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

Course Title: Principles of Economics — Course Code: ECN 201
Time: 2 hours — Full Marks: 50

(Answer all the following questions)

1. Define inelastic demand. Calculate elasticity for the following problems: (0.5+12)
   - (a) Monthly purchases of cell phones rise from 15000 to 20000 when the average price of cell phones decreases from $100 to $80.
   - (b) Monthly purchases of cell phones decrease from 25000 to 20000 when the average price of cell phones increases from $100 to $150.
   - (c) A fall in average consumer incomes from $20000 to $15000 raises weekly purchases of canned sardines from 2000 to 3000 cans.
   - (d) Annual purchases of computers rise from 1000 to 2000 when average consumer incomes increase from $20000 to $30000.
   - (e) Weekly purchases of packs of chewing gum rise from 5000 to 7000 packs when their price declines from $2 to $1.
   - (f) A rise in the price of wheat from $100 to $150 per kg increases the amount supplied by wheat farmers from 100000 to 200000.
   - (g) A fall in the average price of DVDs from $50 to$40 increases purchases of DVD players from 10000 to 15000 per month.
   - (h) An increase in average consumer incomes from $20000 to $25000 raises monthly purchases of cell phones from 2000 to 3000.
   - (i) A fall in the average price of TVs from $250 to$240 increases purchases of TVs from 10000 to 20000 per month.
   - (j) A decrease in average consumer incomes from $20000 to $10000 raises monthly purchases of second hand furniture from 2 to 3.
   - (k) Magazine purchases of consumers fall from 4 to 3 when the price increases from $ 3 to $4.
   - (l) Magazine purchases of consumers increases from 4 to 5 when the price decreases from $ 5 to $2.

2. (a) Explain monopoly market structure with examples. (6)
   (b) How market experience can act as an entry barrier for new entrants? Defend your statement with relevant examples. (6.5)

3. (a) Explain the GDP calculation system using expenditure approach with examples. (6)
   (b) Suppose, a person bought a T-shirt at Tk. 500. He also bought some grocery items worth Tk. 2000. Government bought a power plant by spending Tk. 200000000. Government also contributed Tk. 20000000 in a charity firm. Government also spent Tk. 30000000 as freedom fighter allowance. A company constructed a building by spending Tk. 500000000. By exporting RMG the country earned Tk. 700000000 and the country spent Tk. 400000000. A company paid Tk. 100000 as corporate income tax. (6.5)
   All of those events happened in Bangladesh within one fiscal year 2016-2017. Then, calculate the GDP of this particular country using expenditure approach for

Please Turn Over

that particular year.

4. (12.5)

Furniture	2000000
GDP	50000000
Customs duties	100000
Sales taxes	200000
Labor wages	500000
Depreciation of furniture	200000
Social security contributions	20000
Corporate income taxes	100000
Freedom fighter allowance	600000
Old age payment	750000
Personal taxes	12000

Calculate NDP, NI, PI, and DI from the above table using income approach.

University of Asia Pacific
Department of Basic Sciences and Humanities
Final Examination, Fall-2017
Program: B. Sc. in Civil Engineering

Course Title: Mathematics-IV
Time: 3.00 Hours.

Course Code: MTH 203
Full Marks: 150

There are **Eight** questions. Answer any **Six**. All questions are of equal value. Figures in the right margin indicate marks.

1. (a) When a cake is removed from an oven, its temperature is measured at $300^{\circ} F$. Two minutes later its temperature is $250^{\circ} F$. How long will it take for the cake to cool off to a temperature of $90^{\circ}F$? Here room terperature is $70^{\circ}F$. **13**

(b) Define Cauchy-Euler equation and solve **12**

$$3x^2\frac{d^2y}{dx^2}+2x\frac{dy}{dx}-4y=0$$

2. (a) Solve the differential equation: $(D^3-D^2-6D)y=1+x^2$ **10**

(b) Solve the following differential equations: **15**

(i) $(D^2-2D)y=e^{2x}cosx$

(ii) $(D^2-4)y=sin^2x$

3. (a) Solve the Bernoulli's equation: $x\frac{dy}{dx}+y=\frac{1}{y^2}$ **7**

(b) Solve: **18**

(i) $\frac{dy}{dx}=(4x+y+1)^2$

(ii) $(x-y)dx+xdy=0$

(iii) $\frac{dy}{dx}+3x^2y=x^2$

4. (a) Solve using Laplace transformation: $Y''(t)+9Y(t)=cos2t,\ Y(0)=1, Y\left(\frac{\pi}{2}\right)=-1$ **15**

(b) Use Heaviside's expansion formula to find , $\mathcal{L}^{-1}\left\{\frac{19s+37}{(s-2)(s+1)(s+3)}\right\}$ **10**

5. (a) Find Laplace transformation of the following functions: **5+6+6**

(i) $F(t)=(1+te^{-t})^3$

(ii) $F(t) = \frac{\cos(at) - \cos(bt)}{t}$

(iii) $F(t) = t^2 sin5t$

(b) If $\mathcal{L}\{F(t)\} = f(s)$, then show that $\mathcal{L}\{F'''(t)\} = s^3 f(s) - s^2 F(0) - sF'(0) - F''(0)$ 8

6. (a) Evaluate $\mathcal{L}^{-1}\left\{\frac{1}{s^2(s+1)^2}\right\}$ by using Convolution theorem. Verify the result by evaluating it by partial fraction method. 18

(b) Prove that $\mathcal{L}^{-1}\left\{\frac{s^2-4}{(s^2+4)^2}\right\} = tcos2t$ by using inverse Laplace transform of derivatives. 7

7. (a) Find the Fourier Series of the function 15

$$f(x) = \begin{cases} 0 & , -5 < x < 0 \\ 3 & , \ 0 < x < 5 \end{cases} \quad \text{having } period \ 10.$$

(b) Find Fourier integral of the function $f(x) = e^{-kx}$ when $x > 0$ and $f(x)$ is an even function. Hence show that $\int_0^{\infty} \frac{cosux}{k^2+u^2} \, du = \frac{\pi}{2k} e^{-kx}$ for $k > 0$ 10

8. (a) Find finite Fourier Cosine transform of $e^{-x}, \ x > 0$. 5

(b) Use Finite Fourier Sine transform to solve 20

$$\frac{\partial U}{\partial t} = \frac{\partial^2 U}{\partial x^2} \ , 0 < x < 4 \ and \ t > 0$$

with conditions $U(0,t) = 0, \ U(4,t) = 0, \ U(x,0) = 2x$.

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

Course Title: Engineering Geology & Geomorphology — Course Code : CE 203
Time: 3 hours — Full Marks: 120 (6 X 20 = 120)

SECTION A

There are **FOUR** questions in this section. Answer any **THREE**

1. (a) Compare different types of rocks on the basis of their origin and cycle. 6
(b) Distinguish between sediment and sedimentary rock. 3
(c) Classify (mention names only) geomorphic processes based on origin. Write down the names of major geomorphic agents. 5
(d) What are physical and chemical weathering processes? Discuss, in brief, any two physical weathering processes. 6

2. (a) What is diastraphism? Draw neat sketch of a typical fold geometry showing its major features. 5
(b) Differentiate faults and joints. 6
(c) Compare Horst and Graben with the aid of sketch. 5
(d) With the aid of a neat sketch show different features of Reverse and Oblique faults. 4

