrograph. **(9)** [CO3 PO2]

**5(b)** Two drainage basin A and B are shown in Figure 5. Drainage basin A has a time concentration of 30 minutes which is then drained though a surface drain. This drain has a length of 5 km and water take 25 minutes to travel from the beginning of the drain to the end where it is connected to a river. For the same rainfall, Area B has a time of concentration of 20 minutes which is then discharged in a different drain which discharges the water to the same point of same river after 45 minutes of travel time in the 8 km long drain. Each basin has a peak overland flow of 20 cubic meter per second. Assuming triangular flood hydrograph shape for both basins, what is the maximum flow of the river due to these two drainage basins' overland flow? **(15)** [CO4 PO2]

**6(a)** Distinguish between geology and geomorphology. What is the importance of understanding geomorphology of a construction site from the perspective of a civil engineer? **(9)** [CO3 PO2]

**6(b)** Find earthquake location (using a graph) and magnitude of a given earthquake using the information from seismic stations given below. One of the station has an uncalibrated/inaccurate instrument. Identify the problamatic station along with the concerning instrument and find out what should have been the actual arrival time and ground acceleration of the inaccurate instrument. Richter nomograph is provided in Figure 6. **(15)** [CO4 PO2]

| Station | Coordinates (X,Y) of the Station, km | S-P wave diff., sec. | Amplitude, mm |
|---|---|---|---|
| A | 0,0 | 39 | 10 |
| B | 300,400 | 18 | 50 |
| C | 700,200 | 48 | 20 |
| D | 500,450 | 36 | 9 |
| E | 400,700 | 52 | 2.5 |

**7(a)** What are the assumptions and limitations of rational method of peak runoff flow calculation? **(9)** [CO3 PO2]

**7(b)** Describe the following geomorphological features related to river actions with sketches as necessary: i) river terraces, ii) alluvial fan, iii) flood plain, iv) braided channel, v) river delta. Also, write down the engineering parameters of an earthquake that are important from civil engineering perspective. **(10+5)** [CO4 PO2]

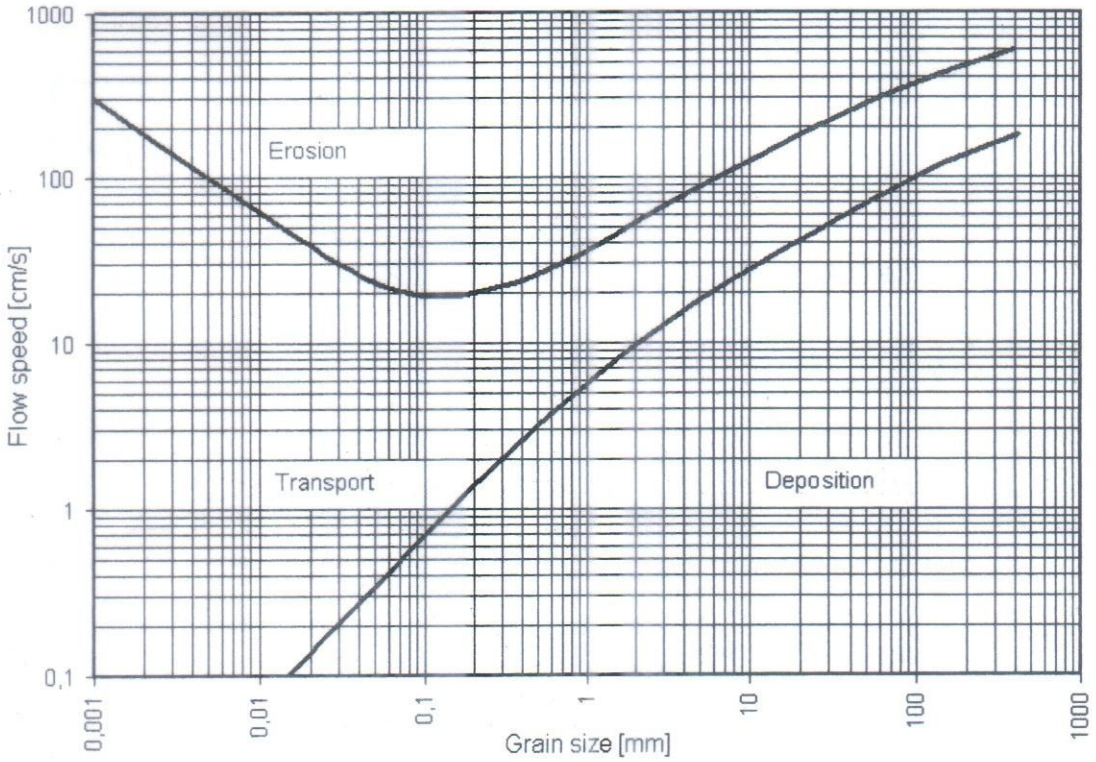


**Figure 1**

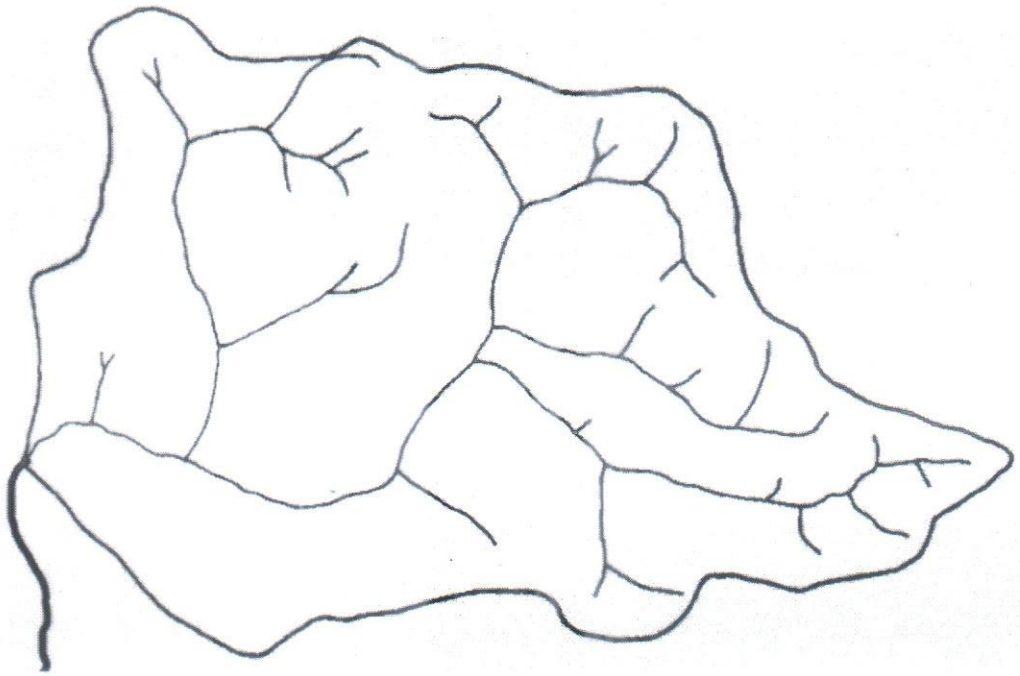

**Figure 2**

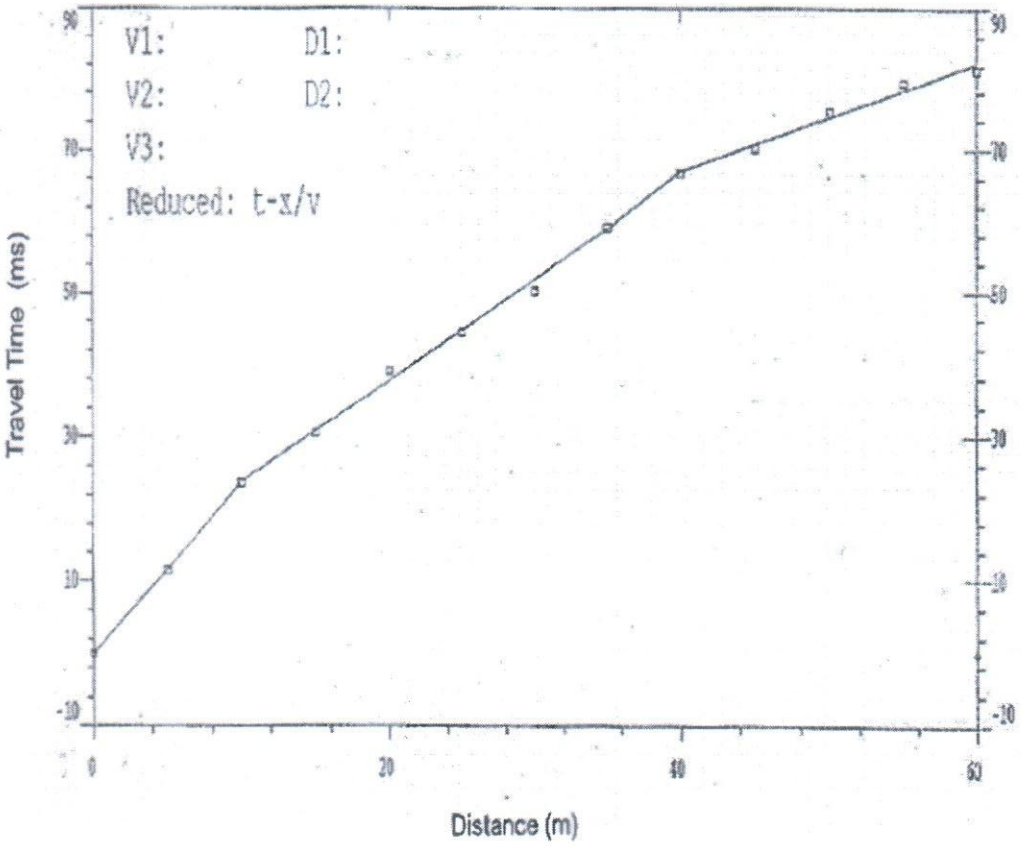


Figure 3

| Type of soil or rock | *P*-wave velocity m/s |
|---|---|
| *Soil* | |
| Sand, dry silt, and fine-grained topsoil | 200–1000 |
| Alluvium | 500–2000 |
| Compacted clays, clayey gravel, and dense clayey sand | 1000–2500 |
| Loess | 250–750 |
| *Rock* | |
| Slate and shale | 2500–5000 |
| Sandstone | 1500–5000 |
| Granite | 4000–6000 |
| Sound limestone | 5000–10,000 |

**Figure 4**

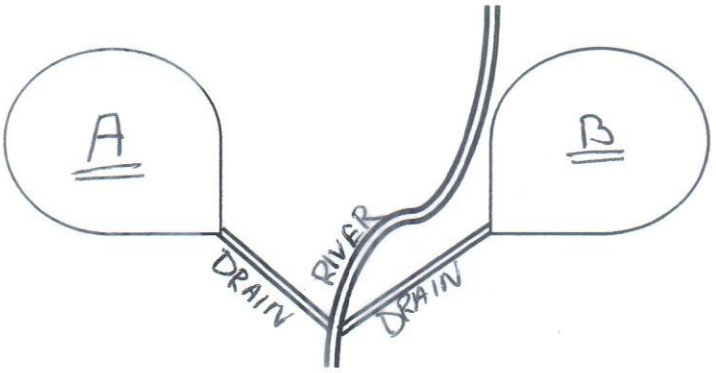


**Figure 5**

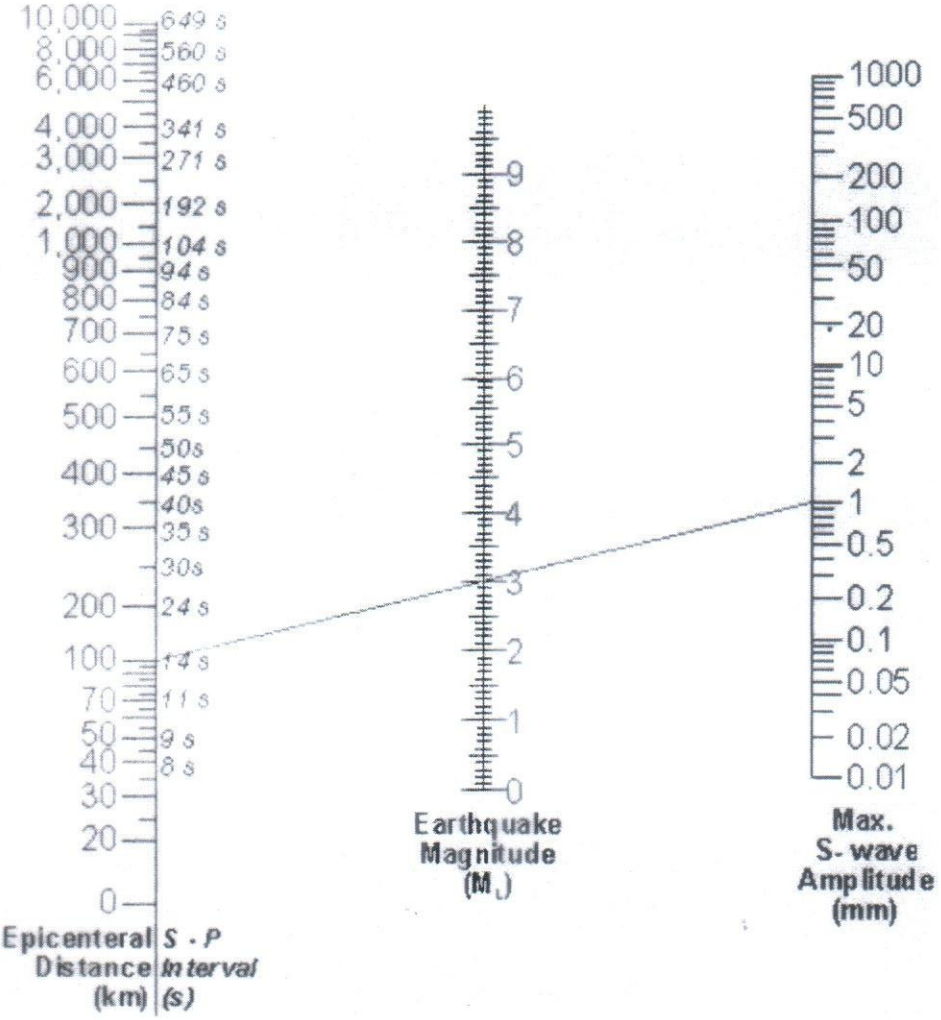


**Figure 6**

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B.Sc. Egg. (CEE)/1st Sem.

6 December, 2022
10:00 A.M to 1:00 P.M

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

**DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING**

**Semester Final Examination** — **Winter Semester: 2021 - 2022**

**Course No.: Math 4153** — **Full Marks: 150**

**Course Title: Differential Calculus, Integral Calculus, Matrix** — **Time: 3 Hours**

**There are 6 (Six) questions. Answer all questions and there are options in Questions 2 – 3. Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks and corresponding CO and PO. The Symbols have their usual meaning.**

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1. a) Expand $\log(1+e^x)$ in ascending powers of x as far as the term containing $x^4$ — (8) (CO2, PO2)

   b) Find the angle of intersection of two curves $r = a\sin 2\theta$ and $r = a\cos 2\theta$ — (9) (CO2, PO2)

   c) Evaluate: $\lim_{x\to 0}(cosx)^{cosec^2 x}$ — (8) (CO1, PO1)

2. a) Perform the following: $\int (x-2)\sqrt{\frac{x+1}{x-2}}\,dx$ — (8) (CO3, PO2)

   b) Perform the following: $\int \frac{x+\sqrt[3]{x^2}+\sqrt[6]{x}}{x\left(1+\sqrt[3]{x}\right)}dx$ — (8) (CO3, PO2)

   c) Find a reduction formula for $I_n = \int x\cos^n x\,dx$ — (9) (CO3, PO2)

   **OR**

   a) Evaluate the following: $\int_0^{\pi/2} \frac{sinxcosx}{a^2sin^2x+b^2cos^2x}dx$ — (8) (CO3, PO2)

   b) By using properties, show that: $\int_0^{\pi} \frac{x^3cos^4xsin^2x}{\pi^2-3\pi x+3x^2}dx = \frac{\pi^2}{32}$ — (9) (CO3, PO2)

   c) Define gamma function and beta function. Prove that: $\int_0^{\infty} x^{\frac{3}{2}} e^{-4x}dx = \frac{3\sqrt{\pi}}{128}$ — (8) (CO3, PO2)

3. Find the value of — (14) (CO3, PO2)

   a) $\int_0^1 \frac{x^2dx}{\sqrt{1-x^4}} \times \int_0^1 \frac{dx}{\sqrt{1+x^4}}$

   b) $\int_0^{\pi/2}\int_0^{\pi/3}\int_0^{4cos\theta} r^3 sin\theta sin\emptyset\, dr d\theta d\emptyset$ — (11) (CO3, PO2)

   **OR**

   a) Discuss the consistency of the following system of equations $2x+3y+4z=11$, $x+5y+7z=15$, $3x+11y+13z=25$. If found consistent, then solve it. — (11) (CO3, PO2)

   b) Give the statement of the Cayley-Hamilton theorem. Using Cayley-Hamilton theorem find the inverse of the following matrix. — (14) (CO3, PO2)

$$A=\begin{bmatrix}2 & -1 & 3\\ 1 & 0 & 2\\ 4 & -2 & 1\end{bmatrix}$$

4. a) Show that any square matrix can be expressed as the sum of two matrices, one is symmetric and the other is anti-symmetric matrix. (7) (CO4, PO1)

   b) Define orthogonal matrix. Determine the values of $\alpha, \beta$ and $\gamma$ when, (9) (CO4, PO1)

$$\begin{bmatrix}0 & 2\beta & \gamma\\ \alpha & \beta & -\gamma\\ \alpha & -\beta & \gamma\end{bmatrix}$$ is orthogonal

   c) Define Singular and non-singular matrices. (9) (CO4, PO1)

   If $A=\frac{1}{9}\begin{bmatrix}-8 & 1 & 4\\ 4 & 4 & 7\\ 1 & -8 & 4\end{bmatrix}$

   Prove that $A^{-1}=A'$, $A'$ being the transpose of A

5. a) Find non-singular matrices P and Q, such that PA$Q$ is a normal form where (14) (CO4, PO1)

$$A=\begin{bmatrix}2 & 1 & -3 & -6\\ 3 & -3 & 1 & 2\\ 1 & 1 & 1 & 2\end{bmatrix}$$

   b) Find the rank of the following matrix by using elementary row transformations (11) (CO4, PO1)

$$A=\begin{bmatrix}3 & -4 & -1 & 2\\ 1 & 7 & 3 & 1\\ 5 & -2 & 5 & 4\\ 9 & -3 & 7 & 7\end{bmatrix}.$$

6. a) If a matrix satisfies a relation $A^2+A-9=0$, prove that $A^{-1}$ exists and that $A^{-1}=9+A$, I being an identity matrix (8) (CO3, PO2)

   b) Find the eigenvalues and the corresponding eigenvectors for the matrix (17) (CO3, PO2)

$$A=\begin{bmatrix}1 & -6 & -4\\ 0 & 4 & 2\\ 0 & -6 & -3\end{bmatrix}$$

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**Name of the Program: B. Sc. in Civil Engineering** **Date: 12 December, 2022**
**Semester: 1st semester** **Time: 10:00 am - 01:00 pm**

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
## DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Semester Final Examination** **Winter Semester: 2021 - 2022**
**Course Number: PHY 4153** **Full Marks: 150**
**Course Title: Physics I** **Time: 3.0 Hours**

There are **8 (Eight)** questions. Answer 6 **(Six)** questions. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets. Any other statements, if necessary.

---

1. (a) Illustrate and explain how the deviation produced by a lens is independent of the position of the object. (05) (CO1) (PO1)

   (b) Find the equivalent focal length $f$ of two thin lenses of focal lengths $f_1$ and $f_2$, separated by a finite distance $d$. (15) (CO2) (PO2)

   (c) Two thin convex lenses of focal lengths, 20 cm and 5 cm are placed 10 cm apart. Calculate the principal points of this combination. (05) (CO3) (PO2)

2. (a) State cardinal points of an optical system. Mention the reasons for considering these points for thick lenses. (05) (CO1) (PO1)

   (b) Illustrate and describe the cardinal points of an optical system. (15) (CO2) (PO2)

   (c) A thin convex and a thin concave lens each of 50 cm focal length are coaxially situated and separated by 10 cm. Find the position and nature of the final image formed of an object placed 20 cm from the convex lens (i.e., 30 cm from the concave lens). (05) (CO3) (PO2)

3. (a) Briefly explain the aberrations, chromatic aberrations, and monochromatic aberrations. (05) (CO1) (PO1)

   (b) Using a neat optical diagram describe the spherical aberration in a lens. (15) (CO2) (PO2)

   (c) Two thin lenses separated by a finite distance have an equivalent focal length 50 cm. The combination satisfies the conditions for no chromatic aberration and minimum spherical aberration. Find the focal length of each lenses and the value of separation. (05) (CO3) (PO2)

4. (a) Explain the term 'Circle of least confusion' for chromatic aberration. (05) (CO1) (PO1)

(b) Find an expression for the axial chromatic aberration in a lens. (15) (CO2) (PO2)

(c) A converging achromat of 40 cm focal length is to be constructed out of a thin crown glass lens and a thin flint glass lens, the surfaces in contact having a common radius of curvature of 25 cm. Calculate the radius of curvature of the second surface of each lens, given that the values of the dispersive powers and refractive indices are 0.017 and 1.50 for crown glass, and 0.034 and 1.70 for flint glass, respectively. (05) (CO3) (PO2)

5. (a) Write down the salient features of Brownian motion. (05) (CO1) (PO1)

(b) Find the relations of the most probable velocity and average energy of gas molecules using Maxwell's velocity distribution law. (15) (CO2) (PO2)

(c) Calculate the root mean square velocity of a gas of neon atoms at temperature $T = 300$ K. Assume that the mass of neon atom is 20 times the mass of a proton. (05) (CO3) (PO2)

6. (a) Describe the following terms with examples: (i) isothermal process and (ii) adiabatic process. (05) (CO1) (PO1)

(b) Deduce the expression of $C_p - C_V$ in case of real gas. (15) (CO2) (PO2)

(c) Vapor is injected into the cylinder of an automobile engine when the piston is in its expanded position. The temperature, pressure, and volume of the resulting gas-air mixture are 20°C, $1.00\times10^5$ N/m$^2$, and 240cm$^3$, respectively. The mixture is then compressed adiabatically to a volume of 40 cm$^3$. What are the pressure and temperature of the mixture after compression? (05) (CO3) (PO2)

7. (a) Explain the term 'entropy' of a thermodynamic system. (05) (CO1) (PO1)

(b) (i) Find out the change of entropy for a reversible and an irreversible process and (ii) Obtain the expression of entropy of a Van der Waal's gas. (15) (CO2) (PO2)

(c) Calculate the entropy change that an ideal gas undergoes in a reversible isothermal expansion from a volume $V_i$ to a volume $V_f$. (05) (CO3) (PO2)

8. (a) Discuss what you understand by Helmholtz free energy. (05) (CO1) (PO1)

(b) Derive Maxwell's thermodynamic relations. (15) (CO2) (PO2)

(c) For 1 mole of Van der Waals gas undergoing a reversible isothermal expansion from a volume $V_1$ to $V_2$, show that the heat transferred $Q$ is given by $\boldsymbol{Q = RT\ln\frac{V_2-b}{V_1-b}}$ (05) (CO3) (PO2)

(429)

**B.Sc. Engg. (CEE) / 1st Sem.** **December 8, 2022**

**Time: 10.00 am – 1:00 pm**

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

**DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING**

TERM: SEMESTER FINAL EXAMINATION — WINTER SEMESTER: 2021-2022
COURSE NO.: Chem – 4153 — TIME: 3.0 Hours
COURSE TITLE: Chemistry I — FULL MARKS: 150

There are 7 **(Seven)** questions. Answer **6 (Six)** questions. Do not write on this question paper. The figures in the right margin indicate full mark and corresponding CO and PO in the brackets. Symbols convey their usual meanings. Assume reasonable values for any missing data.

---

1. (a) What do you understand by Ksp? Explain the effect of nature of solute and presence of a salt on the absorption coefficient and solubility of a solute in water. ($10\frac{2}{3}$) (CO1) (PO1)

   (b) A saturated solution contains 5.3g $Na_2CO_3$ in 50 g water. The density of the solution is 1.02 g $cm^{-3}$. To neutralize 10.0 $cm^3$ of this solution 8.0 $cm^3$ of an HCl solution is required. Calculate the normality of the HCl solution. (6) (CO1) (PO1)

   (c) Define freezing point of a solution relating to vapour pressure. Derive a mathematical expression correlating molecular weight of the solute with the depression of freezing point. ($8\frac{1}{3}$) (CO2) (PO2)

2. (a) Describe the rules involved in writing electronic configuration of an element. Write the electronic configuration of the following elements:
   (i) Cu(24) ; (ii) Fe (26) ; (ii) As(33) and (iv) Ag (47).
   Is there any violation of rules in writing the electronic configurations of these elements? If there is so then explain why this is happened. ($10\frac{2}{3}$) (CO1) (PO1)

   (b) Electrons are essential constituents of all atoms; neutron may not be the essential constituents of an atom. Justify these statements. Atoms contain electrically charged particles, yet these are neutral, explain. (6) (CO1) (PO1)

   (c) Discuss the main cause of heat change in a chemical reaction. Explain the exceptional higher value of heat of neutralization of HF with a strong base. ($8\frac{1}{3}$) (CO2) (PO2)

3. (a) How many two and three phase equilibria are present in the phase diagram of water. Draw the phase diagram of water and describe these equilibria. ($10\frac{2}{3}$) (CO1) (PO1)

   (b) What do you understand by CST? On the basis of CST classify liquid–liquid solution into different classes giving at least one example of each class. (6) (CO1) (PO1)

   (c) Derive different forms of Kirchoff's equation. ($8\frac{1}{3}$) (CO2) (PO2)

(430)

4. (a) Based on chemical equilibrium classify chemical reactions into different classes giving example of each class. Write the basic feature of chemical equilibrium. ($8\frac{1}{3}$) (CO1) (PO1)

(b) State law of mass action and illustrate the meaning of the term 'active mass for different types of substances. Write the points that are usually followed to write the mathematical expression of equilibrium constant. ($8\frac{1}{3}$) (CO1) (PO1)

(c) Describe how chemical energy is being converted into electrical energy. Discuss the chronological development of theories of electrolysis. ($8\frac{1}{3}$) (CO2) (PO2)

5 (a) Derive thermodynamically the mathematical expression for the relation between free energy change and equilibrium constant. ($8\frac{1}{3}$) (CO1) (PO1)

(b) At 27°C the equilibrium constant $K_p$ for the reaction:
$C_5H_{10}$ (gas) + $H_2$ (gas) $\rightleftharpoons$ $C_5H_{12}$ ($l$) is $1.10 \times 10^{17}$ atm $^{-1}$.
Calculate Kc and $\Delta G$ for the reaction ($8\frac{1}{3}$) (CO1) (PO1)

(c) Using diagram describe an experimental method by which one can determine the electrolytic conductance. ($8\frac{1}{3}$) (CO2) (PO2)

6 (a) What do you understand by chemical bond? Discuss the cause of bond formation. Describe sigma bond and pi bond with examples. ($8\frac{1}{3}$) (CO1) (PO1)

(b) Distinguish between ionic bond and covalent bond. State the conditions for ionic bond formation with the example. Describe Fajan's rule with example. ($8\frac{1}{3}$) (CO1) (PO1)

(c) State and explain Faraday's laws of electrolysis. Determine the charge of an electron from Faraday's laws of electrolysis. ($8\frac{1}{3}$) (CO2) (PO2)

7 (a) What is a coordinate bond? How is a coordinate bond formed? Explain the bonds formed in $NH_4^+$. ($8\frac{1}{3}$) (CO1) (PO1)

(b) Why is solid NaCl a non conductor of electricity, but molten NaCl or its aqueous solution is a good conductor? Is NaCl in vapour state a conductor of electricity? Explain your answer. ($8\frac{1}{3}$) (CO1) (PO1)

(c) What do understand by order and molecularity of a reaction? Derive an equation for rate constant of a first order reaction. ($8\frac{1}{3}$) (CO2) (PO2)

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B. Sc. Engg. (CEE)/3rd Semester

5th December 2022 (Group B)

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

## DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Semester Final Examination**
**Course Number: CEE 4311**
**Course Title: Solid Mechanics I**

**Winter Semester: 2021–2022**
**Full Marks: 150**
**Time: 3 Hours**

There are **6 (six)** questions. Answer **all** of them. The symbols have their usual meanings. Marks of each question are written in the brackets along with the corresponding CO and PO.