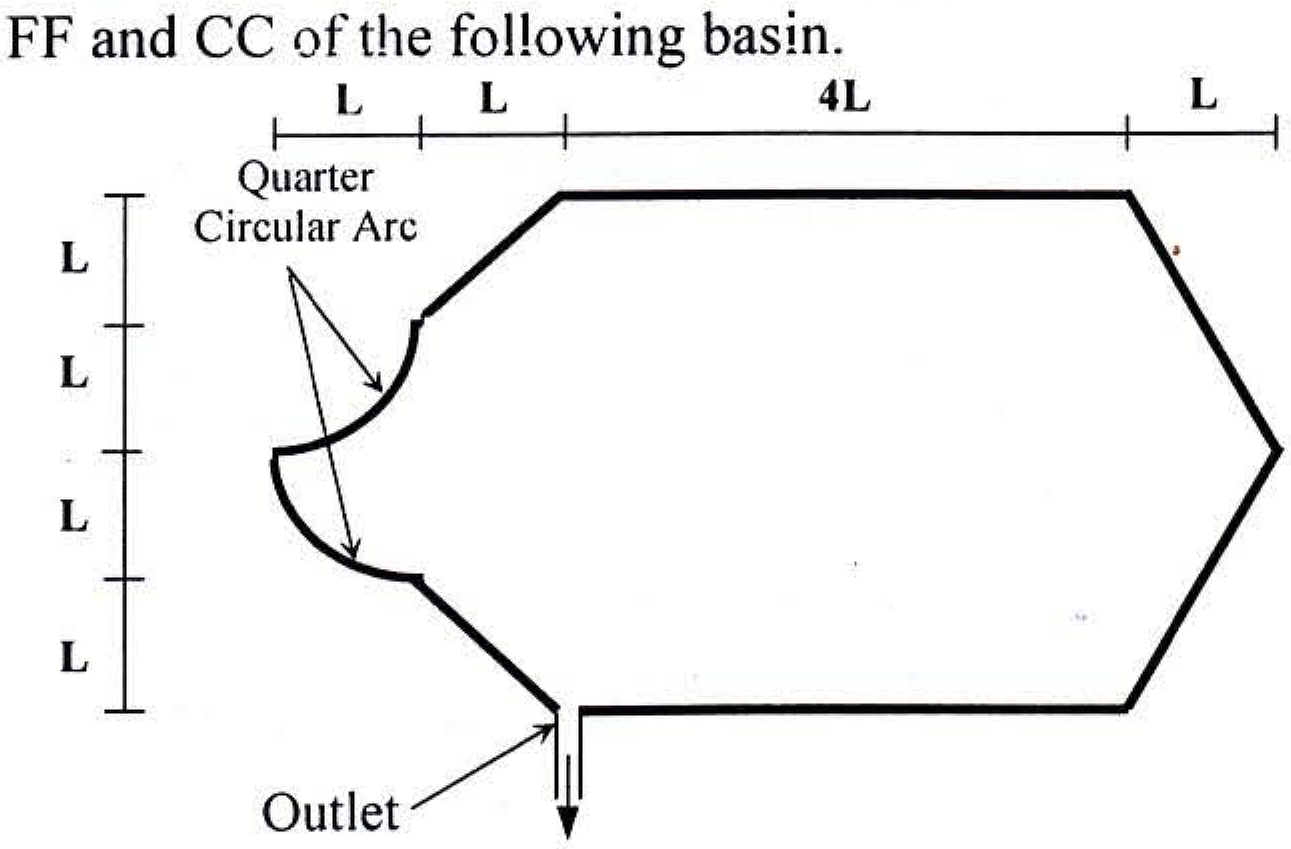
3. (a) Classify (mention names only) folds and discuss any two types showing neat sketches. 6
(b) Discuss liquefaction phenomenon in the light of its basic mechanism and aftermaths. 8
(c) Classify and discuss briefly (no sketch required) any two types of waves generated due to earthquake. 6

4. Briefly discuss, mention or draw sketches, as asked, the following topics:- 5 X 4 = 20
(i) Schematic diagram of rock cycle
(ii) Principal zones of earth (names only) with a schematic diagram showing the thicknesses of different parts of lithosphere/geosphere
(iii) Mention Modified Mercali Intensity (MMI) Scale of earthquake VIII to XII
(iv) Major earthquake parameters (geometric) with neat sketches

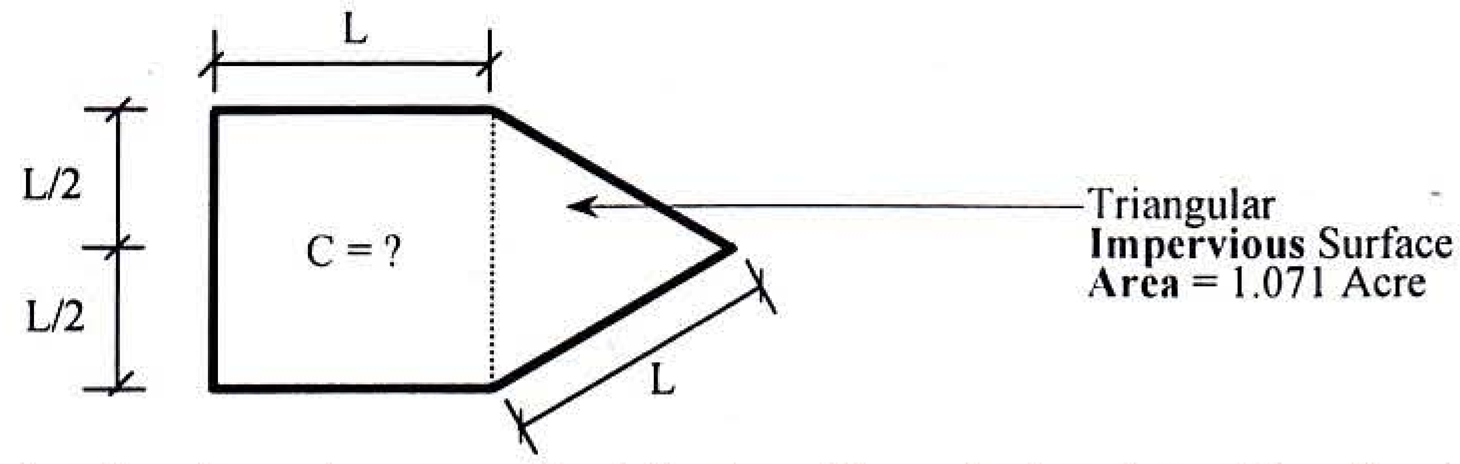
SECTION B

There are **FOUR** questions in this section. Answer any **THREE**

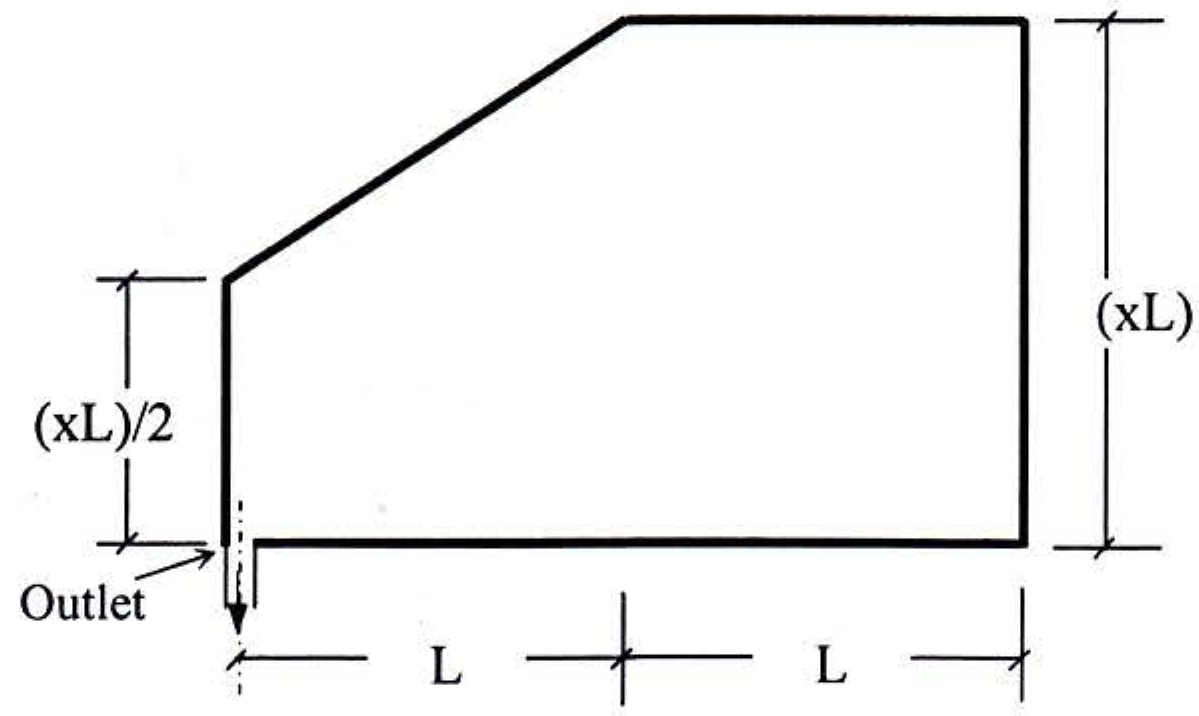
5. (a) Show, in brief, the ways runoff depends on various basin characteristics. 5
(b) Calculate the FF and CC of the following basin. 7



c) For the drainage area as shown below, calculate co-efficient of runoff (C) for $Q_p = 3.072$ ft^3/s and I =25.4 mm/hour. 8



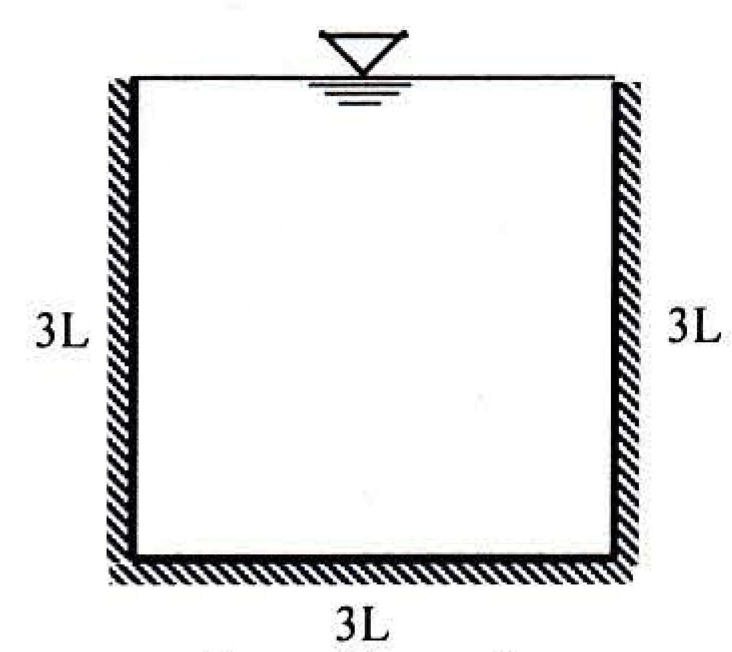
6. (a) For the following basin, x is a constant factor. For what value of x, the flow rate (Q) will be the maximum for the basin? Find the FF of the basin for maximum runoff. **7**



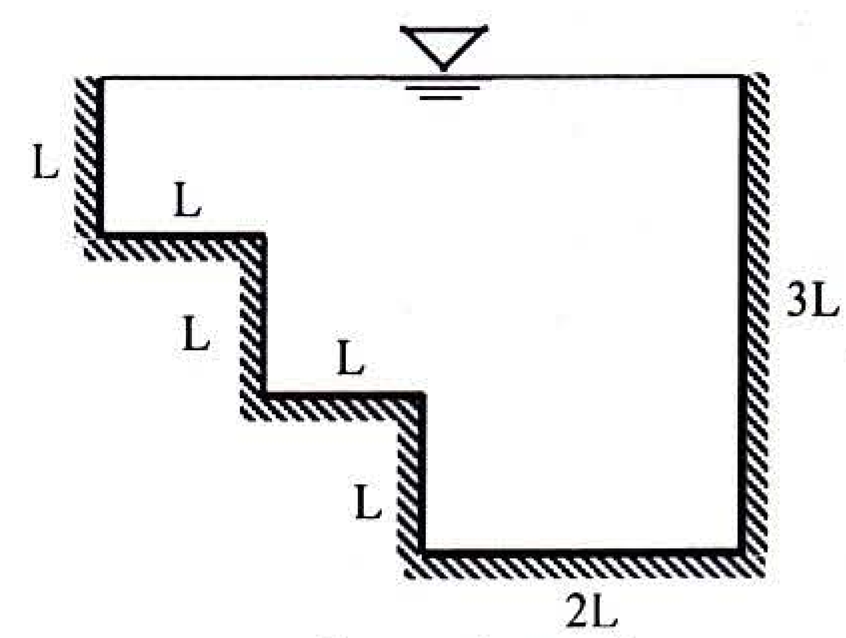
(b) What are the major causes of river erosion? Mention three hydraulic actions responsible for river erosion **3**

(c) Prove that $\tau = \gamma_{\omega} R_H S$; where τ = Tractive pressure, R_H = Hydraulic radius and S = Gradient of river bed. **5**

(d) The cross-sectional profiles at two locations (location-1 and location-2) of a river are shown in the figures below. The gradient (s), unit weight of water and x-sectional area (A = $9L^2$) of these two locations are same. Mention (if all other factors affecting erosion remain constant) which location will exhibit more erosion? Justify your answer. **5**



Location - 1



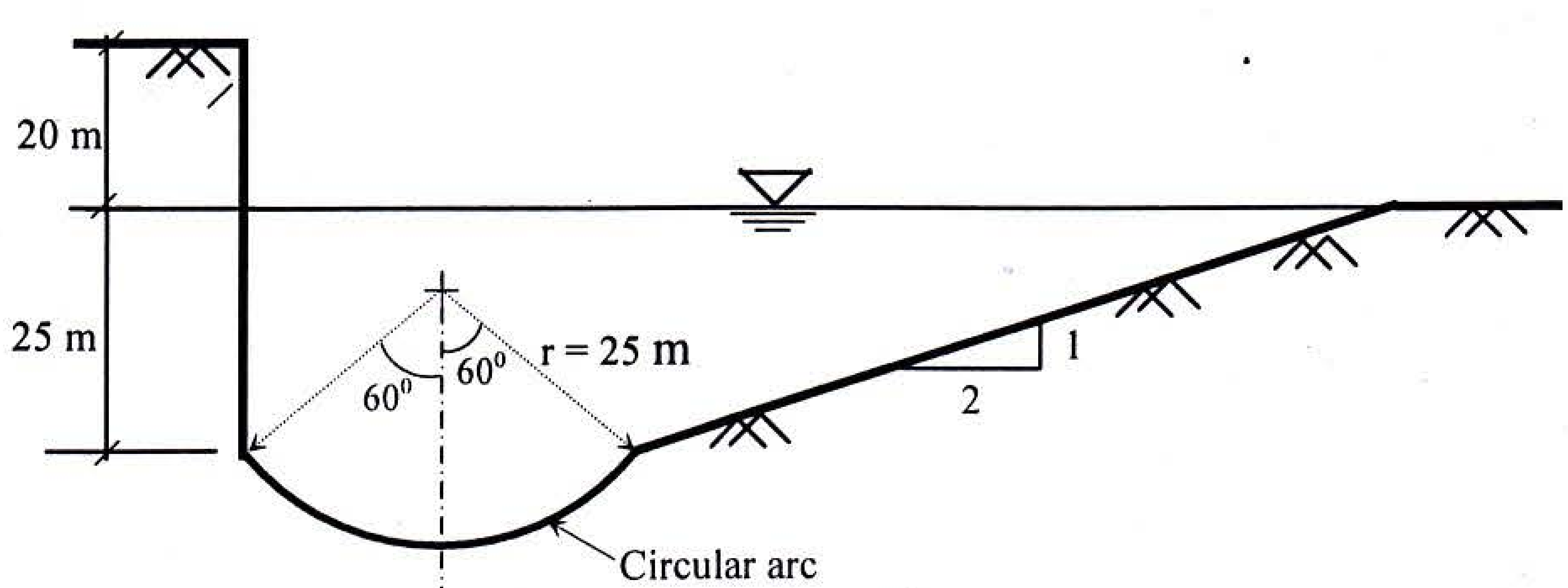
Location - 2

7. (a) For a stream having triangular X-section and T <<<<< D. Justify that the erosional tendency (E) of this stream will depend on T. **4**