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1. A simple beam carries a uniformly distributed load of 5000 N/m for the entire span. Determine the maximum length of the beam if the shearing stress is limited to 110 MPa. The beam is a 300 mm (outside dimension) square hollow box section with uniform thickness of 50 mm on all sides. Determine the maximum moment in that beam. — CO1, PO1: [25]

2. Draw axial force, shear force and bending moment diagrams for the beam with loads as shown in Fig. 1. — CO2, PO2: [25]

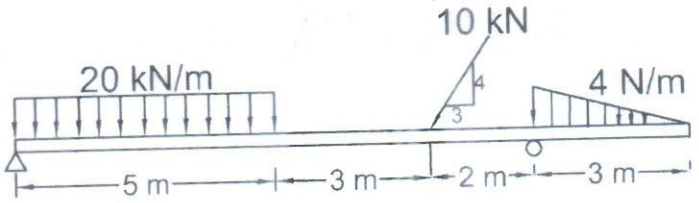


**Fig. 1 for Question 2**

3. A beam with an internal hinge E is loaded as shown in Fig. 2. Determine the value of the moment $M_C$ so that the fixed end moment at A is -60 kN-m. Then, draw shear force and bending moment diagrams for the beam. What value of $M_C$ will make fixed end moment $M_A$ to be zero? Redraw the bending moment diagram for AE portion only. — CO2, PO2: [25]

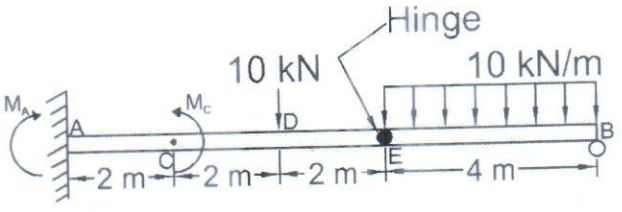


**Fig. 2 for Question 3**

4. A Tee beam, build up as shown in Fig. 3 is secured by screws at uniform spacing. The beam supports a single concentrated load of 3000 N at the first third point only. Determine the maximum screw spacing if each screw can safely transmit 1000 N. Also, compute the maximum shearing stress value in the beam. Assume the beam is simply supported. CO3, PO3: [25]

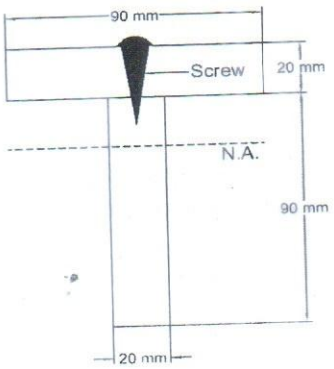


**Fig. 3 for Question 4**

5. Determine the width 'b' of the cross-section for the beam shown in Fig. 4 for an allowable bending stress of 35 ksi. Each segment has same cross-section. CO3, PO3: [25]

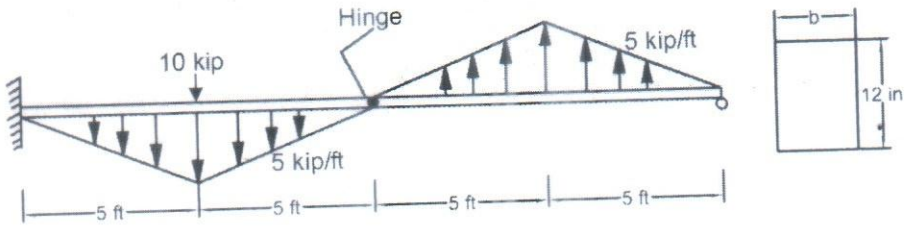


**Fig. 4 for Question 5**

6. Compute the principle stresses and maximum shearing stress at point A in Fig. 5 at a section x = 240 mm. The beam is rectangular, 20 mm wide by 120 mm deep and point A is 20 mm above the centerline of the beam. Use neat sketches to support your answers. CO3, PO3: [25]

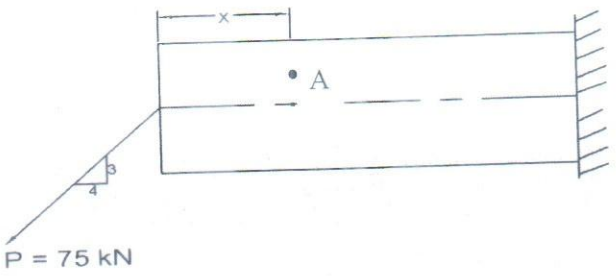


**Fig. 5 for Question 6**

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B.Sc. Egg. (BTM)/ 3rd Sem. 30th November, 2022.

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

**DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING**

TERM: SEMESTER FINAL EXAMINATION — WINTER SEMESTER: 2021-2022
COURSE NO.: CEE 4361 — TIME: 3 Hours
COURSE TITLE: Civil and Environmental Technology I — FULL MARKS: 150

**There are 6 (Six) questions. Answer all of them. Do not write on this question paper. The figures in the right margin indicate full marks.**

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1. Suppose, you are in charge of the construction project of proposed New Academic Building at IUT campus where concrete mix design is required based on the following data: CO3 PO3 (70)

Volume ratio of sand to total aggregate = 0.45
FM of fine aggregate = 2.6
FM of coarse aggregate = 6.6
Location of the Project : Gazipur
Specific gravity of cement = 2.95 (CEM Type II-B/M)
Specific gravity of sand (SSD) = 2.60
Specific gravity of coarse aggregate (SSD) = 2.70
Design compressive strength (28 days) = 5000 psi
Minimum required slump = 175 mm
Maximum aggregate size = 3/4 inch, Aggregate type = Stone chips
Dosage of superplasticizer = 4 ml/kg of cement if W/C $\leq$ 0.55
Air content in concrete = 1.5%
(assume reasonable data, if necessary)

The following graphs are provided:

- Variation of compressive strength (28 days) with W/C (Fig. 1)
- Variation of cement content with compressive strength (28 days) for different aggregate size and slump value (Fig. 2)

(a) Prepare a mix design for the specified strength.

(b) Prepare a mixture proportion table. Typical form of mixture proportion table is attached (Table 1).

(c) Calculate the unit weight of concrete.

(d) Calculate the volume ratio of the mix. Assume unit weights of cement, sand (SSD), and coarse aggregate (SSD) with void are 1410 kg/m$^3$, 1450 kg/m$^3$ and 1620 kg/m$^3$, respectively.

(e) Calculate the cost of concrete for one cubic meter. Assume the cost of 1 bag cement is Tk. 45, cost of 1 cft sand is Tk. 45, and cost of 1 cft stone chips is Tk. 230.

(f) Calculate the compaction factor of the mix.

(g) Graphically represent the variation of strength and workability with time after mixing of concrete.

(h) What changes in the mix design are necessary, if it is decided to increase strength of concrete to 6000 psi?

(i) If FM of fine aggregate is changed to 2.4 (instead of 2.6 as specified), what changes will occur in fresh and hardened properties of concrete?

(j) If the slump is found at 80 mm during a trial mix of the proposed mix, what changes are required in the mix design to get the minimum required slump?

(k) This mix design is prepared based on the cylinder strength of concrete (5000 psi). What will be the strength of concrete based on the strength of cube specimens instead of cylinder specimens?

(l) If the same construction work is to be done in cold climatic region countries with a very low prevailing temperature, what extra measures shall be taken and why?

(m) What probable chemical attacks may arise in that concrete?

(n) To reduce construction noises and ease of construction management if RMC (Ready-mixed Concrete) is used in this project instead of in-situ concrete mixing, what shall be the required features of RMC?

2. For Bus Rapid Transit (BRT) project a sand sample was collected from nearby market and was sent to IUT Concrete Laboratory for sieve analysis. The sieve analysis results of that sample are given below: CO2 PO2 (20)

| Sieve No. | Sieve Opening (mm) | Wt. of sand Retained (gm) |
|---|---|---|
| #4 | 4.75 | 0 |
| #8 | 2.36 | 0 |
| #16 | 1.19 | 80 |
| #30 | 0.59 | 110 |
| #40 | 0.425 | 68 |
| #50 | 0.3 | 55 |
| #100 | 0.15 | 68 |
| #200 | 0.075 | 20 |
| Pan | - | 23.73 |

(a) Calculate FM of the sample. (Up to 2nd digit of your answer)

(b) Draw grading curve of the sample.

(c) Comment on the sample based on the sieve analysis data and grading curve.

(d) If another sample of 500 gm sand with a FM of 2.6 was collected from the local market, at what proportion the samples should be mixed to achieve a desired FM of 2.4

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**Questions 3 to 6 are mapped with CO1 and PO1**

3. (a) Write a short note on different possible moisture condition of aggregates. Which condition is more preferable for construction works? (05)

   (b) Define Bulk and Apparent Specific Gravity. Mention the materials required for preparing mortar and concrete separately. (05)

   (c) Define the following mechanical properties of a material: (05)
   i) Relaxation
   ii) Creep
   iii) Ductility

4. (a) Mention the constituents of portland cement along with their tentative percentages. (05)

   (b) Draw the flow diagram of cement manufacturing (wet process) (05)

   (c) "Brick is not an environmentally friendly material" - Justify. (05)

5. (a) Mention the uses of Rubber and Plastic in construction works. (05)

   (b) How steel bar protected in concrete from corrosion? Why curing is required for concrete? (05)

   (c) Explain bleeding, segregation and laitance of concrete. (05)

6. (a) Shortly describe the constituents of Paint and Varnish. (05)

   (b) Mention three commonly used industrial forms of timber with their uses. (05)

   (c) Discuss the importance of seasoning of timber. List the methods used for seasoning. (05)

## Appendix-01

**Sample Mixture Proportion Table-1 (Question 1)**

| W/C | s/a | Maximum Aggregate Size | Slump | Air Content | Unit Contents (kg/m3) | | | | Super plasticizes |
|---|---|---|---|---|---|---|---|---|---|
| % | % | mm | cm | % | C | W | FA | CA | ml/kg of cement |
| | | | | | | | | | |

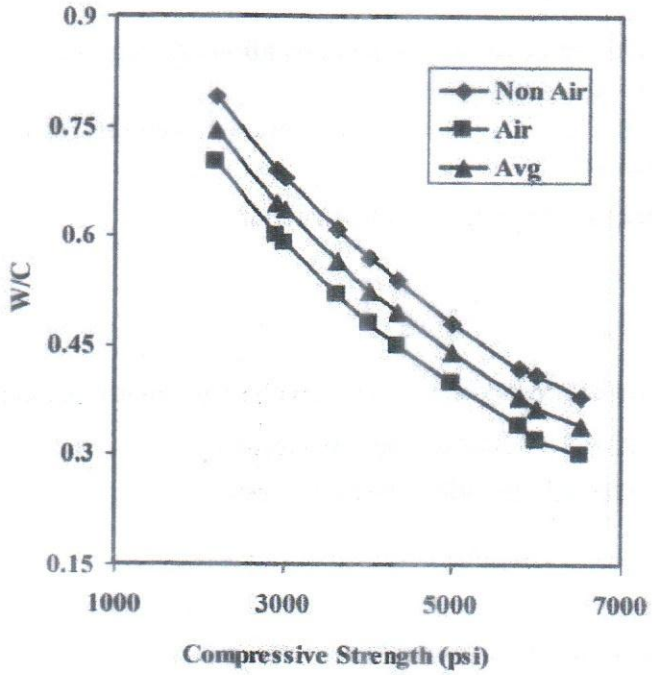


**Fig.1. W/C versus Compressive strength (aggregate = Stone chips)**

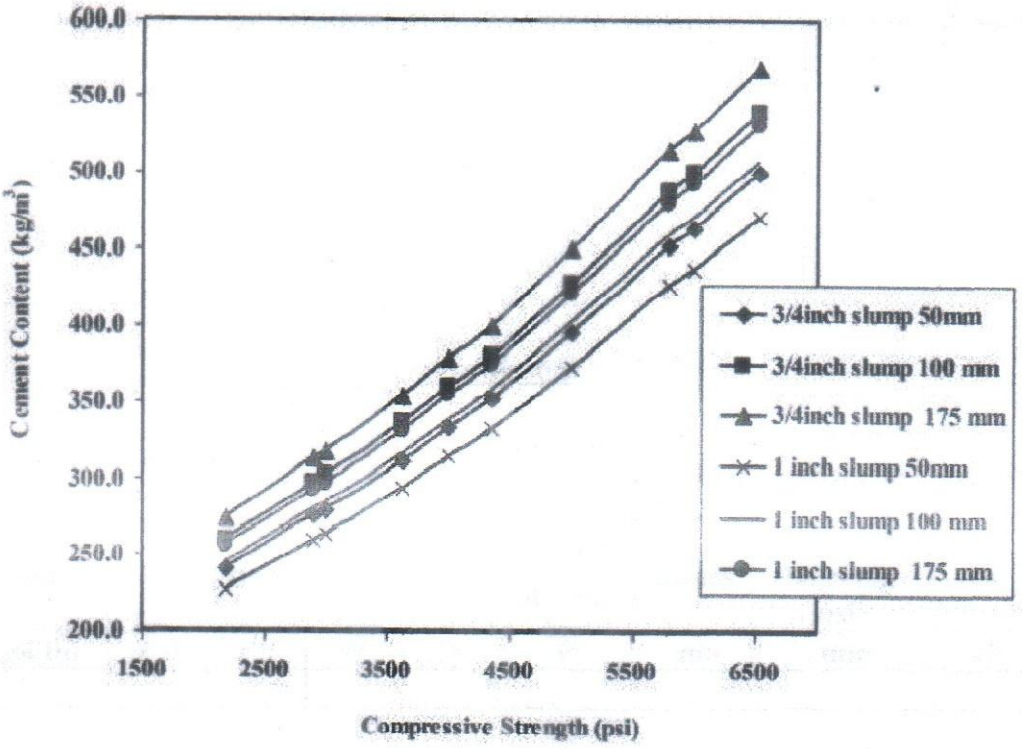


**Fig.2. Cement content versus Compressive strength (aggregate = Stone chips)**

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B. Sc. in Civil Engineering
3rd Semester

Date: 1st December, 2022
Time: 10:00 AM–1:00 PM

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

## DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Semester Final**
**Course Number: CEE 4361**
**Course Title: Fluid Mechanics**

**Winter Semester: 2021–2022**
**Full Marks: 150**
**Time: 3 Hours**

There are **8 (eight)** questions. You can answer **any 6 (six)** questions. Marks of each question and corresponding CO and PO are written in brackets. The symbols have their usual meanings.

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| | | | Full Marks | CO | PO |
|---|---|---|---|---|---|
| 1. | (a) | What is cavitation? How cavitation produce drop in efficiency of machine or propeller and what could be done to avoid this problem? | [3] | [1] | [1] |
| | (b) | Determine the diameter of steel pipe (e = 0.045 mm) to carry 30 l/s of water if the permissible head loss per meter of the pipe length is 0.05 m. Use Moody diagram. Take $\nu = 1 \times 10^{-6}$ m$^2$/s. Apply correction if needed. | [8] | [2] | [2] |
| | (c) | A pipe (f = 0.04) of 100 mm in diameter and 700 m long is fitted with a nozzle of 30 mm in diameter. If the maximum transmitted power provided by the pump is 5 hp, how effectively and at which rate water will discharge through the nozzle? Explain - if no nozzle is attached at the end of the pipe, what change in discharge will occur? | [14] | [3] | [2] |
| 2. | (a) | What is the standard ratio of length of the converging to diverging portion in venturimeter? What is the rationale behind such ratio? | [3] | [1] | [1] |
| | (b) | A pipe 60 m long and 15 cm in diameter is connected to a water tank at one end and flows freely into the atmosphere at the other end. The height of the water level in the tank is 2.8 m above the center of the pipe. The pipe is horizontal with f = 0.04. Determine the discharge through the pipe. | [8] | [2] | [2] |
| | (c) | Initial distribution of flows through a pipe network is shown in Figure 1. Applying Hardy Cross's Principle and taking n = 2 for all pipes, obtain flows in each pipe using two trials. Discharge is in l/s. | [14] | [3] | [2] |

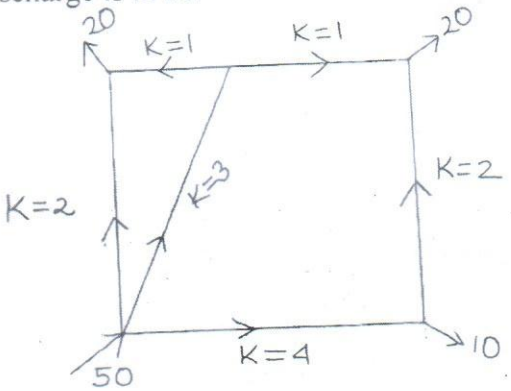


**Figure 1**

| | | | | | |
|---|---|---|---|---|---|
| 3. | (a) | What is the range of pipe length in mouthpiece? Why is such range maintained? | [3] | [1] | [1] |

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(b) The head loss in 60 m of 15 cm diameter pipe is known to be 8 m when oil (s = 0.9, $\mu$ = 0.04 N-s/m$^2$) flows at 0.06 m$^3$/s. Determine the centerline velocity, shear stress at the wall of the pipe, friction factor and the velocity at 5 cm from the centerline. [8] [2] [2]

(c) For the pipes connected in parallel as shown in Figure 2, the pipe dimensions and friction factors are as follows: [14] [3] [2]

L1 = 900 m, D1 = 0.3 m, f1 = 0.021
L2 = 600 m, D2 = 0.2 m, f2 = 0.018
L3 = 1200 m, D3 = 0.4 m, f3 = 0.019

If the total discharge is 0.34 m$^3$/s, determine the flow through each pipe and head loss from A to B using the concept of parallel pipe network.

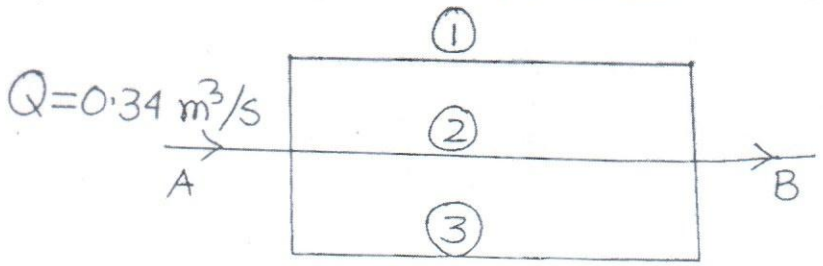


**Figure 2**

**4.** (a) Why is it necessary to ventilate the space below the nappe in weirs? How can you identify vena-contracta when water is discharged through an orifice? [3] [1] [1]

(b) A pump lifts water at a rate of 15 m$^3$/s to a height of 200 m and the friction loss in the pipe is 18 m. What is the horsepower transmitted if the pump efficiency is 80 percent? If friction loss increases in the pipe, what change in the transmitted horsepower will occur? [8] [2] [2]

(c) In Figure 3, assume pipe diameter = 25 cm, BC = 6 m, DE = 900 m and $\Delta z$ = 40 m. Assume, f = 0.022. If the discharge of water is 25 l/s and the pump efficiency is 80 percent, what is the power needed to supply into the pump? [14] [3] [2]

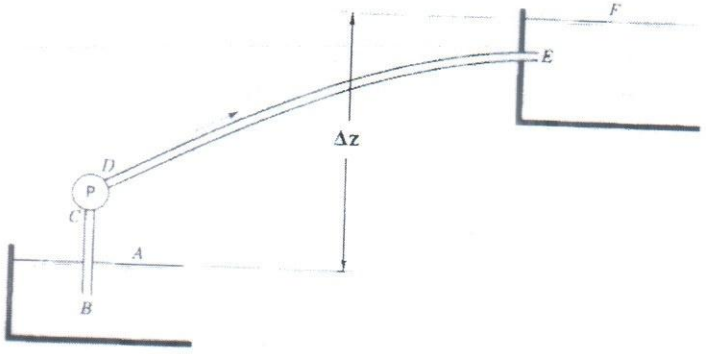


**Figure 3**

**5.** (a) Explain the phenomena of water hammer. [3] [1] [1]

(b) Water at 20°C flows in a 50 cm diameter welded steel pipe (e = 0.046 mm). If head loss per unit length is 0.006, determine Q. Is the pipe can be classified as a wholly rough pipe? Use Moody diagram. Take $\nu = 1 \times 10^{-6}$ m$^2$/s. [8] [2] [2]

(c) Calculate the rate of flow of water from the reservoir A to B for the system shown in Figure 4. Pipe dimensions are as follows: [14] [3] [2]

L1 =400 m, D1 =600 mm, e1 =2 mm
L2 = 300 m, D2 = 1000 mm, e2 = 0.6 mm
Neglect minor losses and $y = 2 \times 10^{-6}$ m$^2$/s. Use Moody diagram.
Explain the change in discharge if minor loss is not considered.

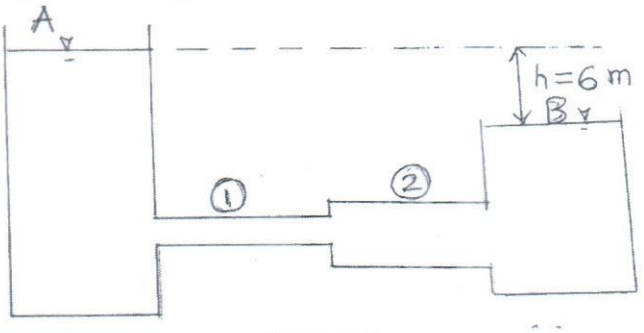


**Figure 4**

6. (a) Why Reynolds Number of a converging pipe is greater than that of a diverging pipe? [3] [1] [1]

(b) Calculate the flow of water in l/s through a 40 cm × 15 cm horizontal venturimeter, when the differential gauge connected to the inlet end of the meter and its thoroat shows 25 cm of Hg. Assume the discharge coefficient as 0.98. [8] [2] [2]

(c) In Figure 5, pipe 1 is 90 cm wrought iron, 1500 m long; pipe 2 is 60 cm cast iron, 450 m long; and pipe 3 is 80 cm cast iron, 1200 m long. The elevations of water surface in reservoir A and B are 90 m and 45 m, respectively. The discharge Q1 is 0.5 m$^3$/s. Find the elevation of the surface of reservoir C applying the theory of branching in pipes. Assume, f = 0.028 for all pipes. [14] [3] [2]

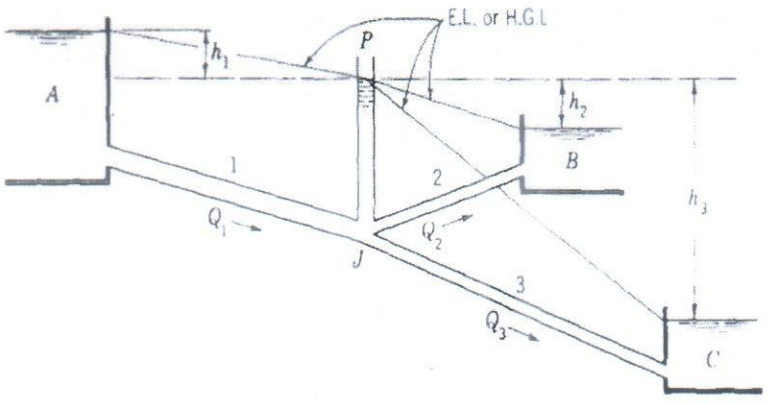


**Figure 5**

7. (a) Write down the differences between absolute pressure and gauge pressure. [3] [1] [1]

(b) A certain liquid of kinematic viscosity $0.02 \times 10^{-4}$ $m^2/s$ is flowing through at a velocity of 5 m/s through a 20 mm diameter pipe. A second liquid of kinematic viscosity $0.029 \times 10^{-4}$ $m^2/s$ is flowing through a 80mm diameter pipe. Calculate the velosity of second fluid if dynamic similarity is to be observed. [8] [2] [2]

(c) Find the magnitude and direction of the resultant force acting on the cylindrical gate (Figure 6) of 8m diameter and 6m long. [14] [3] [2]

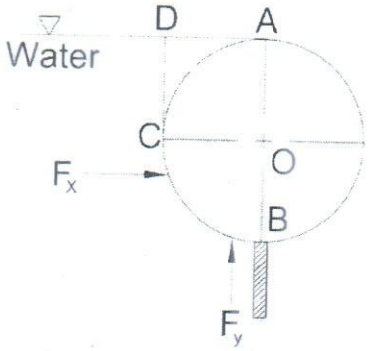


**Figure 6**

8. (a) Write a short note about the kinetic energy coefficient with iis mathematical expression. [3] [1] [1]

(b) The velocity profile for the channel shown in Figure 7, can be expressed by $\mathbf{v} = \mathbf{k}\sqrt{y_0}$ where $y_0$ represents the depth of the water. Calculate the value of momentum energy co-efficient. [8] [2] [2]

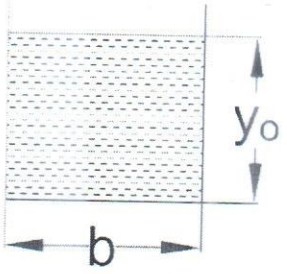


**Figure 7**

(c) A turbine T (Figure 8) draws water from a reservior through a 1m diameter pipe and discharges through another pipe of the same diamter into tailrace B. The headloss from the headrace A to the turbine is found to be 10 times the velocity head in the pipe and from the turbine to the tailrace B headloss is only 0.5 time of the velocity head in the pipe. If the discharge is 1 cumec, [14] [3] [2]

a. Calculate the pressure heads at inlet and exit of the turbine,
b. Compute the power given up by the water to the turbine in HP and
c. Draw the HGL and EGL.