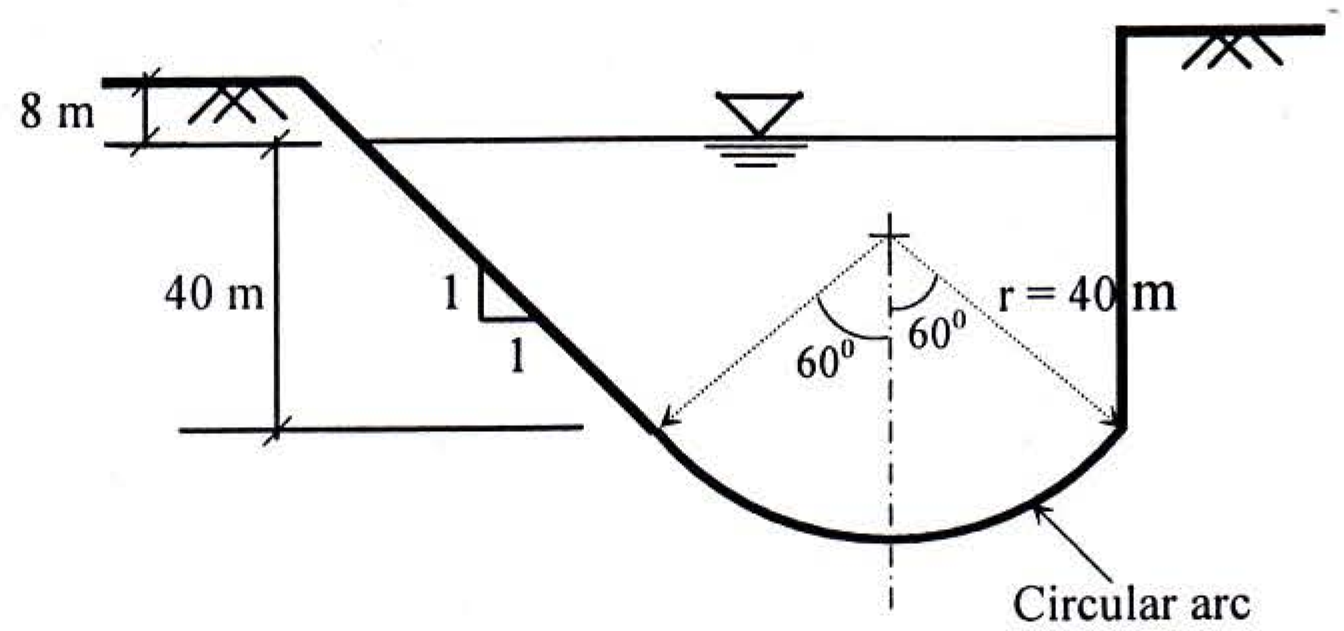
Where

D = depth of stream T = Top width of stream

(b) Cross-sectional profiles of two channel section locations are shown as below. The gradients for both the channels bed is 9.33×10^{-5}. Compare the erosional tendencies at both locations on the basis of tractive pressure. **11**

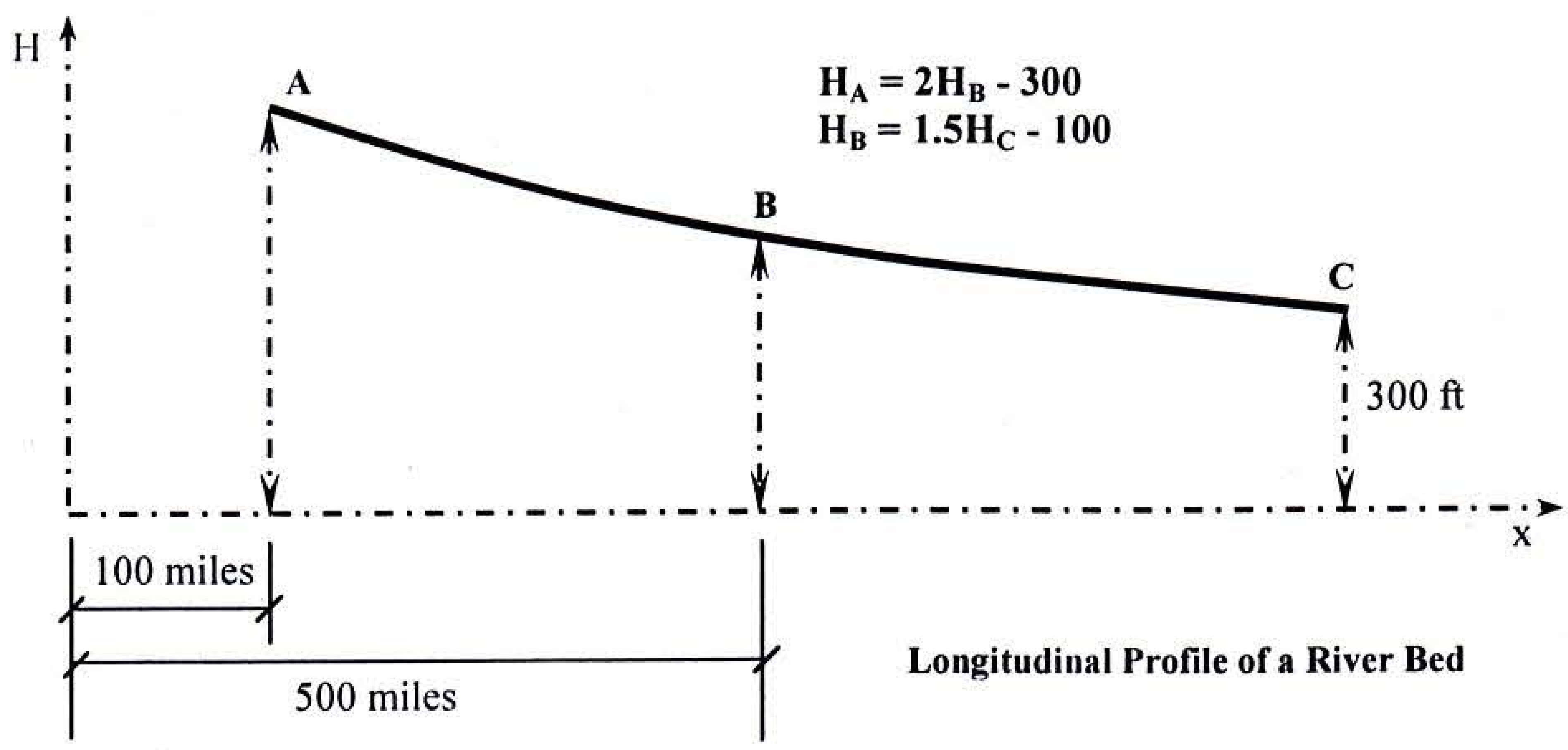


X-Sectional Profile at Channel Section 1



X-Sectional Profile at Channel Section 2

(c) Using the figure shown below, calculate the horizontal distance between B and C. 5



8. (a) Mention the laws of stream order/rank with diagram. 3

(b) Calculate Stream Frequency (SF) of a catchment area (having DD = 0.0340744 Km/Km^2) from the information provided in the table below. 7

Stream Rank	No. of Streams (Ns_i)	BR	ABR	Mean Length (Lm_i, Km)	LR	ALR
1	---	2.143	2.492	---	3.0	2.5
2	---	---		---	---	
3	3	---		---	2.5	
4	---			200		

(c) Mention the factors affecting drainage pattern. Classify and discuss, in brief with sketches, any one type of drainage pattern. 5

(d) Summarize your understanding regarding the ways valleys are widened. 5

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

Course Title: Numerical Analysis and Computer Programming — Course Code: CE 205

Time- 3 hours — Full marks: 100

Answer to the questions 01(a & b) and 02(a OR b) are mandatory

Answer any SEVEN among the other EIGHT questions

01. For the cantilever beam as shown in Figure: 01, the equation of the variation of distributed force on the beam is: $y = 3x^3 - 4x^2 + x$ where, x is the distance from left. Determine the upward support reaction force using the equation $R = \int y dx$ applying the following methods and compare the results with the exact solution.

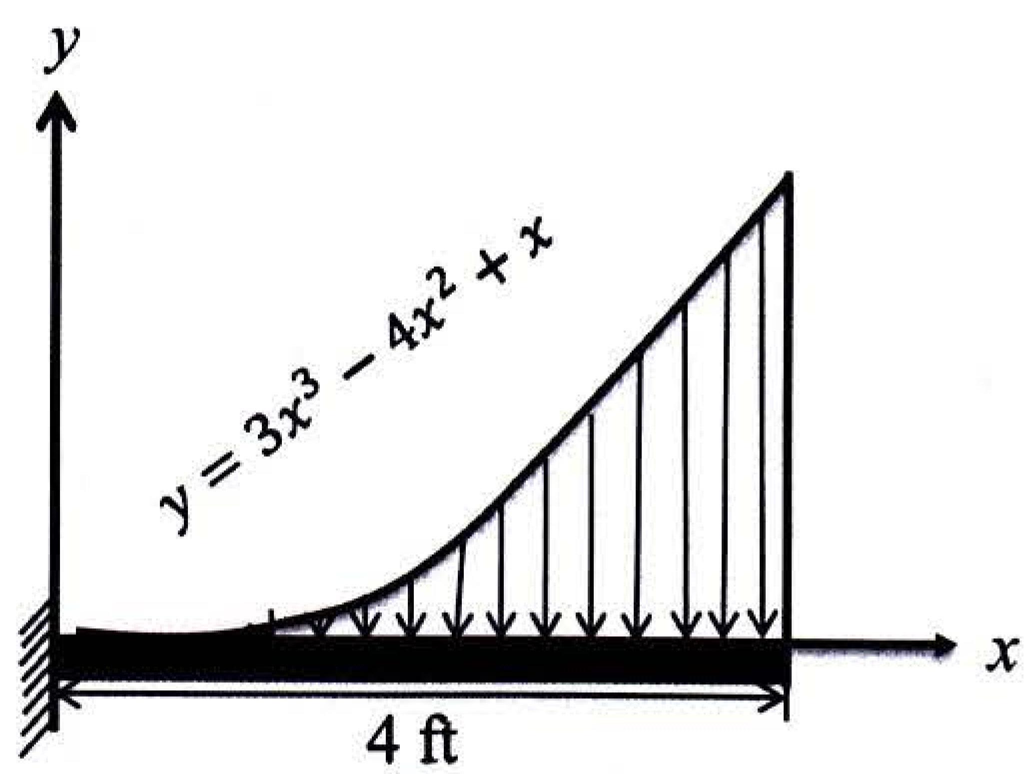


Figure: 01

a) Trapezoidal rule with 10 panels or n = 10. **(10)**

b) Gauss Quadrature with 4 points or n = 4. **(10)**

xi	wi
+0.8611363116	0.3178548451
+0.3399810436	0.6521451549
-0.3399810436	0.6521451549
-0.8611363116	0.3178548451