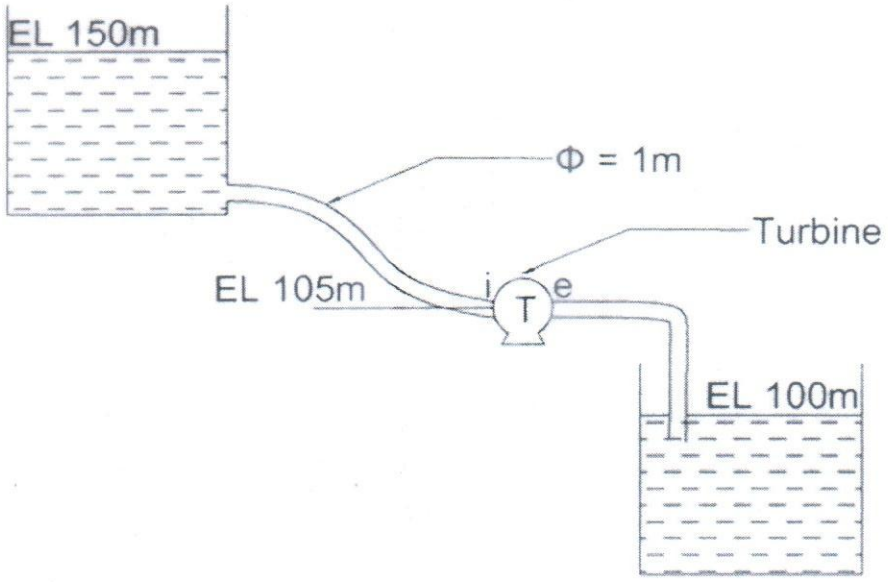


Figure 8

Equivalent Sand Grain Roughness for Different Pipe Materials

| Boundary Material | $k_s$, Millimeters | $k_s$, Inches |
|---|---|---|
| Glass, plastic | Smooth | Smooth |
| Copper or brass tubing | 0.0015 | $6 \times 10^{-5}$ |
| Wrought iron, steel | 0.046 | 0.002 |
| Asphalted cast iron | 0.12 | 0.005 |
| Galvanized iron | 0.15 | 0.006 |
| Cast iron | 0.26 | 0.010 |
| Concrete | 0.3 to 3.0 | 0.012–0.12 |
| Riveted steel | 0.9–9 | 0.035–0.35 |
| Rubber pipe (straight) | 0.025 | 0.001 |

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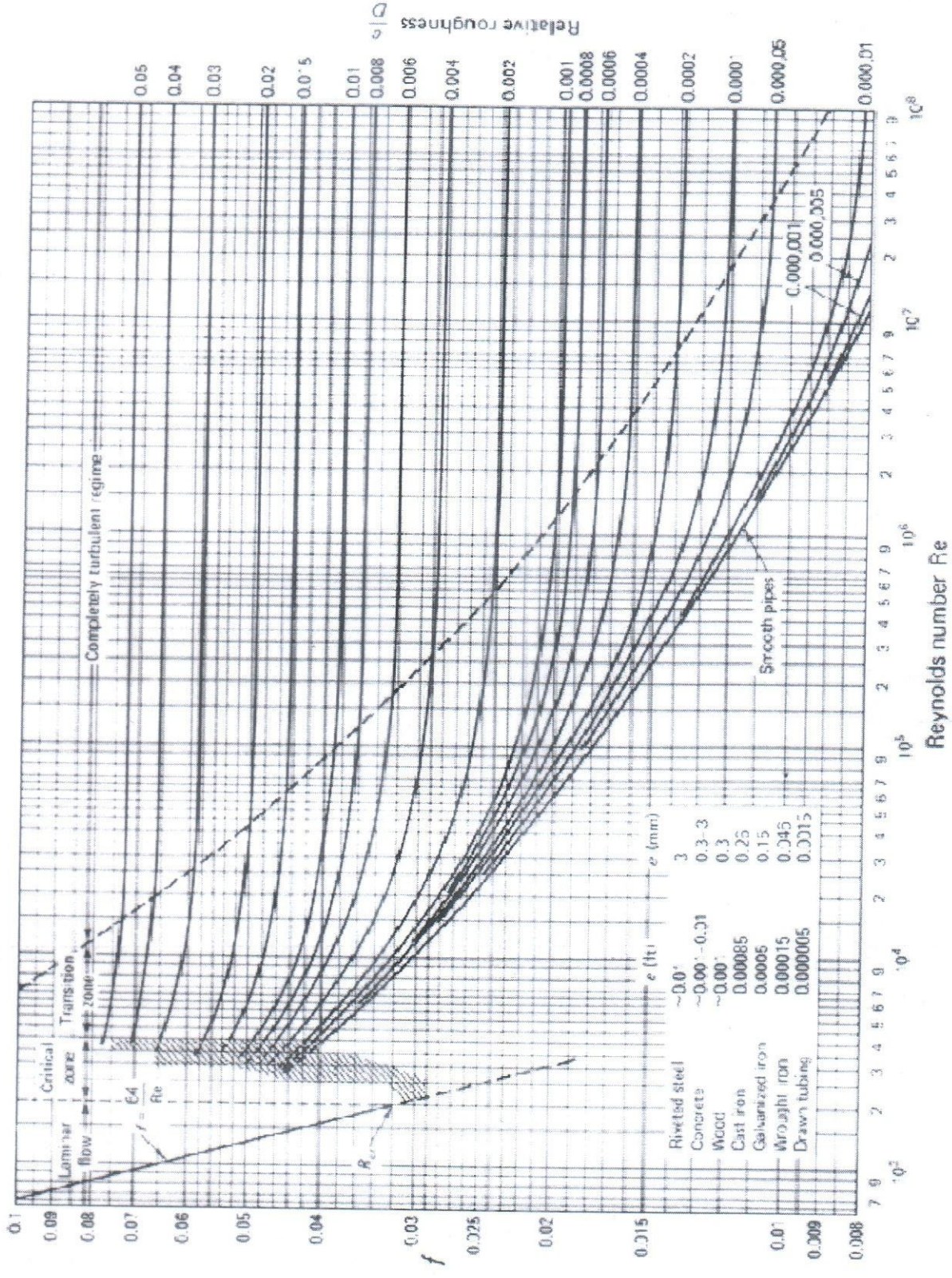

Relative roughness ε/D
Reynolds number Re
Laminar flow
Critical zone
Transition zone
Completely turbulent regime
Smooth pipes
0.000,001
0.000,005
0.000,05
0.000,01
f
Riveted steel
Concrete
Wood
Cast iron
Galvanized iron
Wrought iron
Drawn tubing
e (ft)
e (mm)

(443)

B. Sc. Engg. (CEE)/ 5th Sem. 05 December, 2022.

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

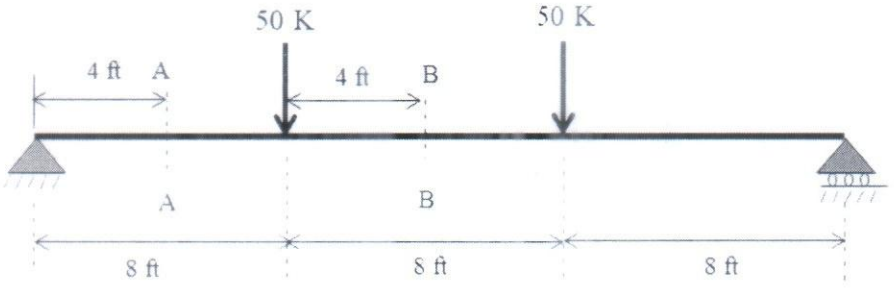
## DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Semester Final Examination** **Winter Semester : 2021 - 2022**
**Course No. CEE 4511** **Full Marks: 150**
**Course Title: Design of Concrete Structures I** **Time : 3.0 Hours**

**There are 6 (Six) questions. Answer all questions. The figures in the right margin indicate full marks. COs and POs are also specified in the right margin of the questions. The symbols have their usual meaning. Assume reasonable values for any missing data.**

---

| | | | |
|---|---|---|---|
| **1(a)** | "The top bars have less bond strength compared to bottom bars in a RC beam" – Why? | **(CO1) (PO1)** | **(3)** |
| **(b)** | Explain the factors related to shear force that can be carried by concrete in a RC beam. | **(CO1) (PO1)** | **(3)** |
| **(c)** | Explain the locations of lap splices in beam and column with sketches. | **(CO1) (PO1)** | **(3)** |
| **(d)** | Explain the requirements for minimum spacing of reinforcement in beams and columns as per ACI 318-19. | **(CO1) (PO1)** | **(3)** |
| **(e)** | "For a RC beam, failure by yielding of tension steel is preferable than failure by crushing of concrete" – Why? | **(CO1) (PO1)** | **(3)** |
| **2(a)** | Refer to the following simply-supported RC beam: | **(CO2) (PO2)** | **(10)** |




Beam Section:
12 in by 20 in
Effective Depth = 17.5 in (one layer of steel)
Effective Depth = 17 in (two layers of steel)
Amount of Bottom Steel = 3.8 in2

Fill the following table for two scenarios of reinforcing bars (use WSD):

**Scenario 1**

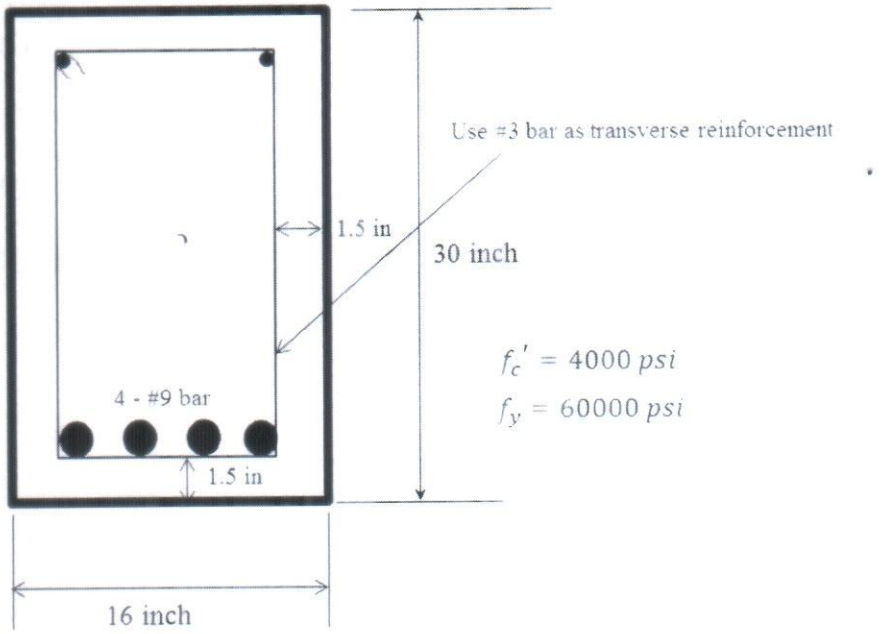
| Section | Number of Steel | Bond Stress ($lb/in^2$) |
|---|---|---|
| A-A | 3 - #10 bars | |
| B-B | 3 - #10 bars | |

**Scenario 2**

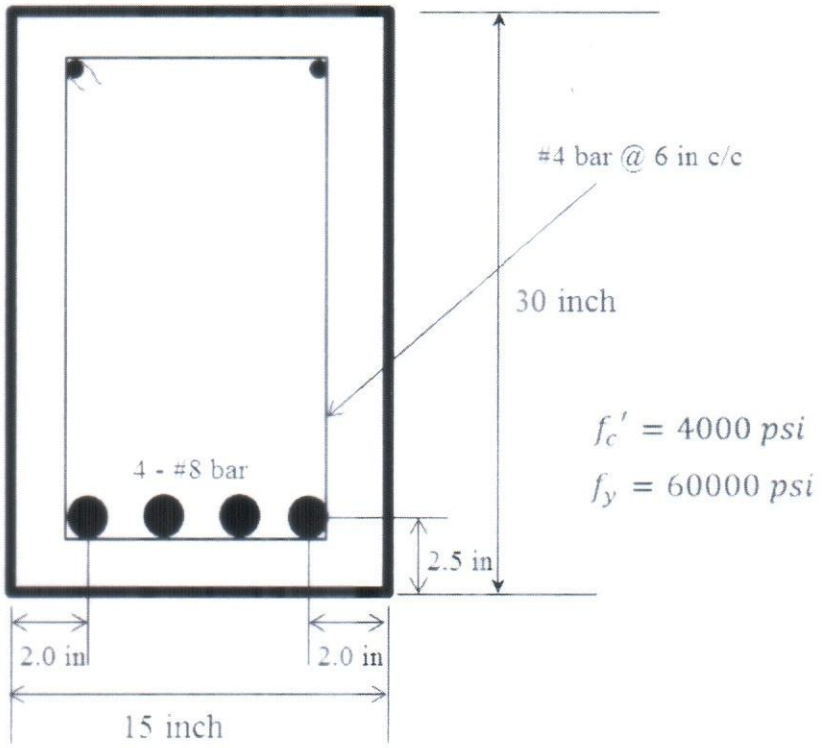
| Section | Number of Steel | Bond Stress ($lb/in^2$) |
|---|---|---|
| A-A | 5 - #8 bars | |
| B-B | 5 - #8 bars | |

Make a brief discussion on the results taking into account the variation of bond stress with shear force and variation of bond stress with the size of bars.

**(b)** A normal concrete beam was designed for flexural reinforcement. The section is give below. In addition to the flexural reinforcement, the beam is to be designed for torsion and shear. Given: $Tu = 50\ k\text{-}ft$, $Vu = 60\ k$, $f_y = f_{yt}$. Check for the requirement of torsional reinforcement and adequacy of the section against torsion and shear. **(CO2) (PO2)** **(10)**

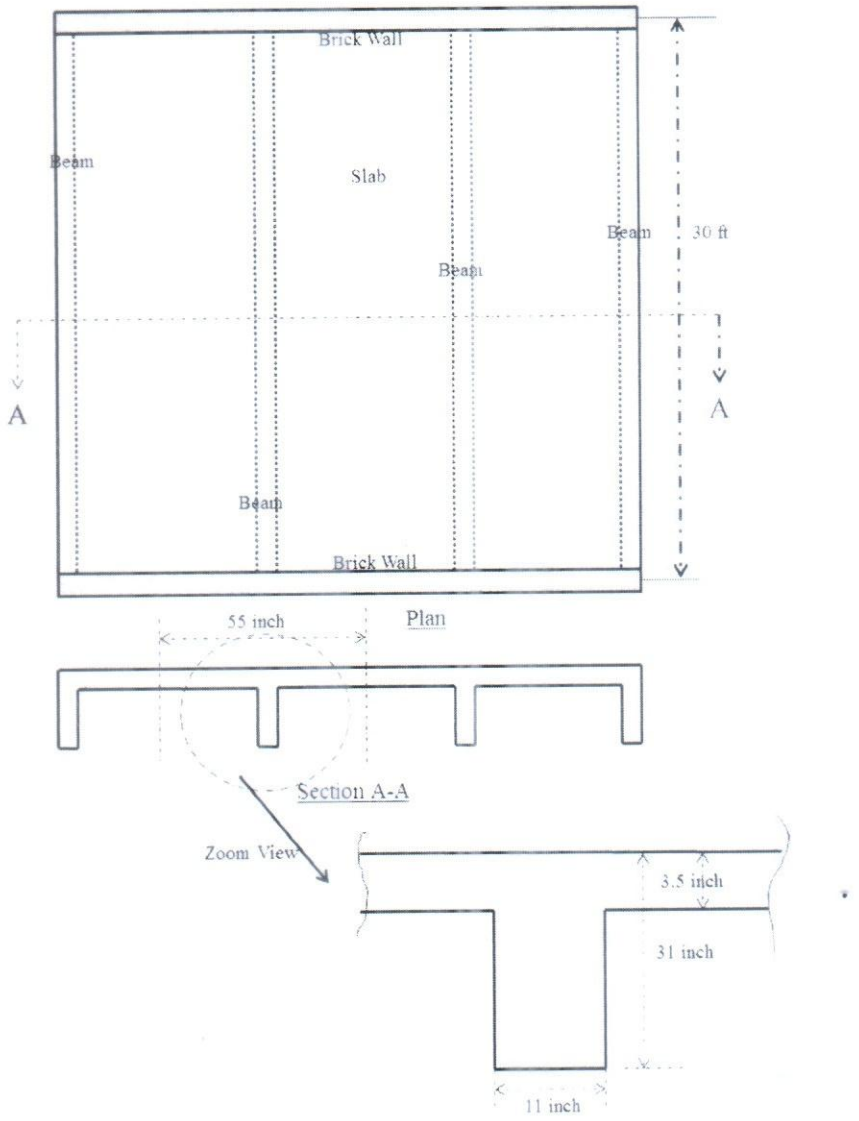



**(c)** Refer to the following beam section for normal weight concrete. For the main reinforcement (bottom bars) (non-coated), the designer proposed a development length of $35d_b$. Do necessary calculation to check it as per ACI 318-19 with and without consideration of the effect of confinement. Assume, the factor related to size of bars = 1.0. Make a brief discussion on the effect of confinement on development length. **(CO2) (PO2)** **(10)**

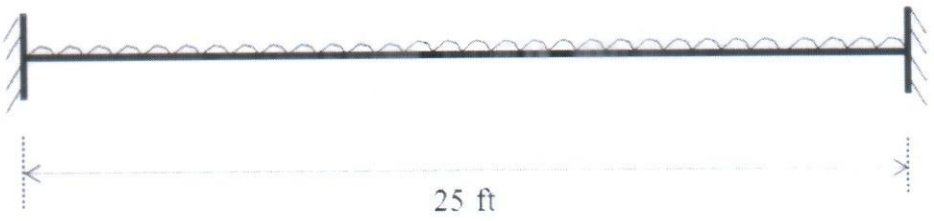



3 Design the shear reinforcement for the simply supported beam shown below by USD. Given: LL = 2.5 k/ft, DL = 1.5 k/ft (excluding self-weight), $f_y$ = 60,000 psi, and $f_c'$ = 4000 psi. Given: width =12 inch, depth = 25 inch, effective depth = 21.5 inch (for two layers of main reinforcement). Show the details of shear reinforcement in a longitudinal section of the beam. **(CO3)** **(PO3)** **(20)**


4 The layout of a beam casted monolithically with slab is given below. Design the beam for flexural reinforcement. Use USD. Design parameters: $f_y$ = 60,000 psi, $f'c$ = 4000 psi. LL = 400 psf, DL (excluding self-weight) = 60 psf. Based on your design, calculate the strain of the tension reinforcement and check with yield strain of steel ($\varepsilon_y$). **(CO3)** **(PO3)** **(20)**




5 Design the following fixed-ended beam by WSD and USD. LL = 1 k/ft, DL = 1 k/ft (excluding self-weight), Width = 12 inch, $f_y$ = 60,000 psi, $f'_c$ = 4000 psi, $f_s$ = 20000 psi. **(CO3)** **(PO3)** **(45)**



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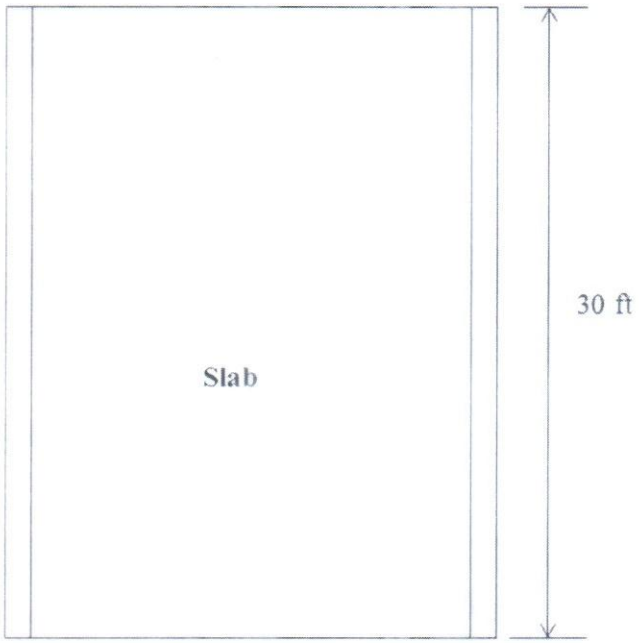
Do a review to verify your design (for USD only).

Show the details of the reinforcements in neat sketches (for WSD and USD).

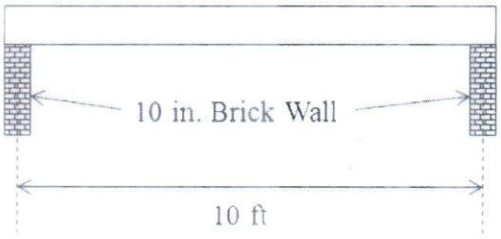
Make a brief comparison of the results (for WSD and USD).

Show cutoff locations of reinforcement for 50% of design positive and negative moments (WSD only).

6 Refer to the following RC slab supported on brick walls. Design the slab by USD. Use $f'_c$=4000 psi, $f_y$ = 60,000 psi, LL = 100 psf, DL = 50 psf (excluding self-weight). Show the layout of the reinforcements in plan and two orthogonal sections. **(CO3)** **(PO3)** **(20)**




Plan




Section

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**Equations related to the calculation for development length for tension bar**

$$L_d = \frac{3}{40}\frac{f_y}{\lambda\sqrt{f_c'}}\frac{\psi_t\psi_e\psi_s}{\frac{C_b + K_{tr}}{d_b}}d_b$$

$$K_{tr} = \frac{40A_{tr}}{sn}$$

**Equations for checking the requirement of torsion steel and adequacy of the section under shear and torsion**

$$T_u < \Phi\lambda\sqrt{f_c'}\left(\frac{A_{cp}^2}{p_{cp}}\right) = \frac{1}{4}T_{cr} \quad .$$

$$\sqrt{\left(\frac{V_u}{b_w d}\right)^2 + \left(\frac{T_u p_h}{1.7A_{oh}^2}\right)^2} \leq \phi\left(\frac{V_c}{b_w d} + 8\sqrt{f_c'}\right)$$

(449)

**B.Sc. Eng. (CEE), 5th Sem** **December 1, 2022**

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
**DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING**

**Semester Final Examination** **Winter Semester: 2021 - 2022**
**Course Number: CEE 4513** **Full Marks: 200**
**Course Title: Structural Analysis and Design-I** **Time: 3 Hours**

There are **6 (six)** questions. Answer **all** questions. Marks of each question and the corresponding CO and PO are written in brackets.

---

**1 a)** Considering loads are moving from right to left, shown in figure 1.1, solve the followings- **(40)**
a) Maximum reaction at A **(CO2)**
b) Maximum Shear at C **(PO2)**
c) Maximum Bending Moment at C
d) Location of the absolute maximum moment from the beam center line.