02. a) Derive the formula used in Simpson's method of numerical integration. **(10)**

OR

b) i. Derive Gregory-Newton forward difference interpolation formula. **(05)**

ii. Write short notes on: round-off error and truncation error. **(05)**

03. **a)** a) Use the Newton-Raphson Method to find a root of the equation: $3x - e^{x} = 0$. **(05)**

b) b) Use the Secant Method to find a root of the equation: $x^2 - \sin x - 0.5 = 0$. **(05)**

04. **a)** a) Solve the following system of linear equations using Gauss-Seidel method. **(08)**

$$7x_1 - 2x_2 + 3x_3 = 6$$
$$-3x_1 + 2x_2 + 6x_3 = 2$$
$$x_1 + 5x_2 + 3x_3 = -5$$

Use $x_1 = 0.5, x_2 = -1$ and $x_3 = 1$ as approximate initial solutions. Correct the results up to three significant figures.

b) b) If you had used Jacobi method in Question 04 (a) would you have required less iteration? Explain why. **(02)**

05. In Geotechnical Engineering laboratory, the result of an unconfined compression test shows the following *Stress-Strain* data. Fit the data using Least-Square method to the following second-degree polynomial equation: $y = a_0 - a_1x - a_2x^2$. **(10)**

Strain (%)	1	2	3	5	7	10	15	20
Stress (psi)	16	30	61	101	132	161	189	198

06. The deflection *d* measured at various distances *x* from one end of a cantilever is given by: **(10)**

x	0.0	0.4	0.8	1.2
d	0.0000	0.1173	0.2987	0.3588

Calculate the value of d when x is 0.95 using Gregory-Newton Backward Difference interpolation method.

07. Use the Lagrange interpolating polynomial formula for the data given in the following table to determine the value of y, when $x = 35$. **(10)**

x	0	10	25	40
y = f(x)	0	125	290	660

08. Solve the following differential equation if y has an initial value $y(0) = 1$ to obtain $y(3)$ by second-order Runge-Kutta method. Use the step length h = 1.0. **(10)**

$$20\frac{dy}{dx} = \frac{x^2 + 5}{y}$$

09. Solve the following boundary value problem by Finite Difference Method to estimate $y(0.5)$ with step length, h = 0.5. **(10)**

$$\frac{d^2y}{dx^2} - 8y + 12 = 0$$

Given that,

$$y\,(0) = 0$$
$$y\,(1) = 4$$

10. Determine $y(0.8)$ by solving the following differential equation using Predictor-Corrector method (Milne's method). Use the accuracy of 0.0001. **(10)**

$$3\,\frac{dy}{dx} = x - 2y^2$$

Given that,

$$y\,(0) = 0$$
$$y\,(0.2) = 0.3$$
$$y\,(0.4) = 0.8$$
$$y\,(0.6) = 1.7$$

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2017 (Set 1)
Program: B. Sc. Engineering (Civil)

Course Title: Mechanics of Solids II	Credit Hours: 3.0	Course Code: CE 213
Time: 3 hours		Full Marks: 100 (= 10 × 10)

[Answer **any 10 (ten)** of the following 14 questions]

1. Fig. 1 shows UAP-CE students working at SM Laboratory on the buckling test of a 30″-long perfectly straight simply supported steel column (of 0.20″-diameter). They find the column to buckle at a compressive load 20 lb, when the transverse midspan deflection is 4″. Calculate the
   (i) Eccentricity (e) of the load and the resulting moment at column ends (due to the load)
   (ii) Plastic moment (M_p) of the column section [Given: $E = 30 \times 10^6$ psi].

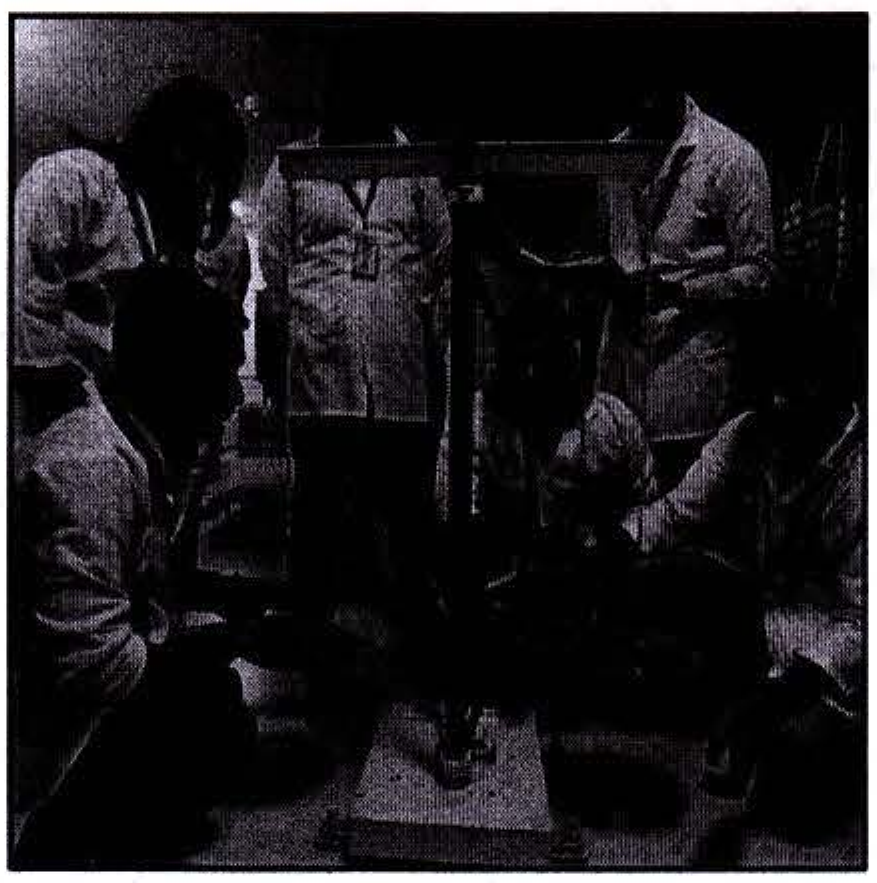


Fig. 1

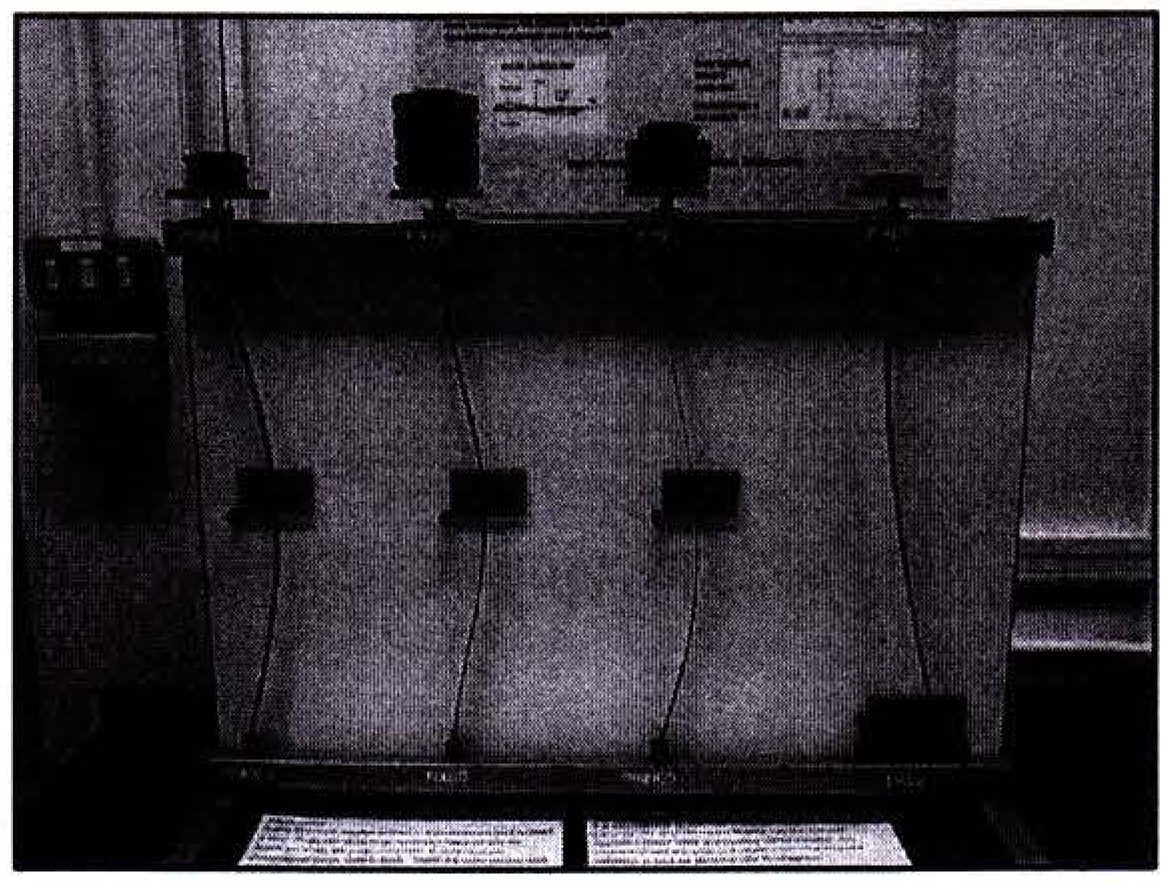


Fig. 2

2. Fig. 2 shows buckling test results of 0.75m-long columns (0.015m-diameter) of different support conditions (i.e. Col 1: Hinged-Hinged, Col 2: Fixed-Fixed, Col 3: Fixed-Hinged and Col 4: Fixed-Free).

   Use the AISC-ASD method to calculate the allowable compressive load for each column [Given: Yield strength $f_y = 175$ MPa, Modulus of elasticity $E = 210{,}000$ MPa].

3. A 12″-long cylindrical column (of 6″-diameter) and a (6″× 6″ × 6″) cubical column are both made of a nonlinear material with stress-strain relationship given by $\sigma = 4(1 - e^{-50\varepsilon})$, where σ is the compressive stress (ksi) and ε is the strain.

   Calculate the critical stresses for the columns, if they are both hinge-supported at each end.

4. Fig. 3 shows a professor (in Texas Tech, USA) sketching on white-board to calculate the maximum force P_{max} that can be applied on the steel frame drawn, including a 120″-long round bar AB of 1.5″-dia.

   If $\sigma_{Allowable}$ = 30 ksi, and E = 30,000 ksi, perform necessary calculations (i.e. axial force and bending moment for AB) using AISC equation of *Moment Magnification Factor* to calculate P_{max}.

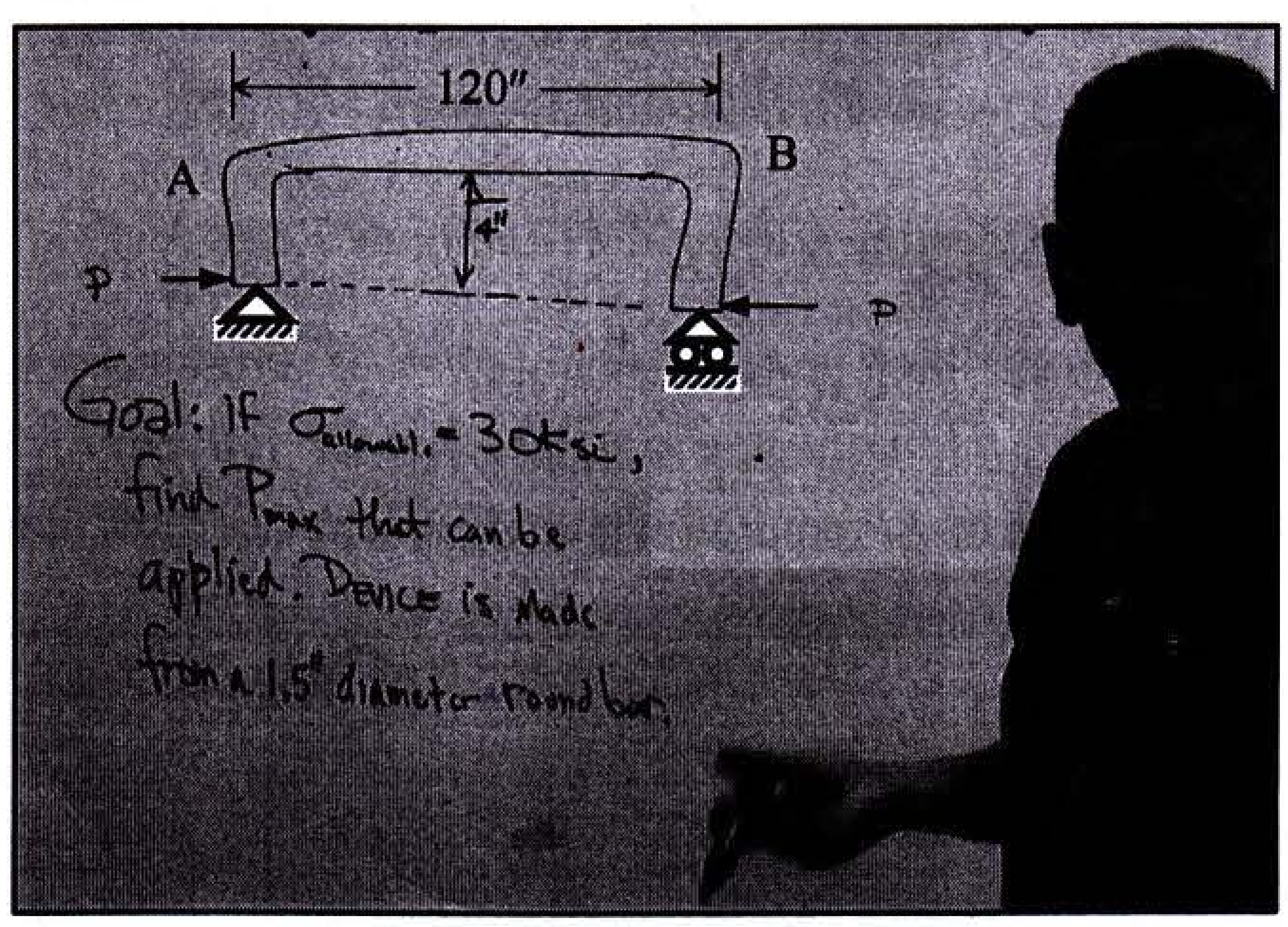


Fig. 3

5. (i) Briefly answer the following questions
   - Explain why the actual buckling loads of slender columns (tested at laboratory) are smaller than the ones calculated using Euler's equation.
   - Explain the effect of ψ factor (in the alignment chart for slender columns) on the effective length factor (k).

   (ii) For the beam loaded as shown in Fig. 4
   - Write the equation for the load $w(x)$ using singularity functions
   - Write boundary conditions
   - Draw qualitative deflected shape.