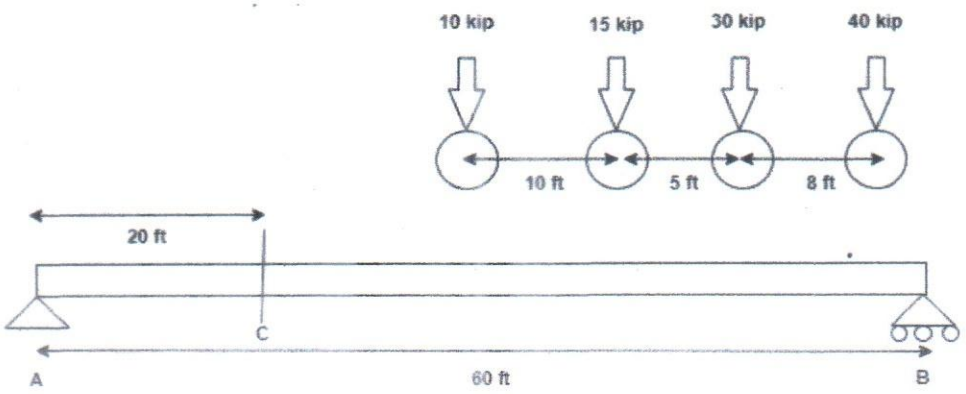


**Figure 1.1**

**2 a)** Calculate the earthquake base shear and shear force distribution at each level of a 7-storied RC office building located in Chittagong. Given that the structural system is IMF, each storey height is 3 m, GF height is 2 m, and site class is SB. The plan dimension is 30 X 20 m (Figure 2.1). Dead load and partition wall load = 12 kN/m$^2$ for typical floors, including the roof and ground floor. The live load of the typical floor is 2.5 kN/m$^2$, including the ground floor, and the live load on the roof is 1 kN/m$^2$, given that the self-weight of all pedestals is 125 kN. **(30)** **(CO3)** **(PO2)**

**Given data:**

$$C_S = S\left(1 + \frac{T}{T_B}(2.5\eta - 1)\right) \quad \text{for} \quad 0 \le T \le T_B$$

$$C_S = 2.5S\eta \quad \text{for} \quad T_B \le T \le T_C$$

$$C_S = 2.5S\eta\left(\frac{T_C}{T}\right) \quad \text{for} \quad T_C \le T \le T_D$$

$$C_S = 2.5S\eta\left(\frac{T_C T_D}{T^2}\right) \quad \text{for} \quad T_D \le T \le 4\ sec$$

Table 6.2.16: Site Dependent Soil Factor and Other Parameters Defining Elastic Response Spectrum

| Soil type | $S$ | $T_B$(s) | $T_C$(s) | $T_D$(s) |
|---|---|---|---|---|
| SA | 1.0 | 0.15 | 0.40 | 2.0 |
| SB | 1.2 | 0.15 | 0.50 | 2.0 |
| SC | 1.15 | 0.20 | 0.60 | 2.0 |
| SD | 1.35 | 0.20 | 0.80 | 2.0 |
| SE | 1.4 | 0.15 | 0.50 | 2.0 |

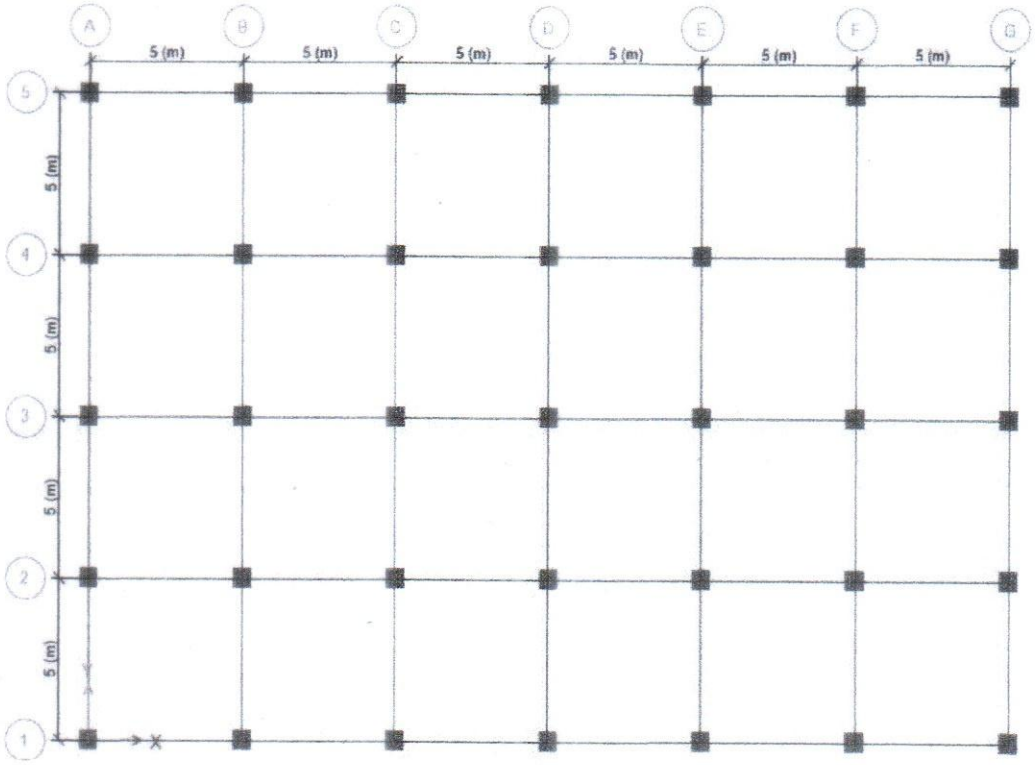


**Figure 2.1**

**3 a)** Using figure 3.1, draw influence lines for **(30)**
(a) Reactions at D **(CO2)**
(b) Shear force at C and at the left of D **(PO2)**
(c) Bending moment at C and D for the beam shown below:

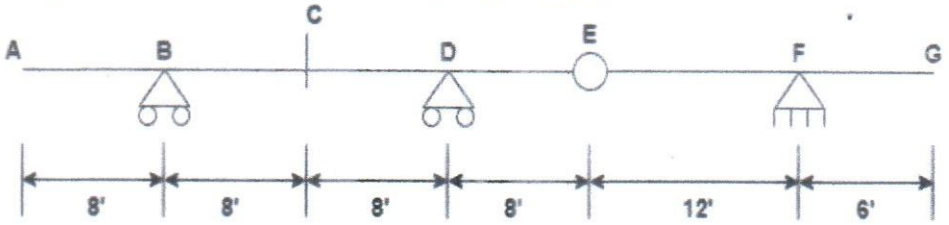


**Figure 3.1**

**4 a)** Draw influence lines for shear force in panels 3-4 of the girder with floor beams. (Figure 4.1) **(30)** **(CO2)** **(PO2)**

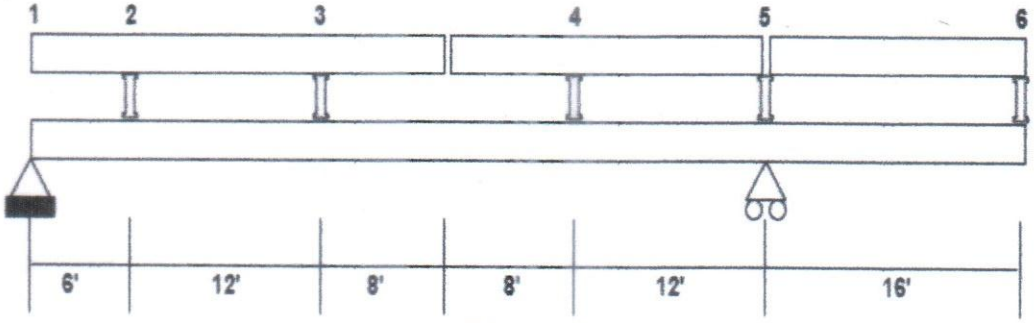


**Figure 4.1**

**Or**

Draw the influence lines for the forces in GH, CH, CD, and DH members of the trusses shown in figure 4.2. Live loads are transmitted to the bottom chords of the trusses.

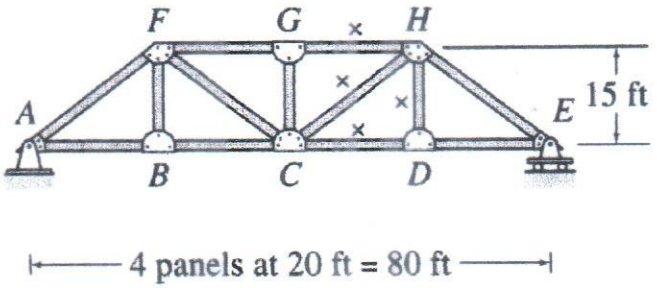


**Figure 4.2**

5 a) Determine the reactions and draw the shear and bending moment diagrams for the beams shown in figure 5.1 using the virtual work method. (Hint: Select the reaction at the interior support to be redundant). **(40) (CO3) (PO2)**

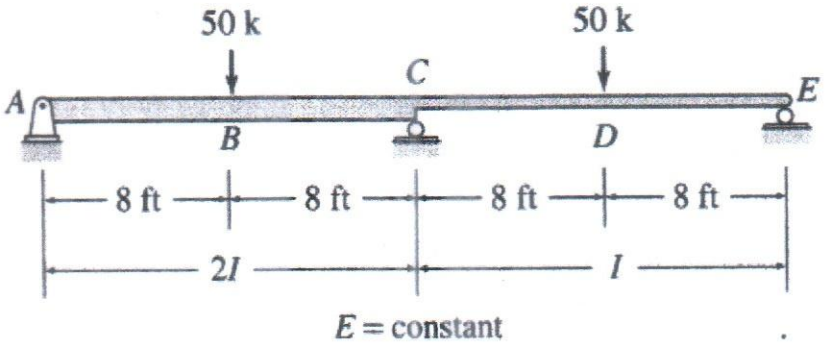


**Figure 5.1**

**Or**

Determine the reactions and the force in each member of the trusses shown in figure 5.2 using the virtual work method.

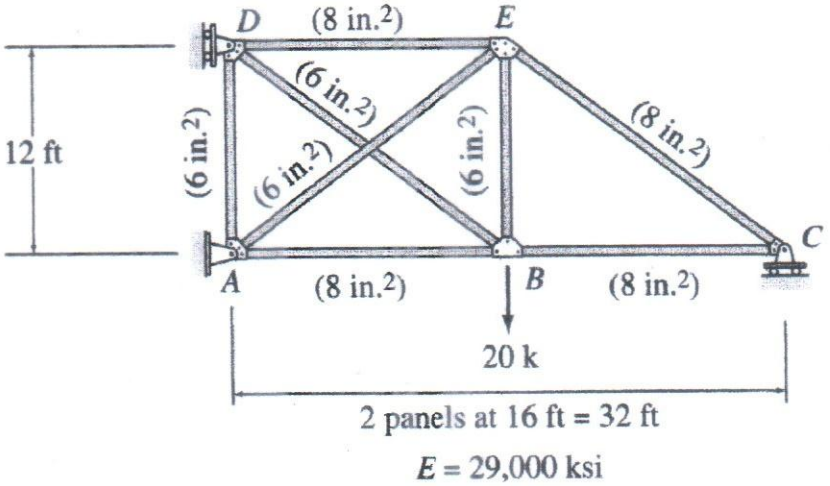


**Figure 5.2**

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6 a) Using approximate analysis for vertical load, solve the following frame (Figure 6.1). **(30) (CO3) (PO2)**

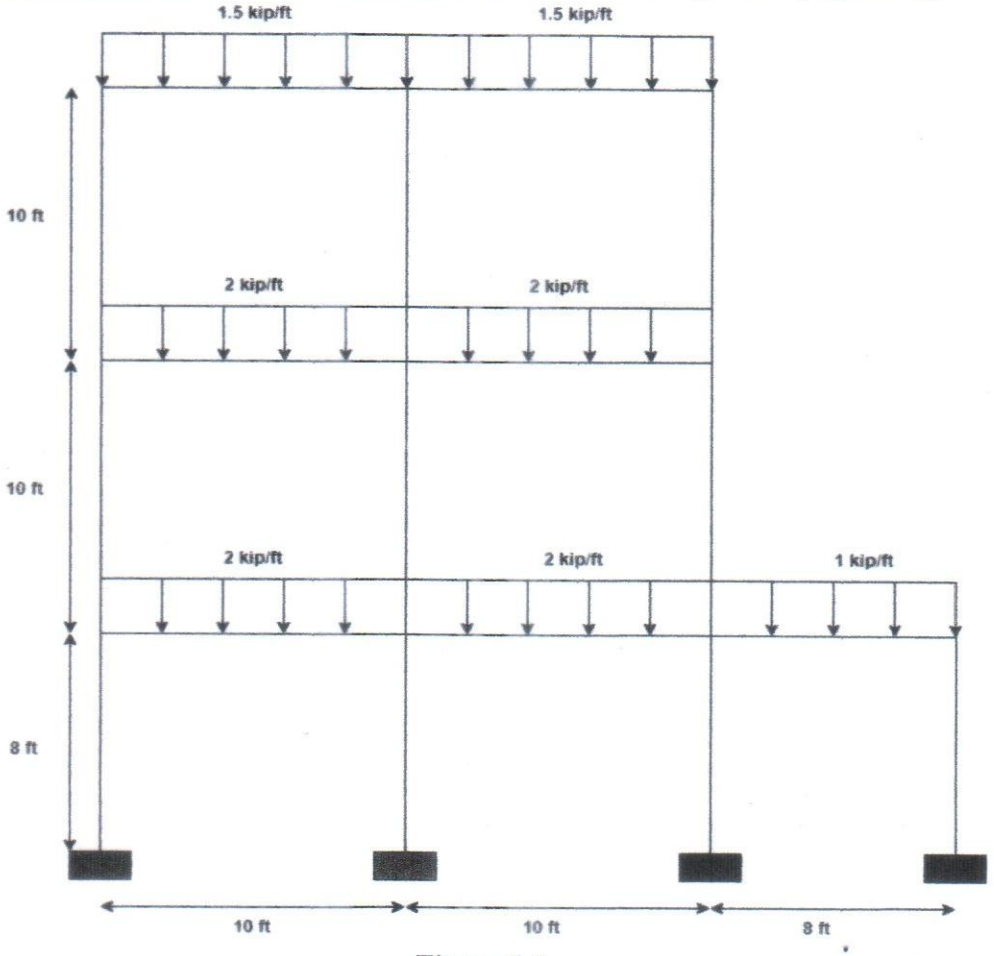


**Figure 6.1**

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B. Sc. Engg (CEE)/5th Semester — 15th December 2022 (Thursday)

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
## ORGANIZATION OF ISLAMIC COOPERATION (OIC)
## DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Semester: Semester Final Examination** — **Winter Semester: 2021-2022**
**Course No.: CEE 4551** — **Full Marks: 150**
**Course Title: Transportation and Traffic Engineering** — **Time: 3 hours**

**Answer all the questions.** Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks and corresponding CO and PO. Symbols convey their usual meanings. Assume reasonable data/values for any missing data/info. The examination is **OPEN BOOK** and **OPEN NOTES**.

---

1. (a) List the steps in travel demand forecasting along with their inputs, outputs, required surveys to collect such data, and methods used to complete each step. — CO1,PO1: (10)

   (b) Order macroscopic traffic flow variables based on their usefulness and ease of data collection. Rationalize your answer. Use diagrams if necessary. — CO1,PO1: (5)

2. Bangladesh and Myanmar governments have initially decided to build a diamond interchange at their border. The alignments of the interchange along with the border and land areas belonging to each country are shown in Figure 1. Bangladesh follows left-hand driving and Myanmar follows right-hand driving. Redesign the interchange and show the flow from each direction from each leg into the other legs in a clear picture (each leg has three movements – left, right, and through). Both countries are willing to provide extra space to accommodate the interchange and it is not mandatory to stick to a diamond interchange design only. The only constraint you have is each country will contribute a roughly equal amount of land space to build the interchange. Use a full page to draw the diagram. Be detailed about the geometric designs and flow directions. — CO2,PO3: (25)

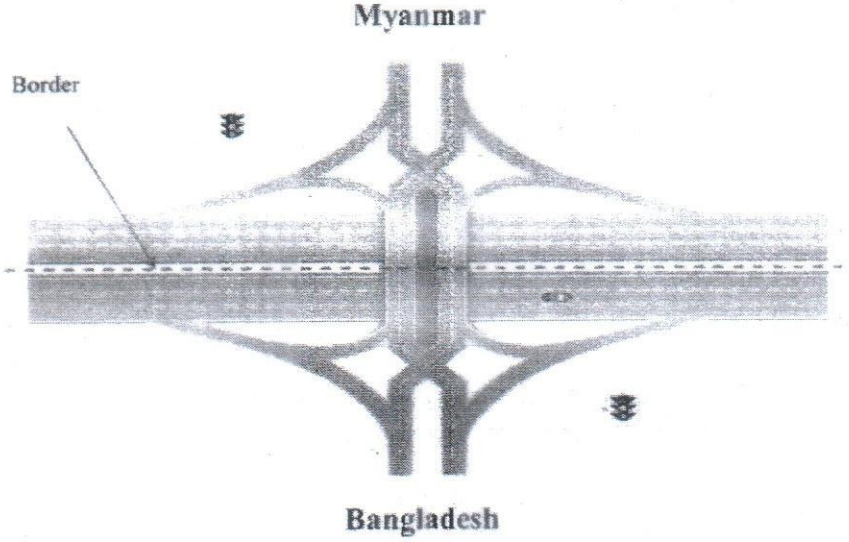


*Figure 1*

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3 The traffic flow for a four-legged intersection is shown in Figure 2. Given that the lost time per phase is 2.3 seconds, saturation headway is 2.4 seconds, amber time is 3 seconds per phase, estimate the cycle length, green time, and performance measure (delay per cycle). Assume the critical v/c ratio as 0.9. CO3,PO4: (20)

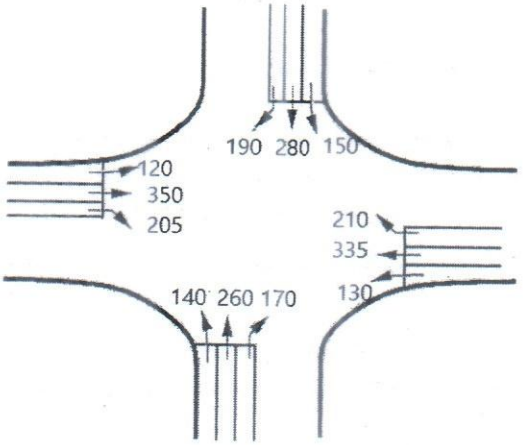


*Figure 2*

4 You are assigned a job to conduct a volume count study and OD survey at 6 locations in Dhaka city. You will generate 24-hr data for each site. The volume on these roads along with the OD characteristics do not change in short intervals (e.g., 15 min). Due to budget constraints, you will be conducting staggered counting. You are given four days to complete the job. Provide your study design plan which will include: CO3,PO4: (20)

i) How many people will you need on each day (the number of people may vary) and how will you be arranging them?
ii) How many will you assign for OD and how many for counting?
iii) How many minutes will the surveyors be counting data at a time (Hint: for a 10-minute short count, the surveyors may do actual counting for 8 minutes and extrapolate the value for 10 minutes)?

Generate hypothetical data in tabular format and show the calculation on how you will calculate the hourly volume and peak hour factor (for one site only).

5 A spot speed study was conducted on a freeway where the flow was 1500 vehicles/lane/hour. The data are aggregated as follows in Table 1: CO3,PO4: (20)

*Table 1*

| Speed (mph) | 15-20 | 20-25 | 25-30 | 30-35 | 35-40 | 40-45 | 45-50 | 50-55 | 55-60 | 60-65 | 65-70 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vehicles | 0 | 3 | 6 | 18 | 25 | 48 | 28 | 22 | 4 | 3 | 0 |

i) Plot the frequency and cumulative frequency curves for the given data.
ii) Determine on the curves: mean, median and modal speed, pace, percent vehicles in pace, and standard deviation.
iii) Conclude if this data be appropriately described as normal?
iv) Make comments on the overall survey design and the reliability of the results.

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6 Below is the diagram of a 5-leg intersection (Figure 3). Draw and identify different conflicting movements. Mark every type of conflict with a distinctive legend. You may show each type of conflict in separate diagrams. Assume that every link of the intersection has two-way traffic and vehicles from any link can enter into any link. CO2,PO3: (20)

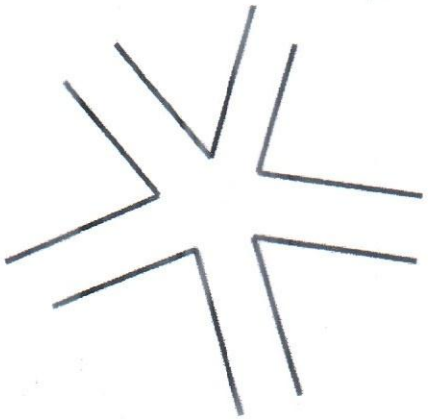

*Figure 3*

7 The base-year trip matrix and cost matrix for three internal zones are estimated in Table 2. The productions in zones 1, 2, and 3 are 400, 460, and 400, and the attractions in zones 1, 2, and 3 are 260, 500, and 500. CO4,PO4: (30)

The cost function is: $f(c_{ij}) = \frac{1}{c_{ij}^2}$

*Table 2*

Base-year trip matrix

| | *1* | *2* | *3* |
|---|---|---|---|
| *1* | 80 | 120 | 75 |
| *2* | 60 | 170 | 85 |
| *3* | 30 | 90 | 180 |

Cost matrix

$$\begin{bmatrix} 1 & 1.2 & 1.5 \\ 1.2 & 1 & 1.4 \\ 1.5 & 1.4 & 1 \end{bmatrix}$$

Construct the origin-destination matrix. Performing two iterations will be sufficient.

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# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
## ORGANISATION OF ISLAMIC COOPERATION (OIC)
## DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Semester: SEMESTER FINAL EXAMINATION** **Winter Semester: 2021-2022**
**Course No.: MATH 4353** **Full Marks: 150**
**Course Title: Laplace Transformation, Series, PDE** **Time: 3.0 hours**

There are 6 **(Six)** sets of questions. Answer **all** of them. Programmable calculators are not allowed. Do not write on this questions paper. The symbols have their usual meaning. Assume reasonable data if needed. Marks are mentioned in the right side of the question along with CO and PO.

---

| | | | Full Marks | CO | PO |
|---|---|---|---|---|---|
| 1. | a) | Define Laplace transform of periodic function. Find the Laplace transform of the square wave shown in Fig. 1. | (8) | 1 | 1 |

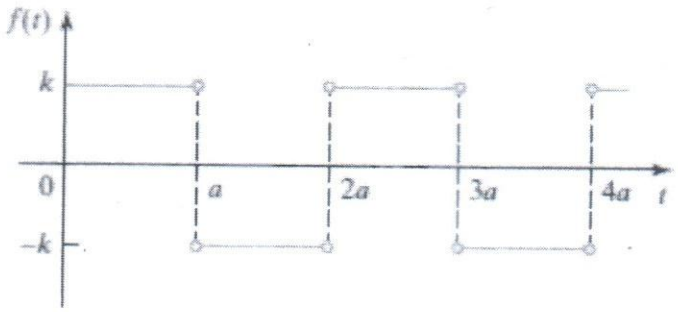


Fig.1 A square wave with period 2a

| | | | | | |
|---|---|---|---|---|---|
| | b) | Using convolution theorem, find $\mathcal{L}^{-1}\left\{\frac{s}{(s^2+1)(s^2+4)}\right\}$. | (8) | 1 | 1 |
| | c) | Solve the initial value problem using Laplace Transformation $(D^2 - D - 2)y = e^t; where\ y(0) = 1, y'(0) = 0$ | (9) | 1 | 1 |
| 2. | a) | Find the Fourier series expansion of $f(x) = \begin{cases} 0; & -\pi < x < 0 \\ \pi; & 0 < x < \pi \end{cases}$. | (13) | 2 | 2 |
| | b) | Expand $f(x) = \pi x - x^2$ as a cosine series valid in $0 \leq x \leq \pi$. | (12) | 2 | 2 |
| 3. | a) | State Parseval's theorem. Use Fourier Transform to calculate | (12) | 2 | 2 |

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$$\int_0^{\infty} \frac{dx}{1+x^2}$$

b) Apply finite Fourier Sine transform to solve (13) 3 1

$\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$, where $u(0,t) = 0, u(4,t) = 0$ *and* $u(x,0) = 2x$.

4. a) Develop a partial differential equation from $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$ by eliminating arbitrary constants. (8) 3 1

b) Write down an algorithm to solve the first order linear partial differential equation by Lagrange's method and solve (9) 3 1

$$(mz - ny)p + (nx - lz)q = ly - mx$$

c) Apply Charpit's method to find complete integral of (8) 3 1

$$2zx - px^2 - 2qxy + pq = 0$$

5. a) Solve the following partial differential equations: (14) 3 1

(i) $\left(D_x^3 - 7D_xD_y^2 - 6D_y^3\right)z = sin(x + 2y) + e^{2x+y}$

(ii) $\left(D_x^2 - D_xD_y - 2D_y^2\right)z = 2x + 3y$

b) Express $f(x) = 4x^3 + 6x^2 + 7x + 2$ in terms of Legendre polynomials. (11) 2 2

6. a) Solve in series the differential equation $4x\frac{d^2y}{dx^2} + 2\frac{dy}{dx} + y = 0$ (18) 2 2

b) Prove that $J_{1/2}(x) = \sqrt{\frac{2}{\pi x}}\, sinx$ (7) 2 2

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B. Sc. Engg. (CEE)/ 3rd Semester — 9th December, 2022 (Group-B)

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
## ORGANIZATION OF ISLAMIC COOPERATION (OIC)
## DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Semester: Semester Final Examination** — **Winter Semester: 2021-2022**
**Course No.: GS 4353** — **Full Marks: 150**
**Course Title: Numerical Methods and Computer Programming** — **Time: 3 hours**

There are **6 (Six)** questions. **ALL QUESTIONS ARE COMPULSORY.** Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks and corresponding CO and PO. Symbols convey their usual meanings. Assume reasonable values for any missing data/info.

---

| | | | Marks | CO | PO |
|---|---|---|---|---|---|
| **1.** | (a) | Using Regula-Falsi Method, derive the following equation - $$X_r = X_u - \frac{f(X_u)}{f(X_u) - f(X_i)} (X_u - X_i)$$ | 6 | CO2 | PO2 |
| | (b) | What are the commonly identified limitations of 'Bracketing Methods'? Explain with necessary diagrams. | 6 | CO2 | PO2 |
| | (c) | The wastewater discharge volume ($m^3/hr.$) from a residential area's sewerage line at different time interval are given below: | 13 | CO3 | PO2 |

| Time (hrs.) | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Discharge ($m^3$/hr.) | 2 | 6 | 19 | 78 | 140 | 241 |

Apply-

i. Graphical method
ii. Linear interpolation
iii. Parabolic interpolation of second order
iv. Newton's 3rd order interpolating polynomial

to predict discharge of wastewater after 3.6 *hrs*. Choose appropriate sets of data in each case to predict more accurate results.

| | | | | | |
|---|---|---|---|---|---|
| **2.** | (a) | Define 'Goodness of Fit'. If the obtained $R^2$ values from three different regression models are $R^2 = 0, R^2 = 0.8, and\ R^2 = 1$, compared to the 'Naïve Model' how much better are each of these models? | 8 | CO1 | PO1 |
| | (b) | Compare the performance of different numerical methods used for solving Ordinary Differential Equations (ODE) using Relative Error vs Effort diagram. | 7 | CO1 | PO1 |
| | (c) | Determine the root of the equation $f(x) = -25 + 82x - 90x^2 + 44x^3 - 8x^4 + 0.7x^5$ using Regula-Falsi method. Use boundary values $x_i = 0.5$ and $x_u = 1$ and perform three iterations. | 10 | CO3 | PO1 |

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3. (a) Differentiate between 'Interpolation' and 'Least-square Regression' based on their purpose of application. Draw qualitative graphs of 'Linear interpolation', 'Polynomial interpolation', and 'Least Square Regression' with assumed data points. 8 CO1 PO1

(b) Use Simpson's $1/3^{rd}$ rule to numerically integrate the following term by dividing the interval into 4 strips. 7 CO3 PO1

$$\int_0^1 \frac{x^2}{1+x^3} dx$$

(c) Numerically integrate the given term from $x = 1$ *to* 2 applying initial condition $y(1) = 2$ and step size $h = 1$ by Heun's method. 10 CO3 PO1

$$\frac{dy}{dx} = \frac{2y}{x}$$

4. (a) The program shown below was written by a student to find the square root of a number using 'Approximate Solution method'. There are a few errors in the program. Examine the code thoroughly and modify the program and mention what will happen if: 10 CO2 PO2

i. You enter **the last two digits of your ID** in the variable epsilon.

**Program**

```
x = 121
epsilon = float(input("Enter an allowable error: "))
step = epsilon**2
numGuesses = 0
ans = 0.0
while (abs(ans**2 - x)) >= epsilon
      ans = step
      numGuesses += 1
print(numGuesses =  + str(numGuesses))
if abs(ans**2-x) > epsilon:
      print('Failed on square root of ' + str(x))
else:
      print(str(ans) + ' is close to the square root
of ' + str(x))
```

(b) Develop a python program that uses Bisection search algorithm to find the root of the equation $\mathbf{f(x) = x^3 - 5x^2 + 5x - 2}$. Consider an allowable error of 0.001. 15 CO3 PO1

5. (a) Describe Imperative Knowledge and Declarative Knowledge in computational problem-solving using example of finding square root of a number. 7 CO1 PO1

(b) i) What type of error will occur if you try to run the given python script? 10 CO2 PO2
ii) Improve the code to handle the error using the concept of exception.