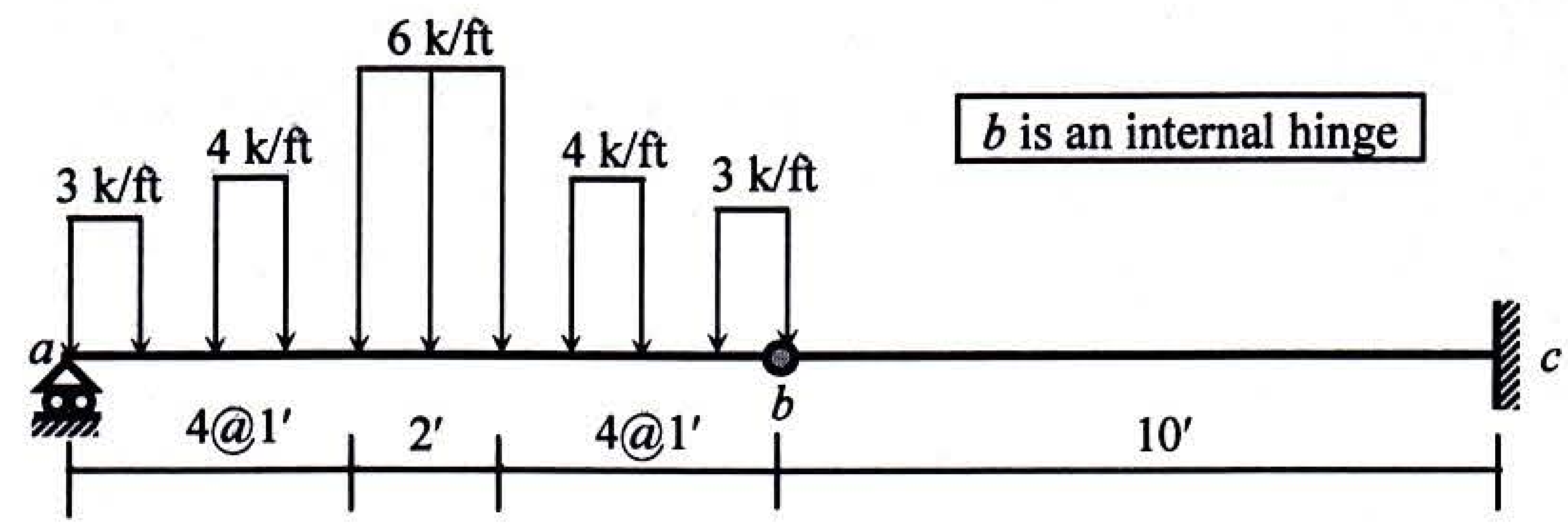


Fig. 4

6. The beam *abcde* is supported at *a*, *d* and *e* by helical springs, which are tested as shown in Fig. 5(b), resulting in a load-deflection graph shown in Fig. 5(c) [Given: EI = constant = 500 k-ft^2].
   (i) Calculate the vertical reactions and deflections at the springs if the beam supports monument *bfg* loaded as shown in Fig. 5(a).
   (ii) Use *Singularity Functions* to calculate the vertical deflection at *c*.

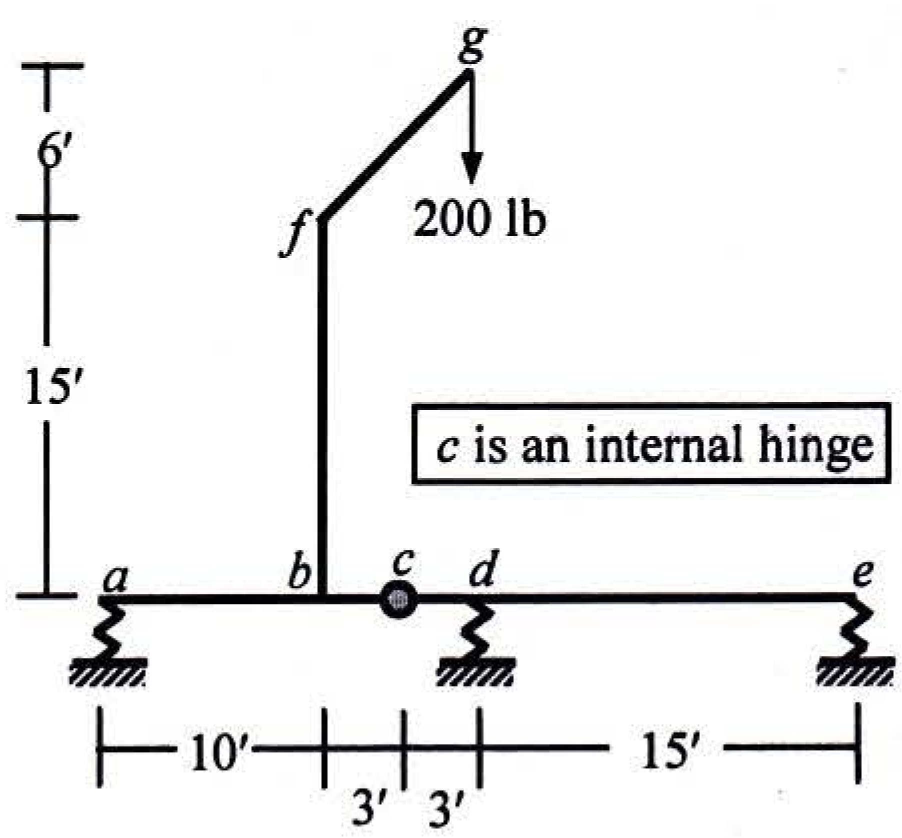


Fig. 5(a)

Fig. 5(b)

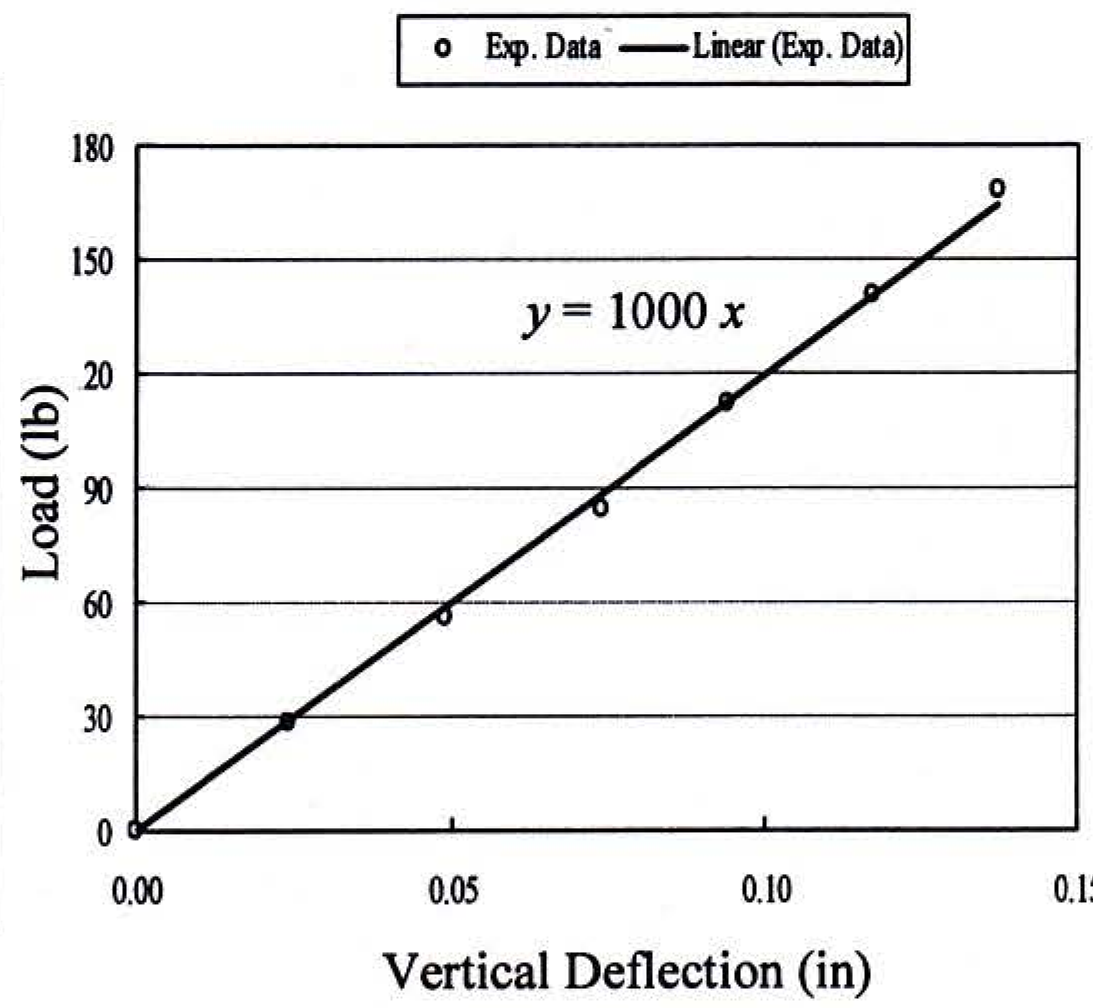


Fig. 5(c)

7. Answer Question 6 using the *Moment-Area Theorems*.

8. Answer Question 6 using the *Conjugate Beam Method.*

9. For the 48″-long timber beam of (2″ × 3″) cross-section loaded as shown in Fig. 6(a), 6(b), calculate the
   (i) Load P if deflection at point c is 0.20″ [Given: E = 2000 ksi]
   (ii) Value of EI required within *ab* and *de* [EI_{ab}, EI_{de}] in Fig. 6(c) to reduce deflection at c by 30%.