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**Program**

```
def get_ratios(v1, v2):
    ratios = []
    for index in range(len(v1)):
        ratios.append(v1[index]/float(v2[index]))
print(get_ratios([1.0,2.0,7.0,6.0],
                 [1.0,2.0,0.0,3.0]))
print(get_ratios([1.0,2.0], [3.0]))
```

6. (a) A programmer with civil engineering background has created two python modules saving by the names "circular_beam.py" and "square_beam.py" in same folder naming "Python" containing geometric properties of a circular beam and square beam as shown below: 20 CO3 PO1

i) circular_beam.py

```
pi = 3.1416
length = 1
def circumference(radius):
    return 2*pi*radius

def area(radius):
    return pi*(radius**2)

def volume(radius, length):
    return area (radius) * length
```

ii) square_beam.py

```
length = 4
def area(width_or_height):
    return width_or_height**2
def volume(width_or_height, length):
    return area(width_or_height)*length
```

Write down the output of each expression given below in a sequential manner by writing beside the expression.

I. import circular_beam

II. print(pi)

III. print(circular_beam.pi)

IV. pi = 3.0

V. import square_beam

VI. print(circular_beam.area(5))

VII. print(circular_beam.area(5))

VIII. print(square_beam.volume(5,4))

IX. print(circular_beam.volume(7,length))

X. from circular_beam import*

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XI. pi
XII. area(10)
XIII. Square_beam.volume(3, length)
XIV. length = 10
XV. volume(3,length)

(b) The following python script uses the concept of class to keep track of your expense for grocery. Introduce a new **subclass** named **MonthlyExpense** to add the following expenditure to find your monthly expense. Use the table given below for cost estimation. 13 CO2 PO2

| Items | Cost ($) |
|---|---|
| House rent | 100 |
| Transportation | 50 |
| Miscellaneous | 30 |

**Program**

```
class Expense():
    def __init__(self, grocery):
        self.grocery = grocery

    def cost(self, tips):
        total = self.grocery + tips
        return total

x = int(input("Enter the last two digits of your student ID:
"))
myexpense = Expense(x)
grocery_cost = myexpense.cost(5)
print("Cost for Grocery: ", grocery_cost)
```

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B.Sc. Engg. (CEE)/ 5th Sem.

07 December 2022
10:00 A.M to 01:00 P.M

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
## ORGANISATION OF ISLAMIC COOPERATION (OIC)
## DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Semester Final Examination** — **Winter Semester: 2021 - 2022**
**Course No.: CEE 4563** — **Full Marks: 150**
**Course Title: Engineering Hydrology** — **Time: 3 Hours**

There are **6 (Six)** questions. Answer all **6 (Six)** questions. Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks and corresponding CO and PO. Symbols convey their usual meanings. Assume reasonable data/values for any missing data/info.

1. **(a)** Explain briefly why the hydrologic cycle is concerned with only about 1% of the world's water. (CO1:PO1:4)

   **(b)** What is a catchment? Write down the water balance equation for a catchment and name the parameters. (CO1:PO1:4)

   **(c)** What is the latent heat of fusion, vapourization and sublimation? How are they related? (CO1:PO1:4)

   **(d)** Explain with a figure how the time of concentration affects the peak flow. (CO1:PO1:4)

   **(e)** What are the limitations of the Moving Boat method of discharge measurement? (CO1:PO1:3)

2. **(a)** Why is the hydrologic cycle considered as a system? What are the subsystems of the hydrologic cycle? (CO2:PO2:4)

   **(b)** Explain the application of remote sensing in hydrology with examples and its advantages and disadvantages. (CO2, PO2: 6)

   **(c)** Describe the characteristics of DAD curves with examples. (CO2, PO2: 4)

   **(d)** Point rainfalls due to a storm at several rain-gauge stations in a basin are shown in the given figure. Determine the mean areal depth of rainfall over the basin by the Arithmetic and Isohyetal method. (Each square box length is 1km and draw at least 5 isohyets) (CO2, PO2: 12)

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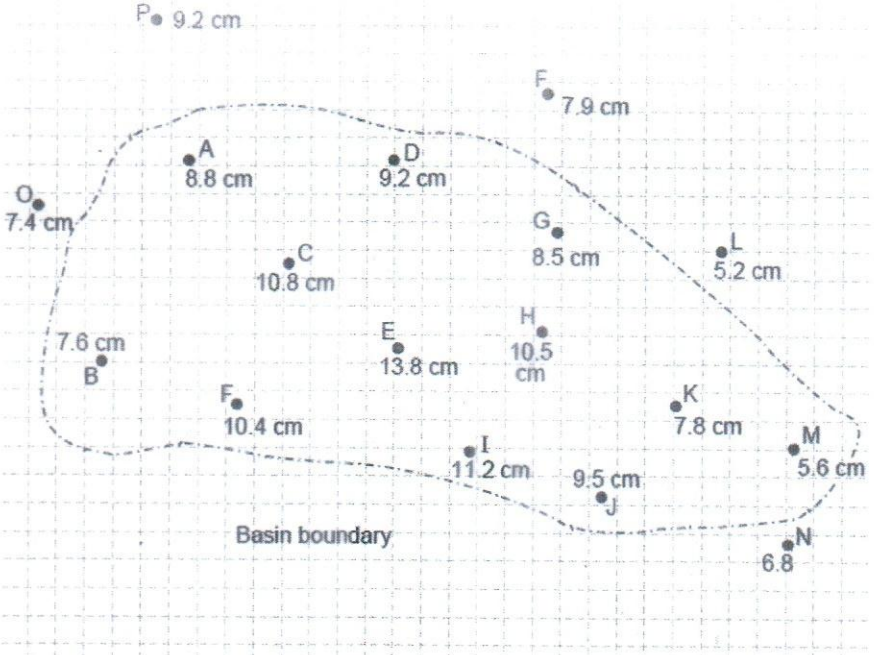


3 **(a)** What are the differences between interception and transpiration? What are the plant characteristics that affect transpiration? (CO2:PO2:4)

**(b)** Classify runoff according to the source. What is the difference between a tributary and a distributary? (CO2:PO2:4)

**(c)** The rainfall intensities during each successive 0.5 hr. of a 3-hr storm are 10, 30, 40, 50, 25, and 8 mm/hr. Calculate the $\phi$ index if the total runoff is 38 mm. (CO2:PO2:6)

**(d)** Explain the loop rating curve with a figure. (CO2:PO2:4)

**(e)** What is the advantage of a double ring over a single ring infiltrometer? How does vegetation affect the infiltration rate? (CO2:PO2:4)

**(f)** Determine the discharge of the Rupali river from the following data if the sections are spaced at 75 m. (CO2:PO2:11)

| Section | Velocity (m/s) | Angle of boat (degrees) | Depth (m) |
|---|---|---|---|
| 0 | Right bank | - | 0 |
| 1 | 1.75 | 55 | 1.8 |
| 2 | 1.84 | 57 | 2.5 |
| 3 | 2.00 | 60 | 3.5 |
| 4 | 2.28 | 64 | 3.8 |
| 5 | 2.00 | 60 | 3.0 |
| 6 | 1.84 | 57 | 2.5 |
| 7 | 1.70 | 54 | 2.0 |
| 8 | Leftbank | - | 0.0 |

4 **(a)** The data from an infiltrometer test are shown in the following table, Determine the Horton's equation and the infiltrated volume after 45 minutes if the catchment area is 426 ha. (CO3:PO3:13)

| Time (hr) | 0 | 0.25 | 0.50 | 0.75 | 1.0 | 1.25 | 1.5 | 1.75 | 2.0 |
|---|---|---|---|---|---|---|---|---|---|
| Infiltration rate (cm/hr) | 10.4 | 5.6 | 3.2 | 2.1 | 1.5 | 1.2 | 1/1 | 1/0 | 1.0 |

**(b)** The runoff from a 2 hr unit hydrograph is shown in the following table. Determine the peak flow from 3 hr effective rainfall with 3 cm depth. (CO3:PO3:13)

| Time (hr) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Flow (m/sec) | 0 | 20 | 45 | 60 | 46 | 34 | 28 | 14 | 9 | 0 |

**5. (a)** A cofferdam has been built to protect homes in a floodplain until a major channel project can be completed. The cofferdam was built for the 20–yr flood event. The channel project will require 3-yr to complete. What are the probabilities that: (CO4, PO4: 5)

(i) The cofferdam will not be overtopped during the 3 yr (the reliability)?
(ii) The cofferdam will be overtopped in any one yr?
(iii) The cofferdam will be overtopped exactly once in 3 yr?
(iv) The cofferdam will be overtopped at least once in 3 yr (the risk)
(v) The cofferdam will be overtopped only in the third yr?

**(b)** The highest annual floods for a river for 60 years were statistically analyzed. The sixth largest flood was 30,000 cumec (30 tcm). Determine: (CO4, PO4: 5)

(i) The period in which the flood of 30 tcm may reoccur once
(ii) The percentage chance that this flood may occur in any one year
(iii) The percentage chance that this flood may not occur in the next 20 years
(iv) The percentage chance that this flood may occur once or more in the next 20 years
(v) The percentage chance that a 50-yr flood may occur (a) once in 50 years, (b) one or more times in 50 years

**(c)** The annual floods for a large period were statistically analyzed by Gumbel's methods, which yielded $\mu = 19000$ cumec, $\sigma = 3200$ cumec. (CO4, PO4: 4)

Determine
(a) the discharge for the 100-yr flood.
(b) the discharge for the 50-yr flood.

**(d)** The annual rainfall at a place for a period of 21 years is given below. Draw the rainfall frequency curve and determine: (CO4, PO4: 14)

(a) the rainfall of 5-year and 20-year recurrence, interval
(b) the rainfall which occurs 50% of the times
(c) the rainfall of probability of 0.75
(d) the probability of occurrence of rainfall of 75 cm and its recurrence interval.

| Year | Rainfall (cm) | Year | Rainfall (cm) |
|---|---|---|---|
| 1950 | 50 | 1961 | 56 |
| 1951 | 60 | 1962 | 52 |
| 1952 | 40 | 1963 | 42 |
| 1953 | 27 | 1964 | 38 |
| 1954 | 30 | 1965 | 27 |
| 1955 | 38 | 1966 | 40 |
| 1956 | 70 | 1967 | 100 |
| 1957 | 60 | 1968 | 90 |
| 1958 | 35 | 1969 | 44 |
| 1959 | 55 | 1970 | 33 |
| 1960 | 40 | | |

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6. **(a)** The silty clay soil of a catchment has a porosity, suction head and hydraulic conductivity of 42.3%, 29.2 cm and 0.2 cm/hr, respectively. If the initial soil moisture is 12.7% and rainfall intensity is 12 mm/hr then calculate the ponding time and cumulative infiltration at ponding. What would happen if the hydraulic conductivity is greater than 12 mm/hr? (CO3:PO3:6)

**(b)** The peak flow from 6 hr unit hydrograph in catchment M is 200 $m^3$/sec and occurs at 37 hr. Determine the peak flow and base period from 6 hr of effective rainfall in catchment N which is in the same area from the following table. (CO3:PO3:12)

| Item | Catchment M | Catchment N |
|---|---|---|
| $L_c$ | 76 km | 52 km |
| L | 148 km | 106 km |
| A | 2718 $km^2$ | 1400 $km^2$ |

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B.Sc. Engg. (CEE)/ 5th Sem. 13 December (Tuesday), 2022

**ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)**
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Semester Final Examination** Winter Semester: **AY 2021-2022**
COURSE NO. : **CEE 4565** TIME: 3.0 hrs
COURSE TITLE: **Open Channel Flow** FULL MARKS: **150**

There are **07 (seven)** questions. **Answer 6 questions.** **Answer either question 2 or 3**. Other questions are compulsory to answer. The figures in the right margin indicate **CO-PO** and also the full marks of the question.

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Q.1 (a) Classify the open channel flow for the following: CO1-PO1: **(04)**

(i) Flow from a sluice gate
(ii) Flow in a municipal sewer line
(iii) Flow at the end of a long prismatic channel
(iv) Flow in a river during flood

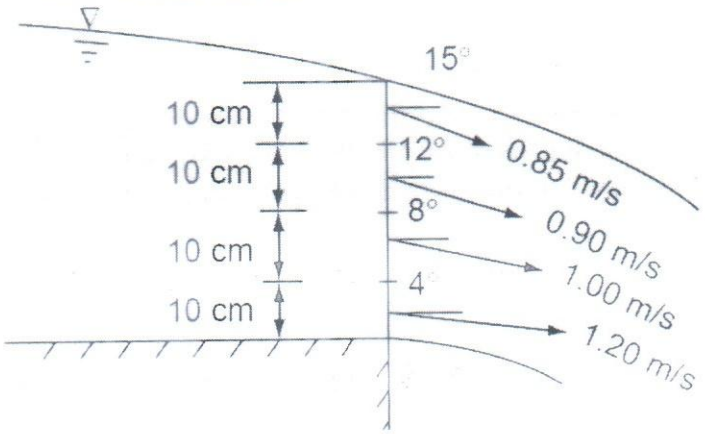
(b) Water flows at a depth of 2 m and velocity of 4 m/sec in a circular channel whose diameter is 2.5 m. Compute the discharge and determine the state of flow. Assume any value if required. CO1-PO1: **(05)**

(c) The velocity distribution in a rectangular channel is given by CO1-PO1: **(06)**

$$v = V_{max}\left(\frac{y}{y_0}\right)^{1/7}$$

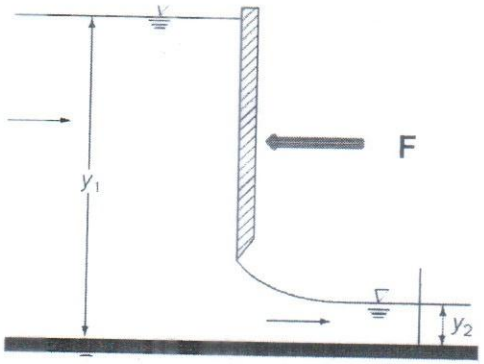
If $v$ is the velocity at y, $V_{max}$ = 2 m/sec, $y_o$= 2.0 m, calculate α and β.

(d) In a rectangular channel, the flow has a free outfall. The velocity measurement at the end section where the flow was curvilinear is indicated in figure below. Estimate the discharge per unit width of the channel. CO1-PO1: **(06)**



(e) Water is flowing through a sluice gate as shown below. Assuming hydrostatic pressure distribution and neglecting the frictional force on the bed, show that the force F acting on the sluice gate is given by: CO1-PO1: **(09)**

$$F = \frac{1}{2}\gamma \frac{(y_1 - y_2)^3}{(y_1 + y_2)}$$




**Q.2 (a)** Define best hydraulic section. Derive the condition for the best hydraulic section of a triangular and a trapezoidal channel section. CO2-PO2: **(06)**

(b) A trapezoidal channel having bottom width 5.0 m and side slope 1:1, carries a discharge of 12 $m^3$/sec. Compute the critical depth and critical velocity. If $n = 0.02$, determine the longitudinal slope of the channel required to maintain the critical depth. CO2-PO2: **(06)**

(c) Water flows at a velocity of 1.0 m/sec and a depth of 2.0 m in an open channel of rectangular cross section 3.0 m wide. At a certain section, the width is reduced to 1.8 m and the bed is raise by 0.65 m. Will upstream depth be affected? If so, to what extent, the upstream depth be affected? CO2-PO2: **(09)**

(d) A trapezoidal channel with side slopes 1.5:1 is required to carry 15 $m^3$/sec of flow with a bed slope of 1 in 4000. If the channel is lined, the Manning's n will be 0.014, and it will be 0.028 if the channel is unlined. What percentage of earthwork is saved in a lined section relative to unlined section, when the hydraulically efficient section is used in both cases? The free board is assumed to be 0.75 m in both cases and lining is assumed to be upto the top of the section. CO2-PO2: **(09)**

**Q.3 (a)** A rectangular channel which is laid on a bottom slope of 0.0064 is to be carry 20 $m^3$/sec. It is desired to create a critical flow condition by reducing the width of the channel. Determine the width of the channel to produce the critical flow condition in this channel. Assuming n = 0.015. CO2-PO2: **(07)**

(b) When the Manning formula is used, show that the critical slope at a given normal depth $y_n$ can be expressed by CO2-PO2: **(08)**

$$S_c = \frac{gn^2 D_n}{R_n^{4/3}}$$

and that this slope for a wide channel is $S_c = \frac{n^2 g^{10/9}}{q^{2/9}}$

Where, q is the discharge per unit width and other symbols has their usual meanings.

(c) The flow depth for a discharge of 15 $m^3$/sec in a long canal having a trapezoidal cross section (bottom width = 10 m; side slopes = 1V:2H) is 2 m. If the discharge is increased to 20 $m^3$/sec, what will be the depth of flow? CO2-PO2: **(07)**

(d) A lined channel ($n$ = 0.014) is of trapezoidal section with one side vertical and other side having a slope of 1H:1V. The canal needs to deliver water at a rate of 5.0 $m^3$/sec, when laid on a slope of 0.0001. Determine the dimensions of the efficient section which requires minimum of lining. CO2-PO2: **(08)**

Q.4 (a) A wide river has an average depth of 5 m, an average slope of 1 in 10,000 and n = 0.02. A dam increases the water depth by 1.0 m at the dam site. Find the length of the flow profile created by the dam assuming that the upstream end of profile is at 1% higher than the average depth. Use the **Bresse method**. Given, CO3-PO2: **(08)**

$$\varphi = \frac{1}{6}\ln\frac{u^2+u+1}{(u-1)^2} - \frac{1}{\sqrt{3}}\tan^{-1}\left(\frac{\sqrt{3}}{2u+1}\right)$$

(b) A rectangular flume 2.0 m wide carries discharge at a rate of 2 .0 $m^3$/sec. The bed slope of the flume is 0.0004. At a certain section, the depth of flow is 1.2m. Calculate the distance of the section downstream, where the depth of flow is 0.9m using the direct step method. Assume n = 0.014. Classify also the water surface profile. CO3-PO2: **(07)**

(c) A rectangular channel with b = 6.5 m, n = 0.025 and $S_0$ = 0.0025 carries a discharge of 40 $m^3$/sec. At a section A of the channel, the depth of flow is 2.0 m. What will be the depth at a distance 50 m upstream of section A, using (i) Euler method and (ii) Modified Euler method CO3-PO2: **(05)**

Q.5 (a) State the necessary conditions for the formation of hydraulic jump. Classify the hydraulic jump based on incoming water Froude's no.?
What are the functions of stilling basins and under what condition USBR II basin is used? CO3-PO2: **(04)**

(b) Show that the loss of KE in a hydraulic jump formed in a rectangular channel can be expressed by: CO3-PO2: **(08)**

$$\Delta E = \frac{(V_1 - V_2)^3}{2g(V_1 + V_2)}$$

Where, $V_1$ and $V_2$ are velocities at upstream and downstream of the hydraulic jump, respectively.

(c) Show that the relative height of hydraulic jump in a rectangular horizontal floor can be expressed as $\frac{h_j}{E_1} = \frac{\sqrt{1+8Fr_1^2}-3}{Fr_1^2+2}$, where, the symbols have their usual meanings. CO3-PO2: **(07)**

(d) A spillway discharges flood flow at a rate of 8.50 $m^3$/sec/m. At the downstream horizontal apron, the depth of flow is found to be 0.6 m. What tailwater depth is needed to form a jump? If the jump is formed, find its type, length, energy loss and relative loss of energy (in percentage). CO3-PO2: **(06)**

Q.6 (a) Using the Tractive Force method, design a trapezoidal channel to carry 25 $m^3$/sec through a slightly sinuous channel on a slope of 0.0015. The channel is to be excavated in coarse alluvium with a 75-percentile diameter of 2 cm (gravel), and with the particles on the perimeter of the channel moderately rounded. Assuming other data, if missing. CO4-PO3: **(09)**

(b) A channel has to be designed for drainage to carry flow from 100 $km^2$. If the flow/$km^2$ is 1.0 $m^3$/sec/ $km^2$, determine the Trapezoidal Channel section using (i) the permissible velocity method, (ii) the regime theory. The material size is 2 mm and $S_O$ = 0.00002. Assuming other data, if missing.
Which design will be more economical-justify your answer? CO4-PO3: **(14)**

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(c) Design a canal in alluvial soil to carry a discharge of 30 $m^3$/sec using Kennedy's theory. Assuming CVR = 0.95, n = 0.0225 and bed slope = 1/5000. Given, CO4-PO3: (07)

$$C = \left[ \frac{\frac{1}{n} + \left(23 + \frac{0.00155}{S}\right)}{1 + \left(23 + \frac{0.00155}{S}\right)\frac{n}{\sqrt{R}}} \right]$$

7.(a) Find the channel section for the maximum discharge that can carry through the channel with the following data: CO4-PO3: (08)
Bed slope = 1 in 5000
Lacey's silt factor = 0.95 and side slope of the channel = 1:1.

(b) What is tractive force? Show that the shear stress ratio is given by: CO4-PO3: (07)

$$K = \sqrt{\frac{1 - sin^2\theta}{1 - sin^2\varphi}}$$

Where, the symbols have their usual meanings.

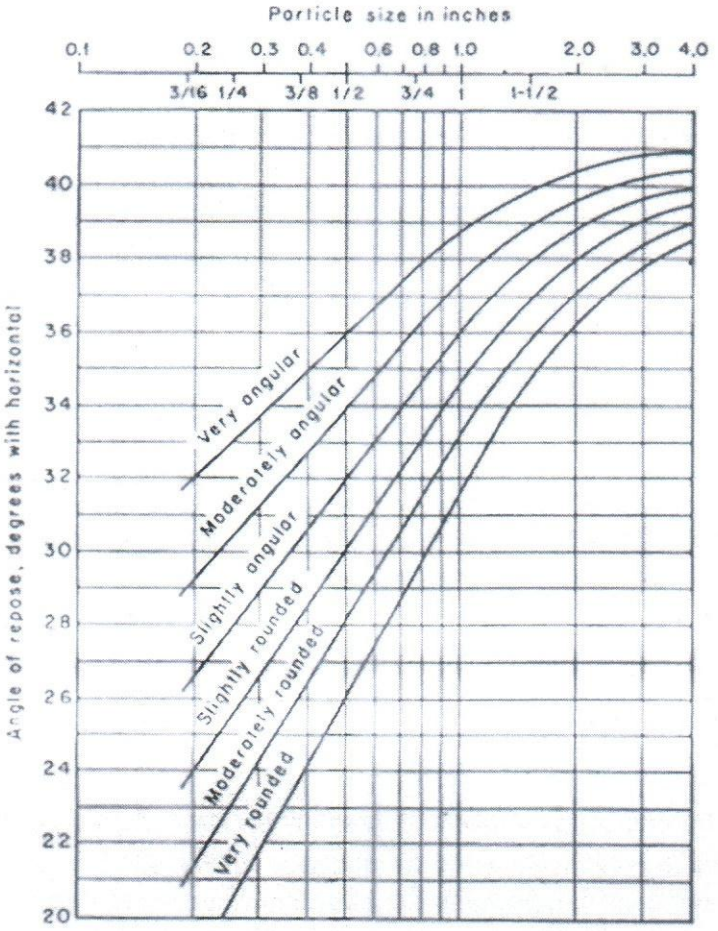


FIG. 7-9. Angles of repose of noncohesive material. (*U.S. Bureau of Reclamation.*)

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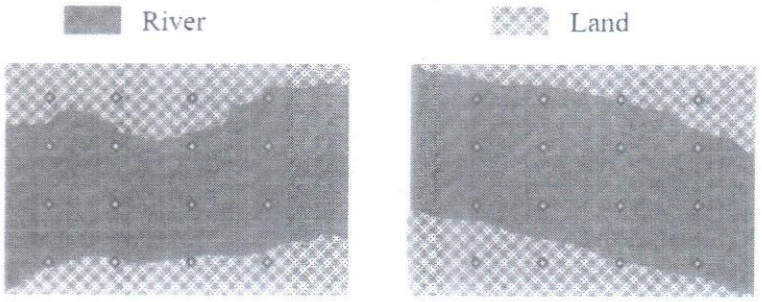
B. Sc. Engg. (CEE)/ 7th Sem. 30 November, 2022 (Group A)

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
## ORGANISATION OF ISLAMIC COOPERATION (OIC)
## DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

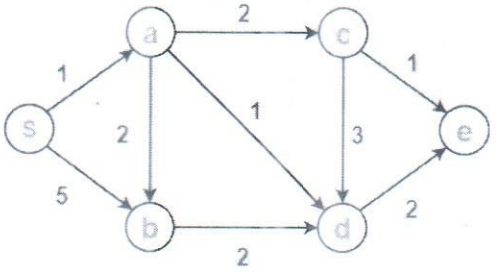
**Semester Final Examination** **Summer Semester: 2021-2022**
**Course No.: CEE 4703** **Full Marks: 150**
**Course Title: GIS Application in Environmental Engineering** **Time: 3 Hours**

There **are 7 (Seven)** questions. Answer **all** questions. Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks. The symbols have their usual meaning. Assume values as needed. The examination is **OPEN BOOK** and the students can bring both **books and lecture materials**.

| | | | |
|---|---|---|---|
| 1(a) | How do you calculate the RMSE error using a DGPS? Demonstrate mathematically. | (10) | CO1 PO1 |
| (b) | Rasterization of vector data is sometimes required in data preparation. What reasons may exist for this? If it is needed, the raster resolution must be carefully selected. Argue why. | (5) | |
| (c) | What is the output of an overlay between a point and a polygon layer? Describe with an example. | (5) | |
| (d) | How is the number "116" stored in BINARY form using 1 byte (8 bit)? | (5) | |
| (e) | You have been tasked with the responsibility to establish GIS technology in a consulting company consisting of 50+ technical employees who are heavily involved in environmental modeling, land use planning and transportation planning. Identify the areas where you can apply GIS and describe your steps to successfully implement GIS in the office. List the software, hardware needs as well. | (5) | |
| 2. | The values of the known 15 points and their interpolated values are represented as $z_i$ and $z_j$, where $z_i$ = {4, 6, 8, ...., 32} and $z_j$ = {6.7, 10.2, 12.7, 14.2, 18.5, 22.9, 24.2, 26.3, 27.4, 30.5, 32.6, 33.65, 36.7, 37.75, 44.8}. The points are unit distance away, i.e, the distance vector for the points is d={1, 2, 3, ...., 15}. Draw a semi-variogram and identify the nugget, range, and sill. Briefly explain the results as well. | (20) | CO2 PO2 |
| 3. | A map along the path of a river was prepared in 2000. However, since then the river has changed its course and a new survey was conducted to classify different ground points. The result is presented in the figure below. Calculate the overall, user/object, procedure/classification, mean and aerial accuracy of the existing map. Also, calculate the coefficient of agreement for the map as well as for the two classes (river and land separately). | (20) | CO2 PO2 |

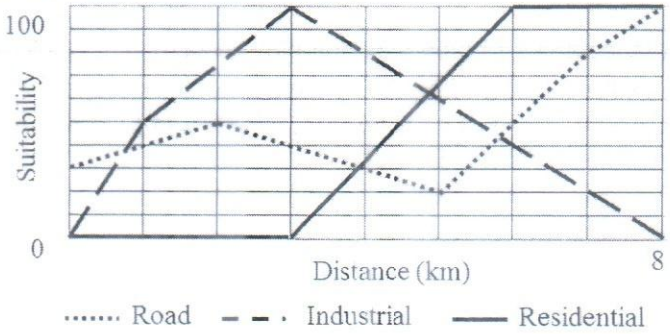



4. Find the shortest path between 's' and 'e' using the Dijkstra algorithm. (20) CO2 PO2

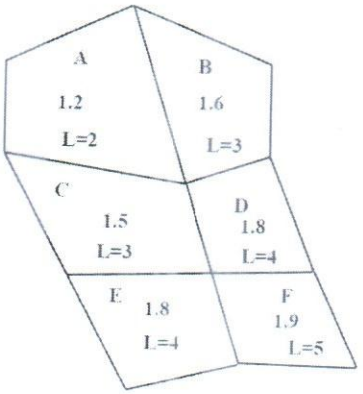



5. You have been hired to evaluate the feasibility of establishing a waste disposal site in Gazipur. The dumping site will receive both industrial and residential waste. The suitability graph for sites has been prepared based on the distance to industrial area, residential area and main road. Three sites have been shortlisted. Their distances from road, industrial and residential areas are as follows: (20) CO2 PO2

Site 1: 1 km, 7 km, 7 km
Site 2: 2 km, 4 km, 6 km
Site 3: 3 km, 4 km, 5 km
Which site shall you pick for waste disposal? (Assume values as necessary)
[The suitability graph is attached below.]




6. Calculate the spatial correlation coefficient for the area below. The area is divided into 6 polygons (A to F). The attribute data and the distance (L) for each of the polygons are given. Also, show with calculations whether the polygon attributes are randomly distributed or spatially correlated. (20) CO2 PO2




7. From the raster map below, calculate the slope, aspect, and flow direction for the shaded area. If each cell has a dimension = 100 m and the rainfall intensity is 50 cm/sq. meter/day then how much water will be accumulated in the three cells in the middle of the last row (2, 1, 2) if it rains for two hours? Assume that the rainwater falls only in the shaded area. (20) CO2 PO2

| | | | | |
|---|---|---|---|---|
| 4 | 7 | 10 | 6 | 9 |
| 9 | 3 | 8 | 1 | 6 |
| 6 | 7 | 9 | 6 | 7 |
| 8 | 5 | 6 | 4 | 8 |
| 3 | 2 | 2 | 2 | 7 |

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B.Sc. Eng. (CEE), 7th Sem

December 6, 2022

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
**DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING**

**Semester Final Examination**
**Course Number: CEE 4711**
**Course Title: Structural Analysis & Design II**

**Summer Semester: 2021 - 2022**
**Full Marks: 150**
**Time: 3 Hours**

There are **8 (eight)** questions. Answer questions **1 or 2, 5 or 6,** and **3,4,7,8**. The symbols have their usual meanings. Marks of each question and the corresponding CO and PO are written in brackets.

---

**1a)** Determine support moments and reactions for the beam presented in Figure 1a. Consider EI = constant. **(12.5) (CO3) (PO2)**

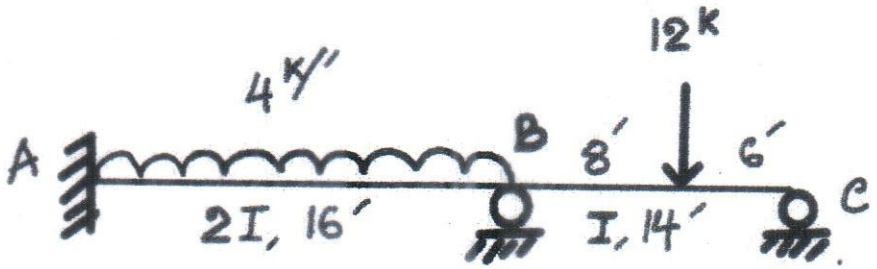


**Figure: 1a**

**1b)** Determine reactions of the truss (Figure. 1b) using direct stiffness matrix method. **(12.5) (CO3) (PO2)**

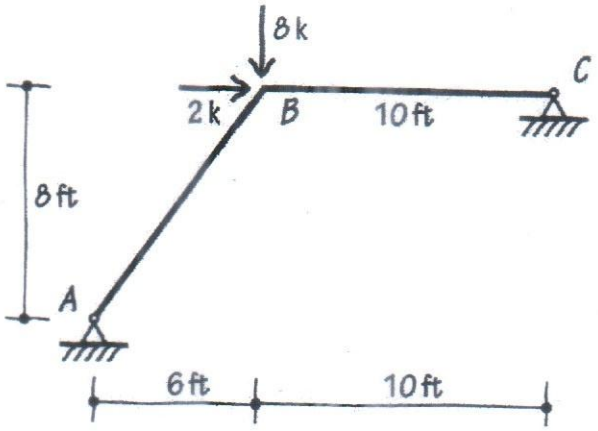


**Figure: 1b**

**Or,**

**2a)** Determine support moments due to the loading and support movements as shown in Figure. 2a. Support A rotates 0.03 radian clockwise and support A moves up by 0.15 feet. (EI=3000 k-ft$^2$) **(12.5) (CO3) (PO2)**

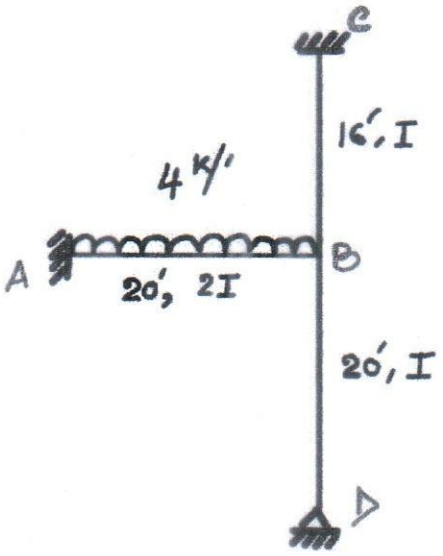


**Figure: 2a**

**2b)** Determine the displacements and reactions for supports B and C of the beam (Figure. 2b) using direct stiffness matrix method. **(12.5) (CO3) (PO2)**

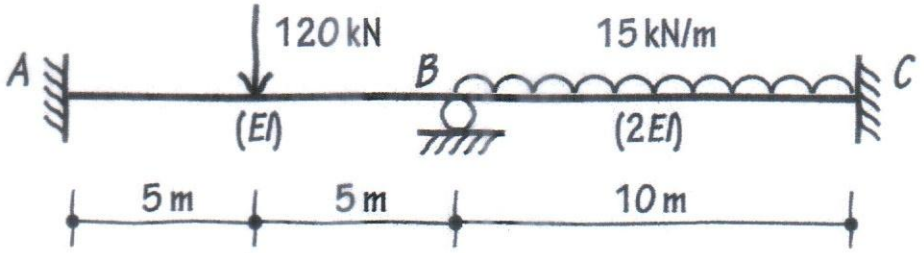


**Figure: 2b**

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**3a)** Determine the support moments of the frame as indicated in Figure. 3a. **(12.5) (CO3) (PO2)**

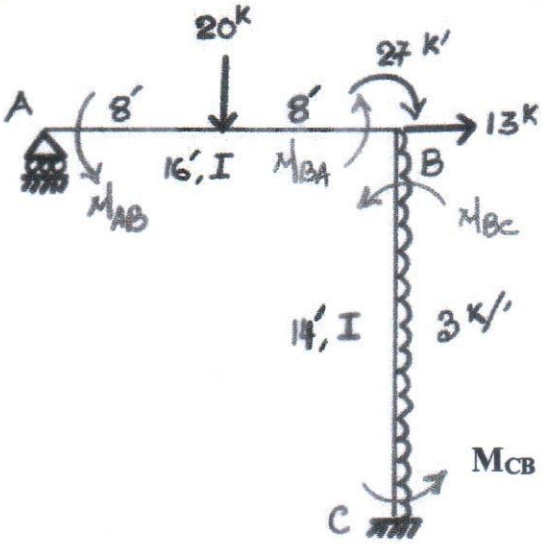


**Figure: 3a**

**3b)** Determine bar forces of the truss (Figure. 3b) using stiffness method. Cross sectional areas in square inch are in parenthesis. **(12.5) (CO2) (PO2)**

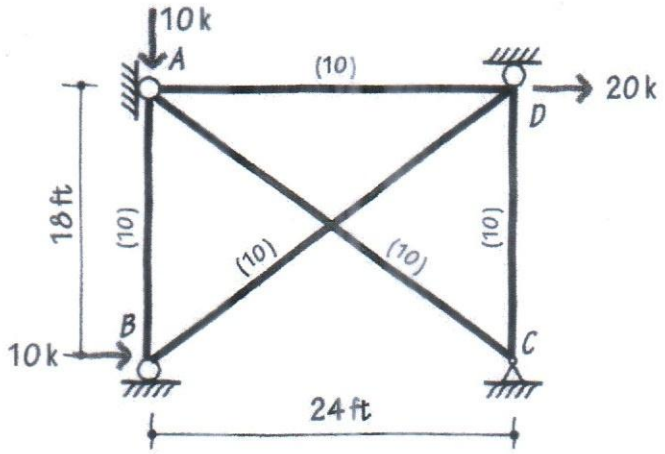


**Figure: 3b**

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**4a** Evaluate the DOKIs due to the loading and support conditions given in Figure 4a. Consider EI = constant. **(12.5) (CO2) (PO2)**

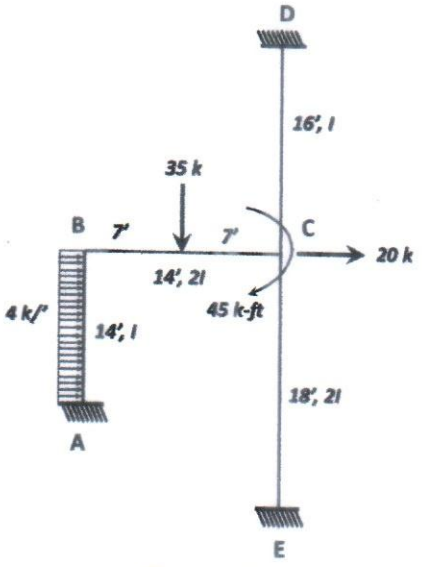



**Figure: 4a**

**4b** Determine bar forces of the frame (Fig. 4b) using stiffness method. Cross sectional areas in square inch are in parenthesis. **(12.5) (CO2) (PO2)**

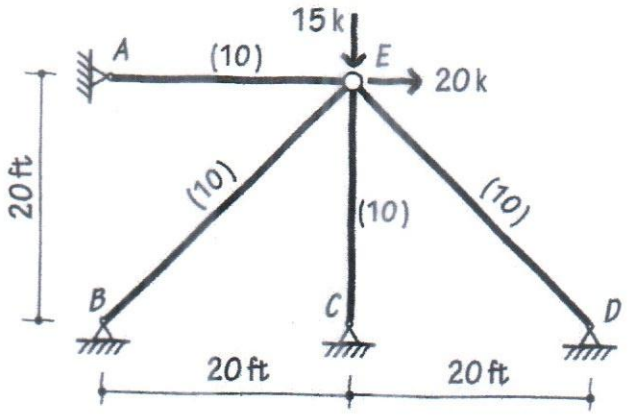



**Figure: 4b**

**5a)** Determine the member end moments for the two-span continuous beam shown in Figure. 5a by using the moment distribution method. **(12.5) (CO3) (PO2)**

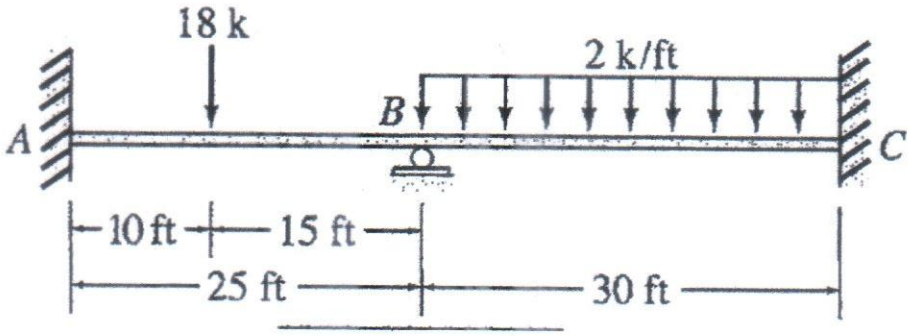



**Figure: 5a**

**5b)** The beam is loaded with concentrated loads, which are moving from right to left as shown in Figure 5b. Compute the maximum shear at the section C. [Distance given are in ft] **(12.5) (CO2) (PO1)**

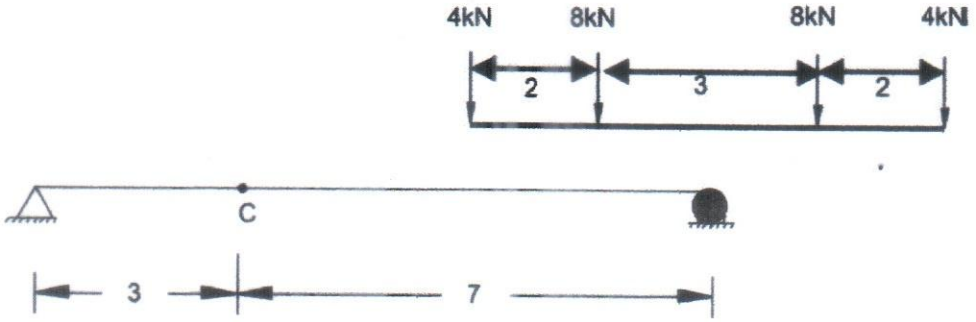



**Figure: 5b**

**Or,**

**6a)** Determine the member end moments for the continuous beam shown in Figure. 6 due to a settlement of 20 mm at support B. Use the moment-distribution method. **(12.5) (CO3) (PO2)**

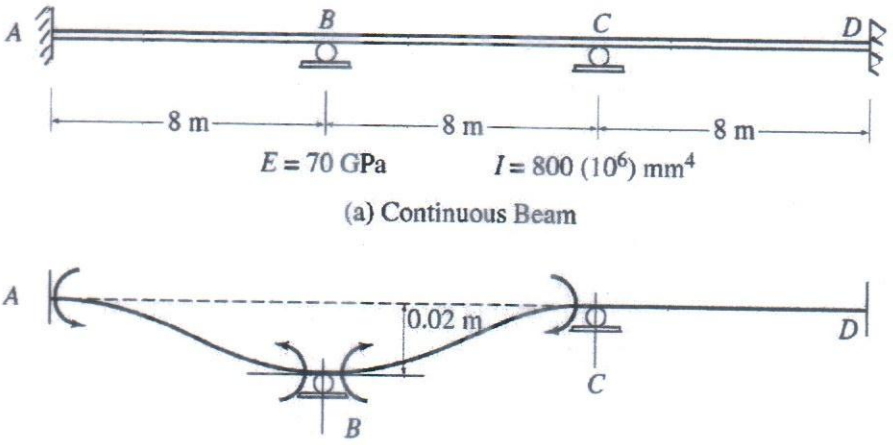



**Figure: 6**

**6b)** Construct the influence line for the force in member $L_2U_3$ of the bridge truss shown in Figure 6b. [Distance given are in ft] **(12.5) (CO2) (PO1)**

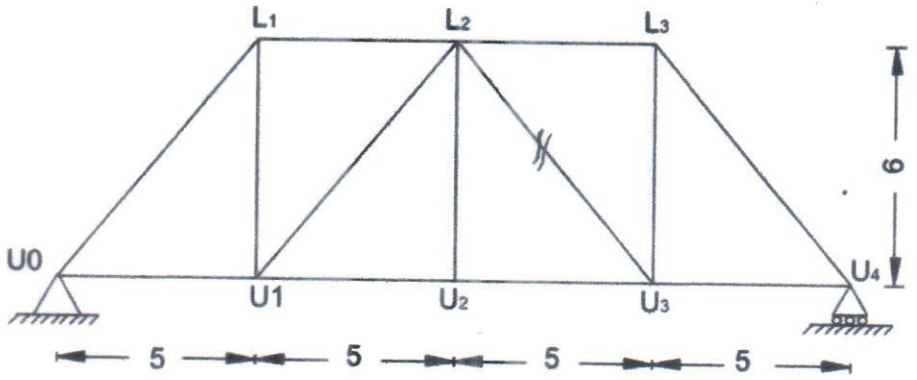



**Figure: 6b**

**7a)** Determine reactions of the beam in figure 7a using flexibility method. **(12.5) (CO3) (PO2)**

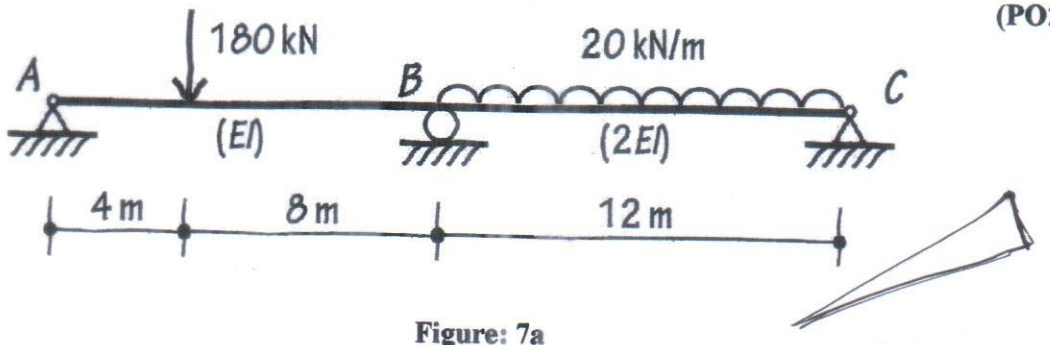
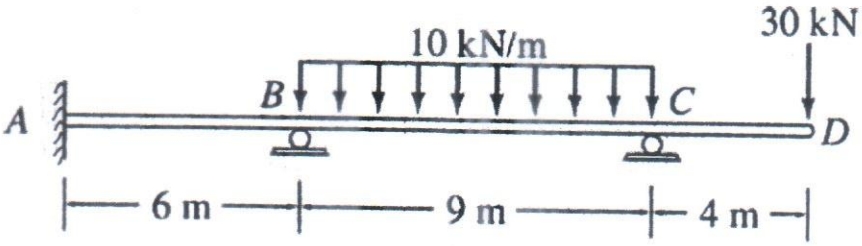



**Figure: 7a**

7b) Determine the member end moments for the continuous beam shown in Figure. 7b by using the moment-distribution method. **(12.5) (CO3) (PO2)**




$EI$ = constant

Continuous Beam

**Figure: 7b**

8a) Determine the reactions of the frame in figure 8a by flexibility method. **(15) (CO3) (PO2)**

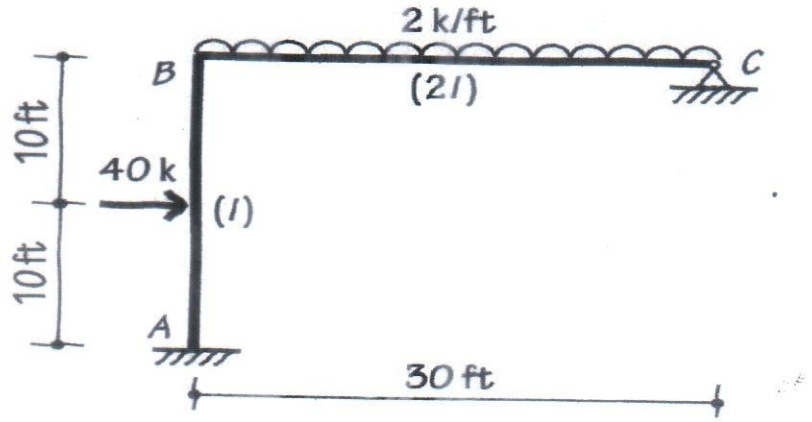



**Figure: 8a**

8b) Construct the influence line for the moment at point C of the beam shown in Figure 8b. [Distance given are in ft] **(10) (CO2) (PO1)**

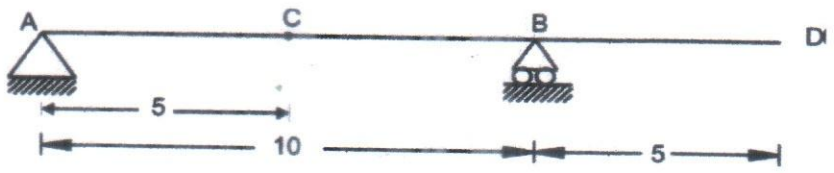



**Figure: 8b**

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B.Sc. Eng. (CEE), 7th Sem

November 30, 2022

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Semester Final Examination**
**Course Number: CEE 4713**
**Course Title: Design of Steel Structures**

**Winter Semester: 2021 - 2022**
**Full Marks: 150**
**Time: 3 Hours**

There are 6 **(six)** questions. Answer all 6 **(six)** questions. The symbols have their usual meanings. Marks of each question and the corresponding CO and PO are written in brackets.

---

1. By following the elastic vector method, compute the required size of E70XX fillet weld for the weld configuration and loading condition shown in **Figure 1**. Assume the plate thickness does not affect the result. Use the **AISC-ASD** method for the calculation. Given: Service load, P = 20 kips **(25) (CO3) (PO3)**

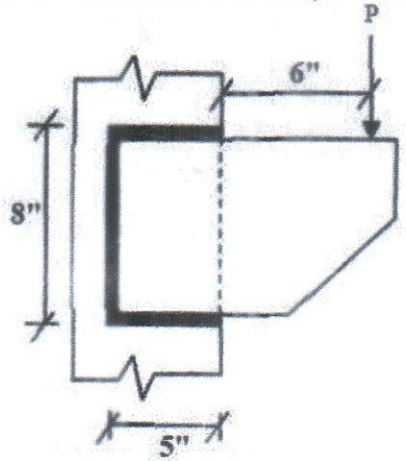


***Figure 1***

2. Compute moment gradient factor $C_b$ for segments AB, BC and CD of the beam shown in **Figure 2**. The beam has lateral bracing only at support points A and D; and its cross-section is doubly symmetric. **(25) (CO2) (PO2)**

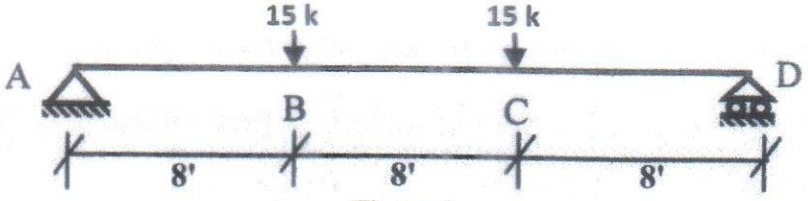


***Figure 2***

(481)

3. Determine the design moment capacity of W10x12 section of A572 Grade 50 steel for the beam shown in **Figure 3.** The beam has no lateral bracings in between support points A and B. Use the **AISC-LRFD** method. What will be the design moment capacity of the beam if a continuous lateral support is provided along the beam? **(25+10) (CO2) (PO2)**

Section properties of W10x12:

| D (in) | $t_w$ (in) | $b_f$ (in) | $t_f$ (in) | $S_x$ ($in^3$) | $Z_x$ ($in^3$) | $r_x$ (in) | $r_y$ (in) | $r_{ts}$ (in) | $h_o$ (in) | T (in) | J ($in^4$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.87 | 0.19 | 3.96 | 0.21 | 10.9 | 12.6 | 3.9 | 0.78 | 0.98 | 9.66 | 8.37 | 0.054 |

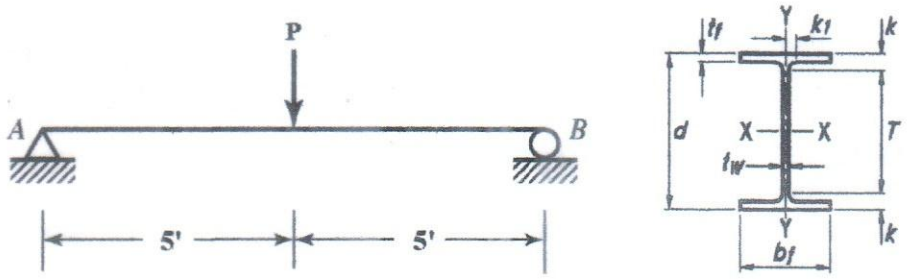


*Figure 3*

4. Determine the number of ½-in dia. A325 bolts ($F_y$ = 92 ksi, $F_u$ = 120 ksi) in standard holes required to develop the full strength of A572 Grade 60 ($F_u$ = 75 ksi) steel plates shown in **Figure 4**. Assume the portion of double lap splice is a bearing type connection with threads included in the shear planes, the arrangement of the bolts is not in a staggered pattern, a double row of bolts is used, and the center-to-center & edge distances of the bolts are 2.5d and 1.5d, respectively, where d is the diameter of the bolt. Show a neat sketch of the designed bolted connection. Ignore block shear mode and use **AISC-LRFD** approach. **(25) (CO3) (PO3)**

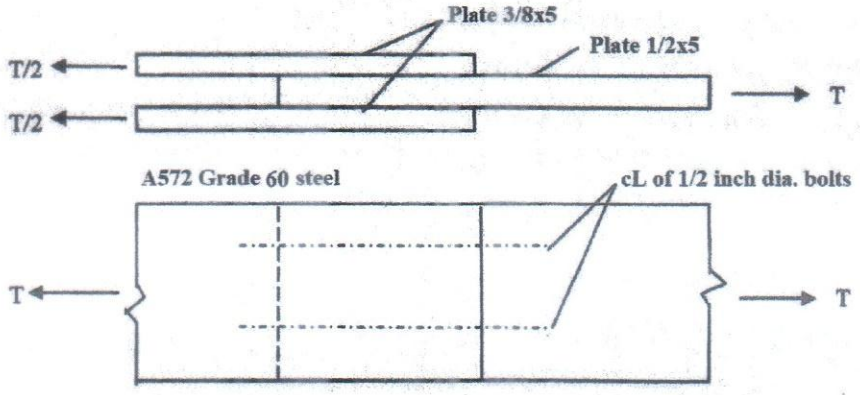


*Figure 4*

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5. From the following table, select the lightest W section of A572 Grade 60 steel to serve as a main member 20 ft long to carry an axial compression service load of 100 kips dead load and 200 kips live load in a braced structure, as shown in **Figure 5**. Assume the member hinged at the top and fixed at the bottom for buckling in either principal direction. Use the **AISC-LRFD** method. **(20) (CO3) (PO3)**

| Shape | $A_g$ ($in^2$) | $b_f$ (in) | $t_f$ (in) | $r_x$ (in) | $r_y$ (in) |
|---|---|---|---|---|---|
| W10x54 | 15.8 | 10 | 0.61 | 4.37 | 2.56 |
| W10x49 | 14.4 | 10 | 0.56 | 4.35 | 2.54 |
| W12x53 | 15.6 | 10 | 0.57 | 5.23 | 2.48 |

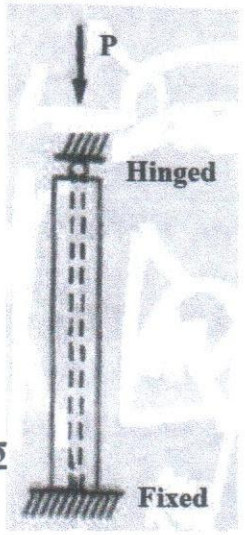


***Figure 5***

6. An A572 Grade 50 steel tension member with no holes is subjected to an axial service dead load of 25 kips and live load of 30 kips as well as a total service bending moment of 35 kip-ft about its major axis. Select the lightest W section from the following table to resist the loads. Assume the member is fully restraint against lateral torsional buckling. Follow the **AISC-ASD** method. **(20) (CO3) (PO3)**

| Shape | $A_g$ ($in^2$) | $b_f$ (in) | $t_f$ (in) | $t_w$ (in) | $I_x$ ($in^4$) | $I_y$ ($in^4$) | $Z_x$ ($in^3$) | $Z_y$ ($in^3$) | $S_x$ ($in^3$) | $S_y$ ($in^3$) | T (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| W8x21 | 6.16 | 5.2 | 0.40 | 0.25 | 75.3 | 9.7 | 20.8 | 5.7 | 18.2 | 3.71 | 6.5 |
| W10x19 | 5.6 | 4.0 | 0.39 | 0.25 | 96.3 | 4.2 | 21.6 | 3.35 | 18.8 | 2.14 | 8.37 |
| W12x40 | 11.7 | 8.0 | 0.51 | 0.29 | 307 | 44.1 | 57 | 16.8 | 51.5 | 11.0 | 9.25 |

## Formula

$$F_{cr} = \left[0.658^{\frac{F_y}{F_e}}\right]F_y \quad \text{For } \frac{KL}{r} \le 4.71\sqrt{\frac{E}{F_y}} \qquad F_e = \frac{\pi^2 E}{\left(\frac{KL}{r}\right)^2}$$

$$F_{cr} = 0.877F_e \qquad \text{For } \frac{KL}{r} > 4.71\sqrt{\frac{E}{F_y}} \qquad P_n = F_{cr}A_g$$

$$C_b = \frac{12.5M_{max}}{2.5M_{max} + 3M_A + 4M_B + 3M_C}R_m \le 3.0 \qquad L_p = 1.76r_y\sqrt{\frac{E}{F_y}}$$

$$L_r = 1.95r_{ts}\frac{E}{0.7F_y}\sqrt{\frac{Jc}{S_x h_o}}\sqrt{1+\sqrt{1+6.76\left(\frac{0.7F_y S_x h_o}{E \quad Jc}\right)^2}}$$

$$M_n = C_b\left[M_p - (M_p - 0.7F_y S_x)\left(\frac{L_b - L_p}{L_r - L_p}\right)\right] \le M_p$$

$$M_n = M_p - (M_p - 0.7F_y S_x)\left(\frac{\lambda - \lambda_p}{\lambda_r - \lambda_p}\right) \qquad F_{cr} = \frac{C_b\pi^2 E}{\left(\frac{L_b}{r_{ts}}\right)^2}\sqrt{1 + 0.078\frac{Jc}{S_x h_o}\left(\frac{L_b}{r_{ts}}\right)^2}$$

$k_c = \frac{4}{\sqrt{h/t_w}}$, where $0.35 \le k_c \le 0.763$ $\qquad M_n = F_{cr}S_x \le M_p$

$$\lambda_r = 0.56\sqrt{\frac{E}{F_y}} \qquad \lambda_r = 1.49\sqrt{\frac{E}{F_y}} \qquad \lambda_{pf} = 0.38\sqrt{\frac{E}{F_y}} \qquad \lambda_{rf} = 1.0\sqrt{\frac{E}{F_y}}$$

$$\frac{P_a}{P_n/\Omega_c} + \frac{8}{9}\left[\frac{M_{ax}}{M_{nx}/\Omega_b} + \frac{M_{ay}}{M_{ny}/\Omega_b}\right] \le 1.0 \qquad M_n = \frac{0.9Ek_cS_x}{\lambda^2}$$

$$\frac{P_a}{2P_n/\Omega_c} + \left[\frac{M_{ax}}{M_{nx}/\Omega_b} + \frac{M_{ay}}{M_{ny}/\Omega_b}\right] \le 1.0$$

$$R_n = mA_bF_{nv}$$
$$R_n = 1.2L_ctF_u \le 2.4dtF_u$$
$$R_n = 0.6F_yA_{gv} + U_{bs}F_uA_{nt}$$
$$R_n = 0.6F_uA_{nv} + U_{bs}F_uA_{nt}$$

$$f'_x = \frac{P_x}{A} \qquad f'_y = \frac{P_y}{A}$$

$$f''_x = \frac{Ty}{I_p} \qquad f''_y = \frac{Tx}{I_p}$$

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B.Sc. Engg. (CEE)/7th Sem. December 14, 2022 (Wednesday)

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

**DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING**

TERM: FINAL SEMESTER EXAMINATION — WINTER SEMESTER: 2021-2022
COURSE NO.: CEE 4733 — TIME: 3.0 Hours
COURSE TITLE: Industrial Wastewater Engineering — FULL MARKS: 150

There are **6 (Six)** questions. Answer **ALL** questions. Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks and corresponding CO and PO in the brackets. Symbols convey their usual meanings. Assume reasonable values for any necessary design data where required.

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1. **(a)** Describe briefly the Bardenpho (four-stage) process with a process flow diagram. **(5)** (CO1, PO1)

   **(b)** A municipal wastewater treatment plant is planning to upgrade to a nitrogen removal plant. It is successfully incorporated nitrification with BOD removal in the existing activated sludge process. The plant wants to add a separate denitrification system consisting of two identical anoxic tanks followed by two clarifiers. Design a suspended growth denitrification system for the plant using methanol as a carbon source. Determine the tank volume and daily methanol dose required to achieve an effluent $NO_3$–N concentration of 3 mg/L. Wastewater effluent characteristics from nitrification system are: Flow rate = 3000 $m^3$/d, temperature = 20°C, $NO_3$–N = 30 mg/L, TSS = 20 mg/L, denitrification kinetic coefficients with methanol at 20°C: $\mu_{max}$ = 1.3/d, $k_d$ = 0.04/d, $k_s$ = 4 mg bsCOD/L, Y = 0.35 kg VSS/kg bsCOD, COD equivalent of methanol = 1.5 kg COD/kg methanol, MLSS in denitrification tank = 2500 mg/L, SRT = 6 d, HRT = 2 h and overflow rate in clarifier = 24 $m^3/m^2 \cdot d$. **(20)** (CO3, PO3)
   Estimate the annual cost if the price of methanol is BDT 100/kg.
   Design and sketch the anoxic tanks and clarifiers with proper dimensions.
   Sketch the process flow diagram of this nitrification-denitrification system.

2. **(a)** Why is Zero Liquid Discharge (ZLD) needed to save our environment? Sketch a diagram to discuss it. **(5)** (CO1, PO1)

   **(b)** Design a two-stage trickling filter using the National Research Council (NRC) equations for treating a municipal wastewater having a BOD of 200 g/$m^3$ is to be treated by a two-stage trickling filter. The desired effluent quality is 25 g/$m^3$ of BOD. If both of the filter depths are to be 1.83 m and the recirculation ratio is 2:1. Determine the i) required filter diameters, ii) BOD loading to each filter, and iii) hydraulic loading to each filter. Assume that the flow rate = 7570 $m^3$/d, wastewater temperature = 20°C and $E_1$=$E_2$. **(20)** (CO3, PO3)
   Design and sketch the trickling filters with proper dimensions.
   Estimate the BOD removal efficiency if the wastewater temperature is 25°C.

3. **(a)** Explain the electrodialysis process used in wastewater treatment with a diagram. **(5)** (CO1, PO1)

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(b) Design an electrodialysis unit for an industry in Tongi area to treat its process wastewater. Determine the area, side dimensions and power required to demineralize 4000 $m^3/d$ of treated wastewater to be used for industrial cooling water using an electrodialysis unit comprised of 240 cells. Assume that the following conditions apply: total dissolved solids (TDS) concentration = 2568 mg/L, cation and anion concentration (Normality) = 0.01 g-eq/L, efficiency of salt removal = 50%, current efficiency = 90%, current density to normality (CD/N) ratio = 500 $mA/cm^2$.g-eq/L, Faraday's constant = 96,480 A.s/g-eq and resistance = 5 Ω. **(20) (CO3, PO3)**

Design and sketch the electrodialysis unit with proper dimensions.
Do you think cylindrical design of electrodialysis unit is better and why?
Select the pollutants in wastewater that can be removed by electrodialysis unit and justify your statement.
Estimate the annual cost if the price of electricity is BDT 10/kW.h and the daily utilization time of the electrodialysis unit is 10 h.

4. (a) Sketch and discuss the followings: osmotic flow, osmotic equilibrium and reverse osmosis. **(7) (CO1, PO1)**

(b) Estimate the quantity and quality of the waste stream, and the total quantity of water that must be processed from a reverse osmosis facility that is to produce 4000 $m^3/d$ of water to be used for industrial cooling operations. Assume that the recovery rate is 90% and rejection rate is 90%, and that the concentration of the feed stream is 400 $g/m^3$. **(18) (CO2) (PO2)**

Determine the overall plant efficiency and solute removal efficiency.
Do you think water and wastewater treatment plants apply reverse osmosis technique and why?
Select the impurities in wastewater that can be removed by reverse osmosis unit and justify your opinion.

5. (a) Describe the MBR process used in wastewater treatment with a diagram. **(5) (CO1, PO1)**

(b) Determine the Freundlich and Langmuir isotherm coefficients using appropriate graphs for the following activated carbon adsorption test data. The liquid volume used in the batch adsorption tests is 1 L. The initial concentration of the adsorbate in solution is 3.37 mg/L. Equilibrium is obtained after 7 days as shown below. **(20) (CO2) (PO2)**

| Mass of GAC, m (g) | Equilibrium concentration of adsorbate in solution, $C_e$ (mg/L) |
|---|---|
| 0 | 3.37 |
| 0.001 | 3.27 |
| 0.01 | 2.77 |
| 0.1 | 1.86 |

6. (a) How recycled water can be produced for irrigation from wastewater? Describe briefly with a process flow diagram. **(7) (CO1, PO1)**

(b) Draw a flow diagram for treatment of a wastewater that has a high concentration of herbicides, as well as suspended solids and organic matter. Describe briefly. **(7) (CO1, PO1)**

**(c)** Estimate the daily required chlorine dosage and the resulting buildup of total dissolved solids (TDS) when breakpoint chlorination is used for the seasonal control of nitrogen. Assume that the flow rate is 1 MGD (3800 $m^3$/d), mass ratio of chlorine to ammonia is 9:1 and TDS increase per mg/L ammonia consumed is 6.2. The effluent characteristics are: $BOD_5$ = 20 mg/L, suspended solids = 25 mg/L and $NH_3$-N concentration = 23 mg/L. The required effluent $NH_3$-N concentration is 1 mg/L.
Determine the annual cost of the plant if the chlorine price is BDT 200/lb. **(11)** (CO2) (PO2)

**Formulae**

$$Y_n = \frac{Y}{1 + k_d \theta_c} \qquad \text{kg bsCOD/kg } NO_3\text{-N} = \frac{2.86}{1 - 1.42\, Y_n}$$

$$E_1 = \frac{100}{1 + 0.4432\sqrt{\frac{W_1}{VF}}} \qquad F = \frac{1 + R}{(1 + R/10)^2} \qquad E_2 = \frac{100}{1 + \frac{0.4432}{1 - E_1}\sqrt{\frac{W_2}{VF}}}$$

$$E_T = E_{20}\,(1.035)^{T-20} \qquad I = FQN\eta/nE_c \qquad P = R(I)^2$$

$$Q_c = Q_p(1-r)/r\,; \quad C_p = C_f(1-R)\,; \quad C_c = (Q_f C_f - Q_p C_p)\,/\,Q_c$$

$$q_e = x/m = (C_o - C_e).V/m \qquad q_e = K_f C_e^{1/n}$$

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B. Sc. Engg. (CEE)/ 7th Semester

12 December 2022 (Morning)

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

## ORGANIZATION OF ISLAMIC COOPERATION (OIC)

## DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Semester: Final Examination** — **Winter Semester: 2021-2022**

**Course No.: CEE 4735** — **Full Marks: 150**

**Course Title: Environmental Pollution and Its Control** — **Time: 3 hours**

**Answer all the six (06) questions.** Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks and corresponding CO and PO. Symbols convey their usual meanings. **Assume reasonable values for any missing data/info.**

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| | | | Marks | CO | PO |
|---|---|---|---|---|---|
| 1. | (a) | Identify how limiting nutrients can affect the condition of a freshwater system. | 5 | CO1 | PO1 |
| | (b) | An agricultural field is near to a lake. After rainfall, the run-off from agricultural field reaches the lake. The characteristics of the run-off and lake are given in Table 1. | | | |

**Table 1**

| | Phosphorus (P) content (mg/L) | T (°C) | Q ($m^3/s$) | $BOD_5$ (mg/L) |
|---|---|---|---|---|
| Agricultural field runoff | 15 | 20 | 0.5 | 15 |
| Lake | 0.0 | 16 | 15 | 3 |

Answer questions (i) and (ii) based on Table 1.

| | | | | | |
|---|---|---|---|---|---|
| | i) | Predict the productivity of the lake based on the P content after the runoff from agricultural field has been mixed in the lake and compute the percentage of P removal based on the data from Table 1. The lake has a surface area of about $150 \times 10^6$ $m^2$. The settling rate of P ranges from 10 to12 m/year on average. | 12 | CO2 | PO2 |
| | ii) | Compute the rate of deoxygenation and amount of BOD remaining after 4 days of mixing of the run-off with the lake based on Table 1. Take $kd_{20} = 0.23$ $d^{-1}$ | 8 | CO2 | PO2 |
| 2. | (a) | Describe the benefits of lake turnovers on aquatic environment. | 2 | CO1 | PO1 |
| | (b) | An industry discharges its effluent into a nearby stream. The characteristics of the effluent and stream are given in Table 2. | 23 | CO3 | PO2 |

Table 2

| | Effluent | Stream |
|---|---|---|
| Flow ($m^3/s$) | 0.2 | 5.0 |
| DO, mg/L | 1.0 | 8.0 |
| Temperature, °C | 15 | 20.2 |
| $BOD_5$, mg/L | 100 | 2.0 |
| $K_1$ at 20 °C, $d^{-1}$ | 0.23 | |
| $K_2$ at 20 °C, $d^{-1}$ | 0.3 | |

Based on the data from Table 2, answer questions (i), (ii) & (iii). Consider the velocity of the stream is 0.2 m/s.

i. Compare the DO after 2 days of mixing of effluent into the stream with that of the saturated DO of the stream.

ii. Analyze if the stream will be suitable for aquatic life considering the mixing of effluent discharge on the stream. Mention the distance of the zone of maximum pollution from the point of mixing of the effluent.

iii. Illustrate the DO profile of the above scenario up to 100 km reach from the point of mixing of the effluent.

3. (a) List the control mechanisms for noise at a machine manufacturing industry. 3 CO1 PO1

(b) A two-lane medium absorptive pavement ($\alpha = 0.75$) has a sidewall of 6.2 ft that separates it from a residential zone. Distance from the center line of the nearest lane to the receiver is 55 ft. Consider receiver height at road level. The information related to the traffic volume and vehicle speed are listed below: 22 CO3 PO2

Auto = 384 vph/lane; 50 mph

Medium Truck (MT) = 315 vph/lane; 45 mph

Heavy Truck (HT) = 137 vph/lane; 34 mph

Lane width = 25 ft

Predict the total equivalent noise level based on above scenario explaining the factors behind the attenuation of noise.

4. (a) Select appropriate control mechanisms for the following situations: 5 CO1 PO1

i. The groundwater table below a residential zone is polluted due to landfill over the area. The residents rely upon water supply from ground water. Select a control mechanism to use the ground water.

ii. A powerplant has been set up near to a stream. The environmentalists are concern about thermal shock on aquatic life and it is required to set up a control mechanism.

(b) Describe the effects of plastic pollution on ecosystem. How plastic eating bacteria can create a revolution in minimizing plastic pollution? 5 CO1 PO1

(c) A truck produces a sound of 60 dBA. Analyze the changes of the noise level based on different flow conditions and distance from the receiver end with necessary diagrams. 6 CO2 PO2

(d) The average noise level from a two-lane highway is 65 dBA at a receiver located 50 m from the centerline. The ground between the highway and receiver is a grassy field. 9 CO2 PO2

i. Estimate the noise level that can be expected for a receiver 20 m from the centerline of the same highway.

ii. Demonstrate the changes of sound if a barrier is placed on a transmission path.

iii. Compute the loss of sound level due to the presence of barrier if only one-fourth of the estimated sound is transmitted.

**5.** (a) Derive the equation to compute efficiency for the gravity settling chamber using the plug flow model. 5 CO1 PO1

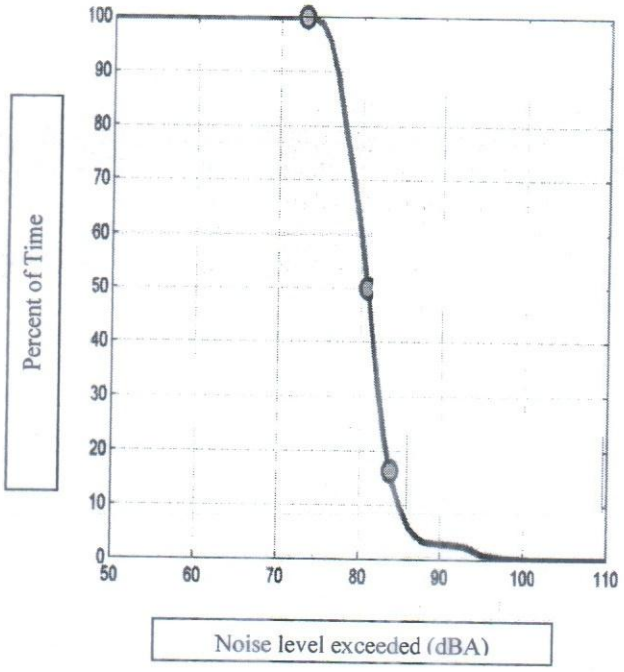
(b) The responsible pollutant in Gazipur, according to the AQI report, is particulate matter. Gazipur's mayor takes some steps to control this pollutant. At initial stage a demo model was implemented. To achieve the emission standard of 200 $mg.m^{-3}$, a flue gas with a particulate matter concentration of 6200 $mg.m^{-3}$ needs to be treated before being released into the environment. The building managers are thinking about creating a settling chamber to clean the flue gas. The height of the settling chamber is limited to 3 m by the facility's space constraints. Assuming a density of 1800 $kg.m^{-3}$, an average particle size of 35 microns and dynamic viscosity of 1.8x10- 5 $kg.m^{-1}.s^{-1}$ for the flue gas. 9 CO4 PO3

i. Estimate the length needed to achieve the emission standard while designing the settling chamber, then create a schematic diagram.

ii. What needs to be changed in order to achieve 100% efficiency?

(c) A statistical distribution of noise level of a classroom is shown in Figure 1. 6 CO2 PO2

**Figure 1**




i. Analyze the significance of the three statistical terms related to the fluctuations of noise level based on Figure 1.

ii. Compute the equivalent noise level and noise climate of the classroom based on Figure 1.

(d) The noise levels recorded through a sound level meter ranges from 65 to 92 decibel. Assume any 5 unequal noise levels. Estimate the equivalent noise level with the help of necessary equation and then verify the estimated equivalent noise level. 5 CO2 PO2

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6. (a) Turag river is the upper tributary of the Buriganga. Additionally, there is severe water pollution there. Three significant industrial sources of this pollution were identified by a survey team: a textile plant, a food processing factory, and a paint factory. A kilometer separates each source from the starting point. Draw the schematic diagram of downstream of discharge point of: — 7 CO3 PO2

   i. Buildup of conservative substances
   ii. Dissolved oxygen depletion
   iii. Microbial pollutant die-off

(b) Answer the following questions in brief.
   i. Justify the statement "AQM process is dynamic". — 3 CO1 PO1
   ii. Explain the "technique of phase change" to control soil pollution. — 2 CO1 PO1

(c) The $BOD_5$ of the raw wastewater is 225 mg/L. A long term BOD test has revealed that this wastewater also has an ultimate carbonaceous BOD of 325 mg/L. Plant effluent testing has shown that the $BOD_5$ drops by 92% across the plant. Long term tests on the effluent also show that the BOD decay coefficient is half the original value in the raw wastewater. — 8 CO3 PO2
   i. What is the BOD decay coefficient of the raw wastewater?
   ii. What is the ultimate carbonaceous BOD of the effluent wastewater?

(d) If one noise source produces 45 dB at a given distance, compute the noise level of 8 of the same sources combined at the same distance? Estimate the percentage of change in noise level if the number of vehicles is doubled? — 5 CO2 PO2

**Necessary Formulae**

***Heavy Trucks:***
**25-31 mph (40-50 km/h):**

**REMEL=51.9+19.2Log$_{10}$(Speed, mph) or 47.9+19.2Log$_{10}$(Speed, km/h)**

**35-65 mph: (56-105 km/h):**

**REMEL=50.4+19.2Log$_{10}$(Speed, mph) or 46.4+19.2Log$_{10}$(Speed, km/h)**

**31-35 mph: (50-56 km/h):**

**REMELS=Approximately 80 dBA**

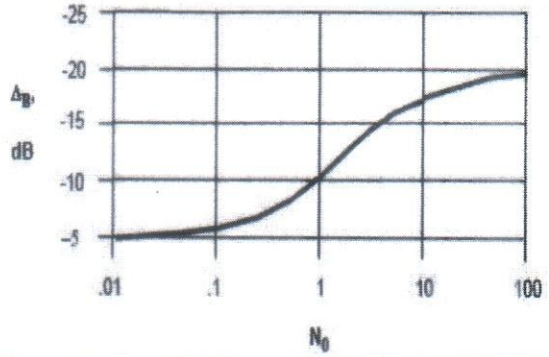
***Medium Trucks:***

**REMEL=35.3+25.6Log$_{10}$(Speed, mph) or 30.0+25.6Log$_{10}$(Speed, km/h)**

***Autos:***

**REMEL=5.2+38.8Log$_{10}$(Speed, mph) or -2.8+38.8Log$_{10}$(Speed, km/h)**

**REMELS is measured individually for HT, MT and Auto.**




$$t_c = \frac{1}{k_2 - k_1} \ln\left\{\frac{k_2}{k_1}\left(1 - D_o \frac{k_2 - k_1}{k_1 L_o}\right)\right\}$$

$$D_t = \frac{k_1 L_o}{k_2 - k_1}\left(e^{-k_1 t} - e^{-k_2 t}\right) + D_o e^{-k_2 t}$$

$DO_{sat} = 14.62 - 0.394T + 0.007714T^2 - 0.0000646T^3$. T in °C

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**Program: B. Sc. in Civil Engineering**
**Semester: 7th Semester**

**Date: 08 December 2022**
**Time: 10:00 am – 1:00 pm**

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
**DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING**

**Final Examination**
**Course Number: HUM 4753**
**Course Title: Engineering Economics and Accounting**

**Winter Semester: 2021 - 2022**
**Full Marks: 150**
**Time: 3 Hours**

There are **6 (Six)** questions. **Answer all questions**. The symbols have their usual meanings. Marks of each question and the corresponding CO and PO are provided in brackets. The examination period is 3 hours.

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**1. (a)** Exemplify the "Optimization Principle", and the "Equilibrium Principle" in terms of engineering economics. **(5) (CO1) (PO1)**

**(b)** Explain the mathematical philosophy of the factor notations and formulas used in "Single Amount" and "Uniform Series" calculations. **(10) (CO1) (PO1)**

**(c)** State the steps required in preparing a "Trial Balance". What kind of errors cannot be detected in the "Trial Balance"? **(10) (CO1) (PO1)**

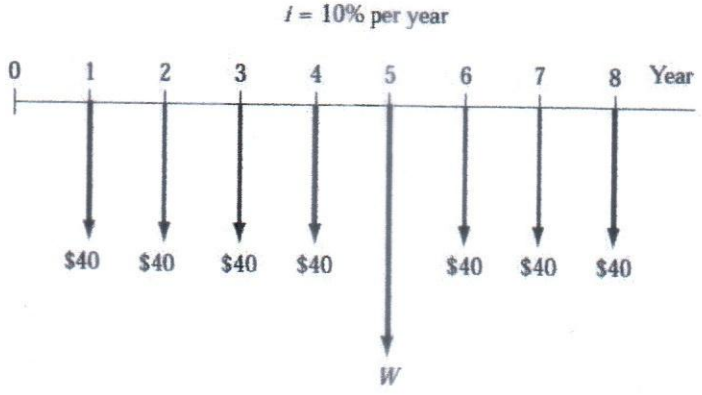
**2. (a)** What is "Pareto Efficiency"? Explain "Marginal Utility". Differentiate between "Ordinal Utility" and "Cardinal Utility" in terms of economic goods. **(10) (CO1) (PO1)**

**(b)** For the cash flows shown below, obtain the value of $G$ such that the present worth in year 0 equals \$16,000 at an interest rate of 10% per year. **(5) (CO2) (PO2)**

| Year | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Cash Flow, \$ | 0 | 8000 | 8000 | $8000-G$ | $8000-2G$ | $8000-3G$ |

**(c)** For the cash flow diagram shown below, determine the value of $W$ that will render the equivalent future worth in year 8 equal to \$-500 (-ve 500 \$) at an interest rate of 10% per year. **(10) (CO2) (PO2)**

Cash flow diagram for Question # 2(c):




3. **(a)** November – December 1994 transactions of Rapid Delivery Company are as follows: **(15) (CO2) (PO2)**

| | |
|---|---|
| Nov 28 - | John Turner formed Rapid Delivery Company when he invested Tk. 50,000 in business |
| Dec 01 - | Cash paid for small delivery trucks Tk. 40,000 |
| Dec 01 - | Paid Tk. 2,400 cash for insurance on the trucks which will cover 3 years period from this date |
| Dec 01 - | Rented a building and paid Tk. 1,200 to cover a 3-year period from this date |
| Dec 04 - | Purchased Tk. 1,400 supplies on account which will be used over the years |
| Dec 07 - | Received Tk. 4,500 from a customer in payment for future delivery services |
| Dec 15 - | Performed delivery services for a customer for cash Tk. 5,000 |
| Dec 17 - | Paid the Tk. 1,400 accounts payable from the transactions of Dec 04 |
| Dec 20 - | Billed a customer for a delivery service performed Tk. 5,700 |
| Dec 24 - | Received a bill for advertising which appeared in a local newspaper in Dec Tk. 50 |
| Dec 26 - | Received Tk. 500 on delivery fees receivable from a customer |
| Dec 28 - | Paid salaries of Tk. 3,600 to truck drivers |
| Dec 29 - | Paid the utility bill for Dec Tk. 150 |
| Dec 30 - | Received a bill for gas and oil used in trucks for Dec Tk. 680 but not yet been paid |
| Dec 31 - | John Turner withdrew Tk. 3,000 cash to pay personal living expenses |

Prepare a Journal to record the transactions.

**(b)** Derive the 'Accounting Equation' encompassing 'Assets', 'Liabilities', 'Owner's Equity', 'Revenues', 'Expenses', and 'Drawings'. Explain the steps of the 'Accounting Cycle' with examples. **(10) (CO1) (PO1)**

4. (a) Post the Journal entries into Ledger Accounts for the transactions stated in Question # 3(a). **(15) (CO2) (PO2)**

   (b) Prepare the Trail Balance for the Ledger Accounts of Question # 4(a). **(10) (CO2) (PO2)**

5. (a) Differentiate between 'Transaction Events/Activities' and 'Non-Transaction Events/Activities' in terms of accounting. Explain 'Cash-basis Accounting', 'Accrual-basis Accounting', and 'Double-entry Accounting'. **(10) (CO1) (PO1)**

   (b) As a credit manager of the Central Bank of Bangladesh, you have been approached by 2 companies for a loan of Tk. 1,00,000 for 6 months with no collateral offered. Since the bank has reached its quota for loans of this type, only one of these requests can be granted. The relevant information supplied to you by the 2 companies is presented below. **(10) (CO2) (PO2)**

| Particulars | Company X | Company Y |
|---|---|---|
| **Assets** | | |
| Cash | 1,70,000 | 3,00,000 |
| Marketable Securities | 2,74,000 | 4,24,000 |
| Stock | 9,00,000 | 13,50,000 |
| Other Assets | 10,00,000 | 10,20,000 |
| **Liabilities and Capital** | | |
| Current Liabilities | 5,00,000 | 6,40,000 |
| Long-term Loans | 8,00,000 | 10,00,000 |
| Equity Share Capital | 8,00,000 | 12,00,000 |
| Retained Earnings | 2,44,000 | 2,54,000 |
| **Other Information** | | |
| Sales | 24,00,000 | 17,00,000 |
| Rate of Gross Profit on Sales | 30% | 40% |

   Considering the above data, specify the company which should be granted the credit. Explain your answer with proper reasoning.

   (c) Explain a company's business profile in terms of the 'Gross Profit Margin Ratio'. **(5) (CO1) (PO1)**

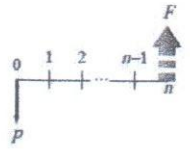
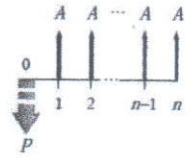
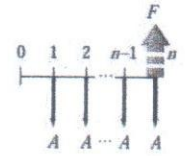
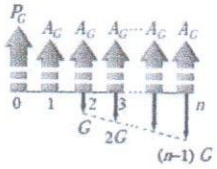
6. (a) Present the rules for 'Debit' and 'Credit' when the accounts are classified based on 'Accounting Equation'. **(10) (CO1) (PO1)**

   (b) What are 'Return on Investment (ROI)' and 'Return on Capital Employed (ROCE)'? **(5) (CO1) (PO1)**

(c) Calculate the 'Current Asset', 'Current Liabilities', and 'Stock' from the following information. Assume, there is no prepaid expense. **(10) (CO2) (PO2)**

| | |
|---|---|
| Net Working Capital | Tk. 1,20,000 |
| Current Ratio | 2.5 |
| Quick Ratio | 1.5 |

## NOTES

| Type | Find/Given | Factor Notation and Formula | Relation | Sample Cash Flow Diagram |
|---|---|---|---|---|
| Single Amount | $F/P$ Compound amount | $(F/P,i,n) = (1+i)^n$ | $F = P(F/P,i,n)$ |  |
| | $P/F$ Present worth | $(P/F,i,n) = \frac{1}{(1+i)^n}$ | $P = F(P/F,i,n)$ | |
| Uniform Series | $P/A$ Present worth | $(P/A,i,n) = \frac{(1+i)^n - 1}{i(1+i)^n}$ | $P = A(P/A,i,n)$ |  |
| | $A/P$ Capital recovery | $(A/P,i,n) = \frac{i(1+i)^n}{(1+i)^n - 1}$ | $A = P(A/P,i,n)$ | |
| | $F/A$ Compound amount | $(F/A,i,n) = \frac{(1+i)^n - 1}{i}$ | $F = A(F/A,i,n)$ |  |
| | $A/F$ Sinking fund | $(A/F,i,n) = \frac{i}{(1+i)^n - 1}$ | $A = F(A/F,i,n)$ | |
| Arithmetic Gradient | $P_G/G$ Present worth | $(P/G,i,n) = \frac{(1+i)^n - in - 1}{i^2(1+i)^n}$ | $P_G = G(P/G,i,n)$ |  |
| | $A_G/G$ Uniform series | $(A/G,i,n) = \frac{1}{i} - \frac{n}{(1+i)^n - 1}$ (Gradient only) | $A_G = G(A/G,i,n)$ | |

$$Gross\ Profit\ to\ Sales = \frac{Gross\ Profit}{Net\ Sales} \times 100$$

[*Gross Profit = Sales – Cost of Goods Sold*]

$$Operation\ Profit\ Margin = \frac{Operating\ Profit}{Sales}$$

[*Operating Profit = Earnings Before Interest and Taxes (EBIT)*]

$$Net\ Profit\ Margin = \frac{Net\ Profit\ After\ Tax}{Sales}$$

[*Net Profit After Tax = Earnings After Taxes (EAT)*]

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M.Sc./M. Engg. (CEE). 15 December, 2022 (Group-B)

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
## ORGANISATION OF ISLAMIC COOPERATION (OIC)
## DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Semester Final Examination** **Winter Semester: 2021-2022**
**Course No.: CEE 6501** **Full Marks: 150**
**Course Title: Highway Engineering** **Time: 3 hours**

There are 7 **(Seven)** Questions. **Question 1** is compulsory. Answer any **5 (Five)** questions from remaining **6 (Six)** questions. All questions carry equal marks. Programmable calculators are not allowed. Do not write on this question paper. The symbols have their usual meaning. Assume reasonable values for any missing information. **Conditional OPEN BOOK. Students can only bring Highway Capacity Manual and Highway Safety Manual.**

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**1.** What can be the performance measures for estimation of level of service of a) pedestrian crosswalk, b) highway entry ramp, c) rural 4 lane highway section, d) an urban bus station serving school area, e) a highway section with mixed use of high speed and slow-moving vehicle? **(5x5)**

**2(a)** As a designer, you have been tasked to design pedestrian (at-grade) crossing at an urban highway intersection. What factors you will consider? **(15)**

Which factors should be taken into account for an inclusive pedestrian experience, considering women, children, person with different physical disability etc.?

**2(b)** What you understand by breaking sight distance, passing sight distance and decision time? **(10)**

**3(a)** Collision diagram of an intersection is provided in Figure 1 and geometric layout can be seen in Figure 2. Identify potential causes of crushes and suggest remedial measures. **(15)**

**3(b)** You have been tasked with safety assessment of a) rural 2 lane highway segment and b) an unsignalized intersection (local road connecting to a highway). During site visit, what types of data you should collect from each site for safety assessment? **(10)**

**4.** Calculate the required intersection sight distance need for a truck to turn left from a yield controlled minor road approach to a major rural expressway, as seen in Figure 3. **(25)**

Given: Local Road intersecting a 4-lane rural expressway; Design speed of the expressway = 70 mph and of local road 30 mph; Median width = 64 feet; Design vehicle = Combination truck; Assume the vehicle will turn into the outside lane. Length of leg: $b=1.47\ V_{major}t_g$; Time gap, $t_g$=11.5 (for left turn), 10.5 (for right turn and crossing maneuver) second for Combination truck. A truck usually takes 0.7 second to cross a 12' lane.

**5.** A rural two-lane curved roadway segment information is provided below. What is the predicted average crash frequency of the roadway segment for a given year? Show crush distribution as well. **(25)**

Characteristics: 1-mile length curved roadway segment; 12,000 veh/day; 3% grade; 1,000-ft horizontal curve radius; No spiral transition; 5 driveways per mile; 14-ft lane width; 1-ft paved shoulder, Roadside hazard rating = 3; Truck traffic= 20%; 0.1-mi horizontal curve length; 0.04 superelevation rate.

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6. Consider a scenario where an agency is considering the conversion of a two-way stop-controlled intersection along an urban arterial to a signalized intersection or a single-lane roundabout to serve for next 20 years. This represents a project with a single countermeasure, but two alternatives, compared to the base condition. Alternative 1 evaluates the potential installation of a traffic signal, while Alternative 2 evaluates the potential construction of a roundabout. The base condition represents no change in existing conditions (i.e., maintaining the urban, two-lane, two-way stop-controlled intersection). The facility type best matches the 'urban arterial' category. *Find after economic analysis that whether the change of base condition to any of the proposed alternatives is economically beneficiary and which one is the most viable?* **(25)**

The free flow speed is 45 mph, the traffic volume in the peak period is 1,600 vehicles per hour per lane, and the peak period is two hours per day (0.8). Consider 3% discount rate for the project. Crush value and hours lost: K=$11,637,947 (1258.26 Hour); A=$674,353(68.56 Hour); B=$204,143 (68.56 Hour); C= $129,001 (68.56 Hour); O=$12,108 (49.94 Hour). Each hour lost due to crush costs about $26.60 (value of time lost).

| | Alternative 1 (Traffic Signal) | Alternative 2 (Roundabout) |
|---|---|---|
| Service Life (years) | 10 | 20 |
| Construction Period | 1 | 1 |
| Project Initial Cost | $300,000 | $900,000 |
| Yearly Maintenance Cost | $8,000 | $0 |
| 10th Year Rehabilitation Cost (to last till 21st year) | $210,414 | $0 |
| CMF | 0.950 | 0.610 |
| K-Fatal Crush Reduction | 0.003 | 0.020 |
| A- Injury Crush Reduction | 0.034 | 0.261 |
| B-Injury Crush Reduction | 0.040 | 0.308 |
| C- Injury Crush Reduction | 0.184 | 1.431 |
| O-Property Damage Crush Reduction | 0.434 | 3.381 |

7. A proposal is being offered to convert a 4-lane urban highway to 6-lane urban highway Find the change of level of service for initial scenario and final scenario. Relevant information is given below: **(25)**

| | **Case 1 (Before)** | **Case 2 (After)** |
|---|---|---|
| Number of Total Lanes | 4 | 6 |
| Lane width | 13' | 11' |
| Right lateral clearance | 2' | 2' |
| Peak hour traffic (veh/hour) | 2500 | 3200 |
| Directional Split | 50/50 | 50/50 |
| FFS | 65 mph | 70 mph |
| Truck traffic | 12% | 14% |
| PHF | 0.8 | 0.8 |
| No passing zone | 0% | 0% |
| Access points | 5 | 8 |

Facility is frequently operating under heavy rain.

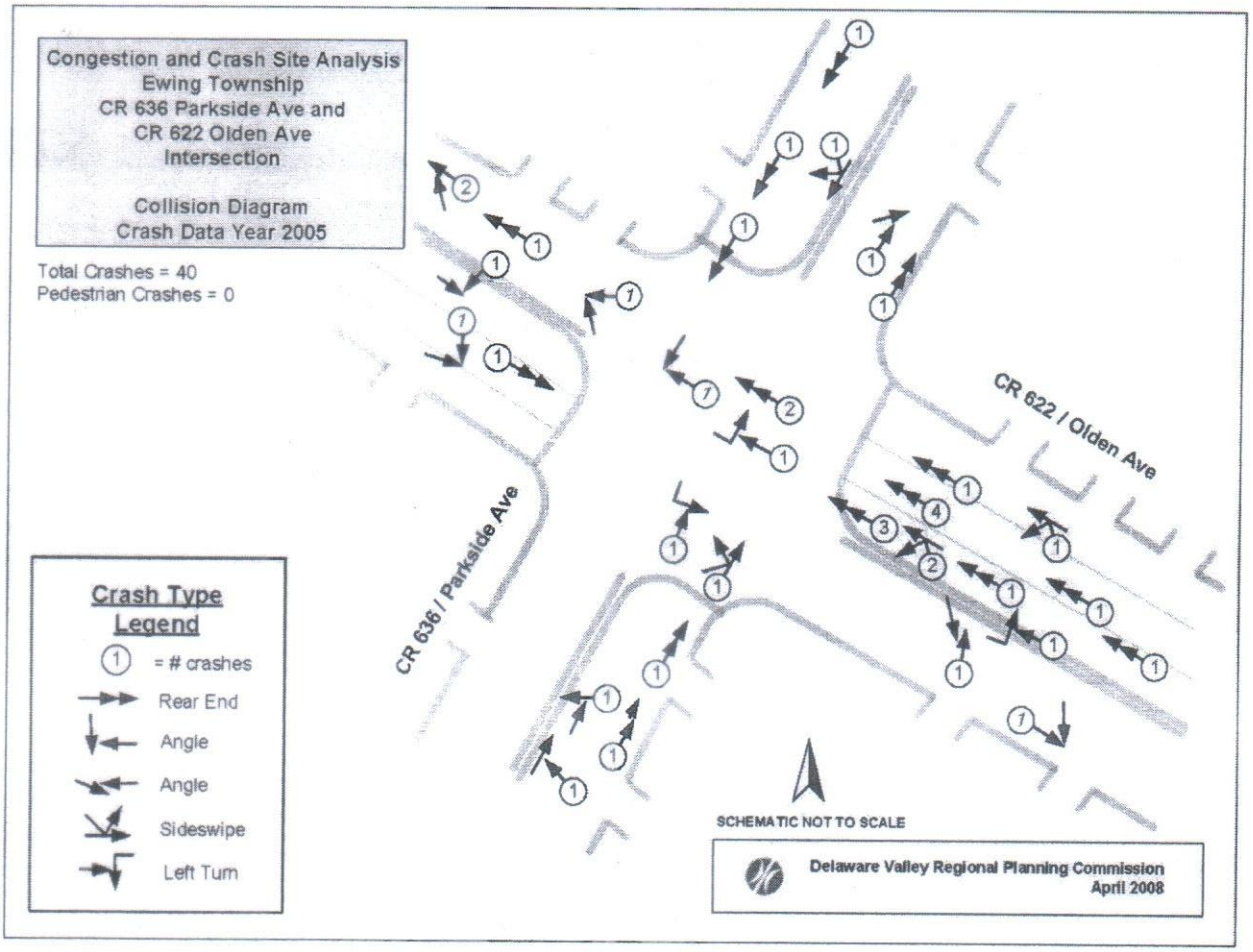


**Figure 1**

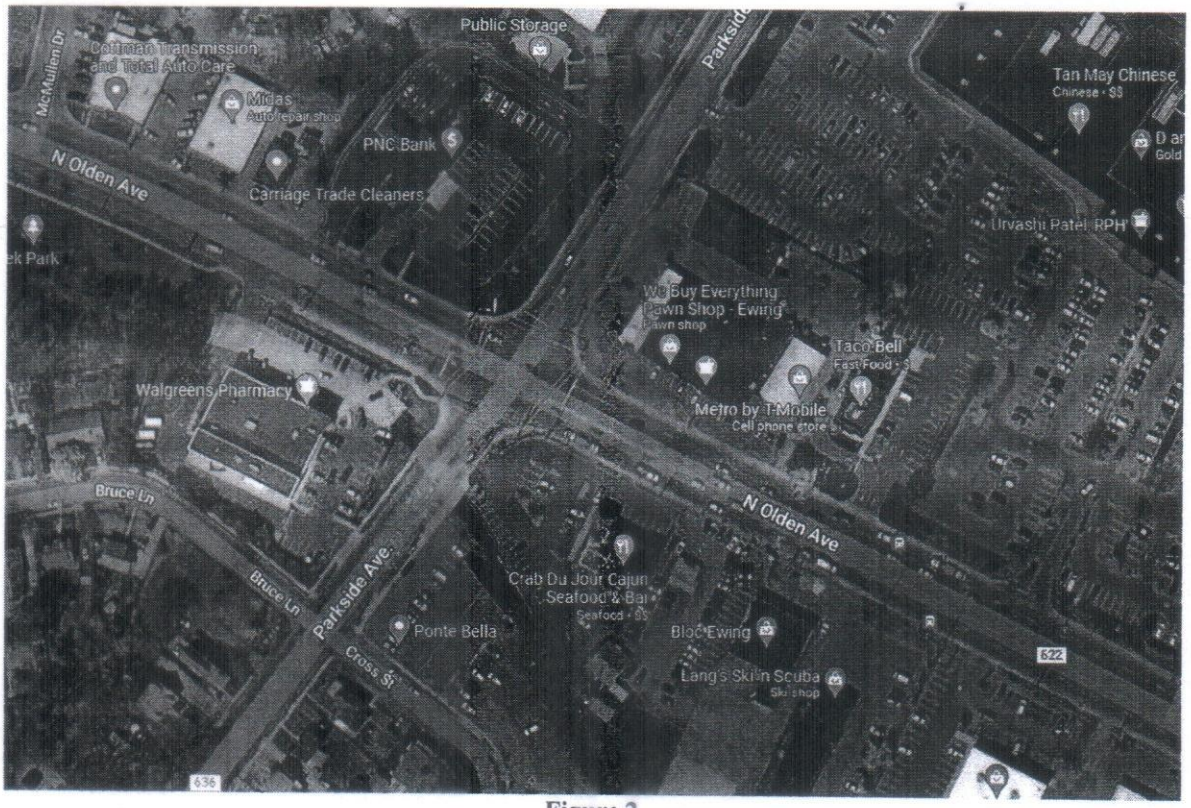


**Figure 2**

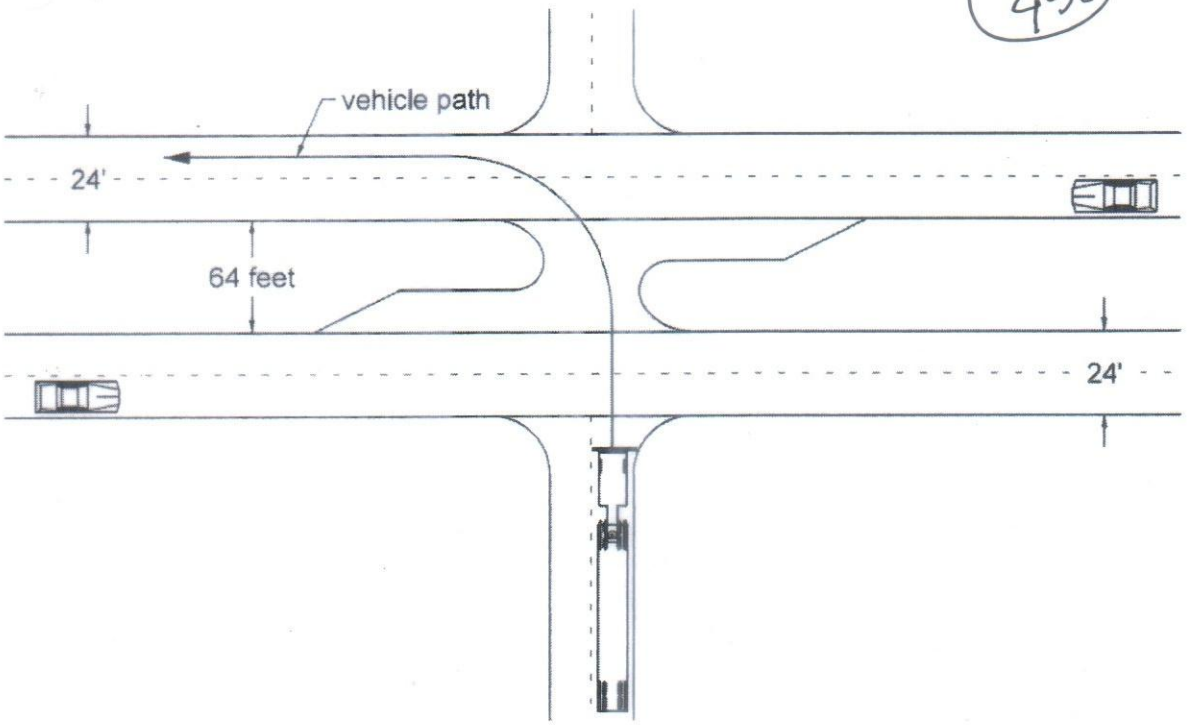


**Figure 3**

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**Semester Final Examination** **Winter Semester: 2021-2022**
**Course No.: CEE 6701** **Full Marks: 150**
**Course Title: Advanced Soil Mechanics I** **Time: 3.0 Hours**

**There are 6 (six) questions. Answer all 6 (six) questions. Do not write on this question paper. The figures in the right margin indicate full marks. The symbols have their usual meaning.**

1(a). Derive the equation of principle of virtual work. Formulate the work done for discontinuous surface (cracks) using the derived equation of principle of virtual work and Mohr-Coulomb failure criteria. (20)

1(b). Briefly describe the limitations of upper bound and lower bound theories in solving geotechnical problems. (5)

2. The diameter of a bored pile is 0.60 m having a length of 30 m, and the top of the pile is at the existing ground level. The soil layers are as follows- (25)

**Soil Layers:**

0 – 9 m, sandy soil, $\gamma = 18$ kN/m$^3$, $\phi = 30^0$ and

9 – 30 m, sandy soil, $\gamma = 19$ kN/m$^3$, $\phi = 34^0$.

Estimate the ultimate load capacity of the bored pile, when
i) Water table is at 30 m below the ground level
ii) Water table is at the ground level. Use, $\gamma_w = 9.8$ kN/m$^3$.
Use, the condition of medium dense sand. The $K$ and $\delta$ values for both layers are 0.90 and $0.80\phi$, respectively. Use, $N_q = \frac{1+\sin\phi}{1-\sin\phi}\exp(\pi\tan\phi)$
Limiting skin friction and end bearing capacity should comply with BNBC 2020.

3(a). Explain long-term stability and short-term stability in geotechnical problems showing the figures of deviatoric stress and mean principal stress for drain and undrain conditions. (6)

3(b). Calculate the ultimate bearing capacity of a footing by upper bound theory for the ground with cohesion, $c_u = 50$ kPa, $\phi = 0$, and $\gamma = 0$. Show all necessary steps of the calculation. Use Mohr – Coulomb failure criteria for the ground. (7)

3(c). Derive the equation of factor of safety for a slope by Fellenius Method. (12)

4. Answer the following questions for points ① to ⑤ shown in Fig.1 (25)
   (i) Draw the graphs showing the relations of deviatoric stress ($q$) ~ deviatoric strain ($\varepsilon_d$), volumetric strain ($\varepsilon_v$) ~ deviatoric strain ($\varepsilon_d$), and stress ratio ($q/p'$) ~ deviatoric strain ($\varepsilon_d$) in Triaxial Drain test under constant mean principal stress of clay.
   (ii) Draw the graphs showing the relation of deviatoric stress ($q$) ~ effective mean principal stress ($p'$) in Triaxial Undrain test of clay.
   (iii) Comments on the undrained shear strength based on the 5 points in the figure regarding confining pressure and void ratio. Which one is important in design consideration of clayey ground.

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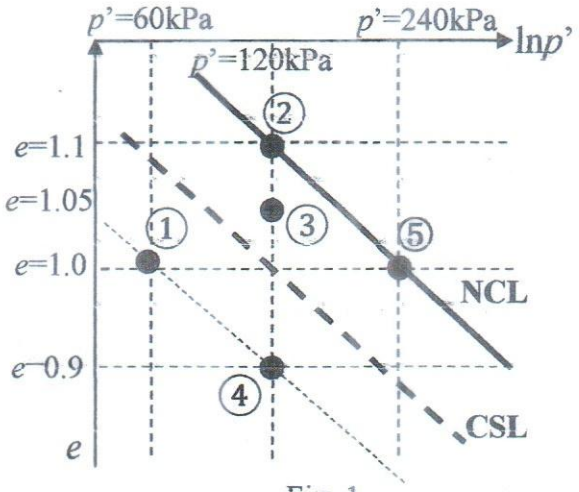


Fig. 1

5(a). Derive the expression of passive earth pressure for $c$ -$\phi$ soil by lower bound theory using Mohr-Coulomb failure criteria. (12)

(b). Answer the following questions corresponding to the retaining structure shown in Fig.2. (13)
Consider no friction between the wall and the ground.

(i) For active earth pressure condition, draw the distributions of the active earth pressure coefficient ($K_a$) on a graph paper.

(ii) For passive earth pressure condition, draw the distributions of the passive earth pressure coefficient ($K_p$) on a graph paper.

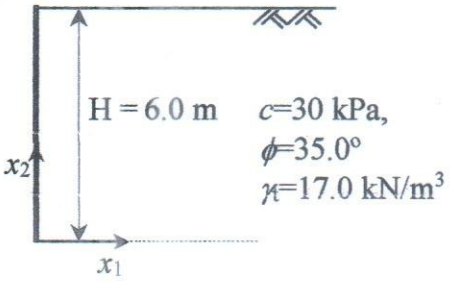


Fig.2

6. Answer the following questions related to Fig. 3, where the water table is at the top of the ground in both sides. Use, $\gamma_{sat}$=19.8 kN/m$^3$ and $\gamma_w$=9.8 kN/m$^3$ for all layers. (25)

(i) Draw Mohr circles for points A and B for illustrating the active stress conditions with the numerical value at each pole.

(ii) Draw lateral stress distributions for active and passive conditions.

(iii) Compute the active and passive earth pressures on the retaining wall.

(iv) Comments on the results regarding the stability of the retaining wall.

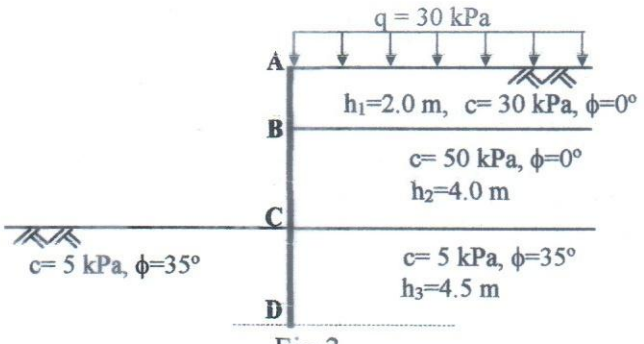


Fig.3