Fig. 6(a)

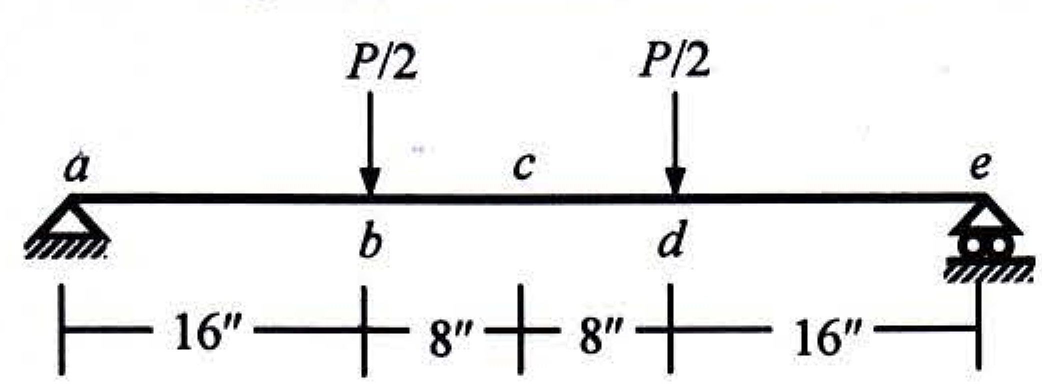


Fig. 6(b)

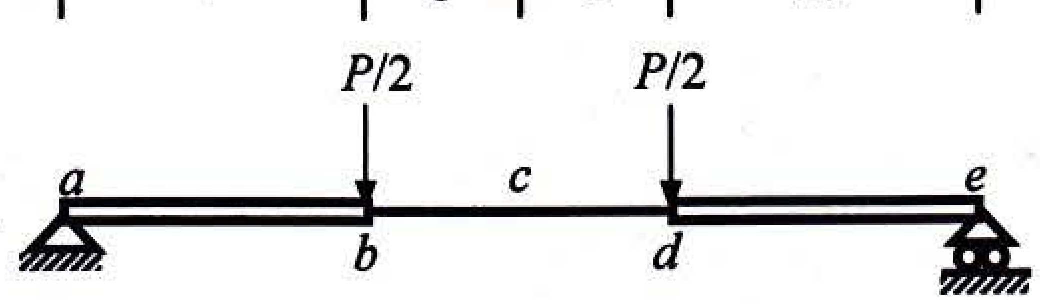


Fig. 6(c)

10. Fig. 7(a) shows test arrangement on a 10″-long cantilever beam *AB*, while Fig. 7(b) shows the cross-section and loading condition at free-end.

    For point *B* (at fixed-end of beam), calculate the

    (i) Normal stress σ_{xx} and shear stress τ_{xy}

    (ii) Yield strength of material required to avoid yielding (according to Von Mises).

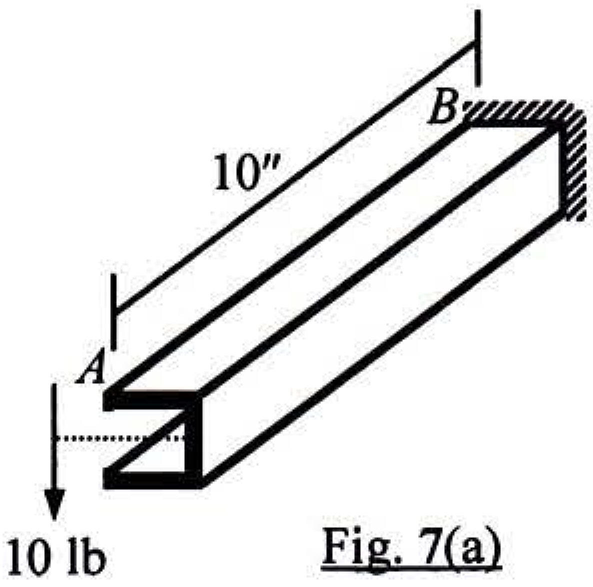


Fig. 7(a)

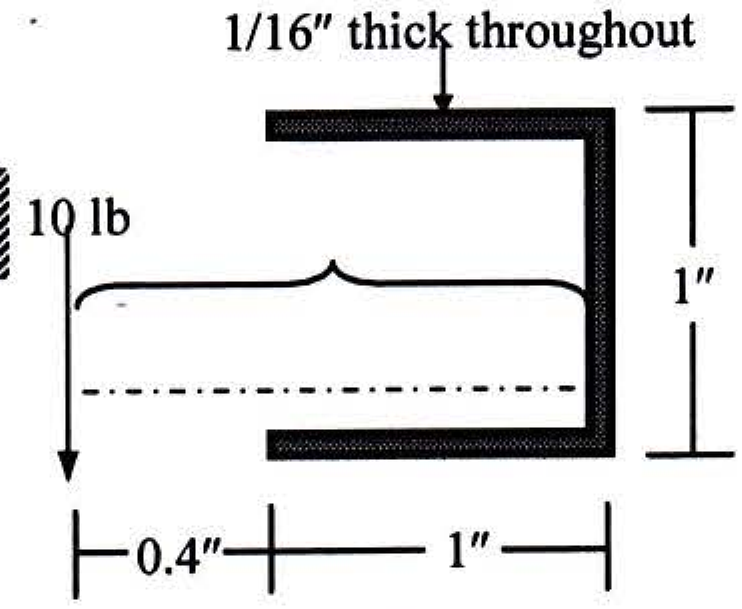


Fig. 7(b)

11. Fig. 8(a) represents a simplified schematic diagram of the middle tower and supporting footing (with centroidal axis at $\bar{y}$ = 1.05′) of the Saheed Minar in Tokyo, Japan, shown in Fig. 8(b).

    If the tower weighs 1000 lb and the footing is 6″ thick, calculate the horizontal force *H* (e.g. due to earthquake) acting 5′ above ground required to overturn the structure.

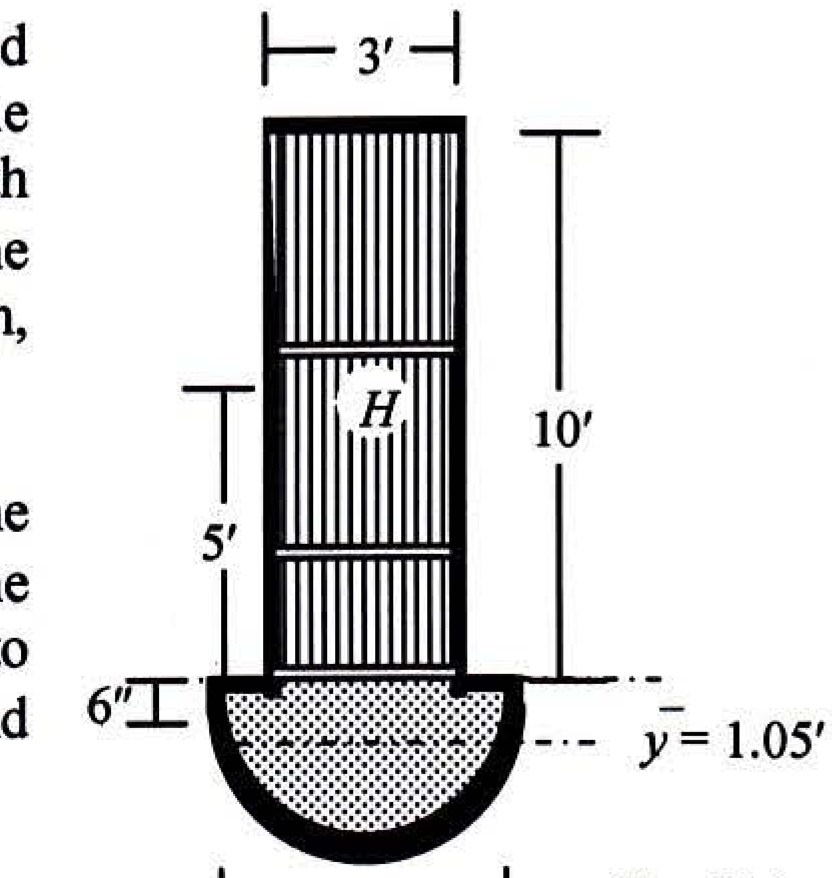


Fig. 8(a)

Fig. 8(b)

12. Fig. 9(a) shows a steel base-plate (with four 0.025m-dia steel bolts) supporting a tower of a Saheed Minar at London, UK, shown in Fig. 9(b).

    Consider direct shear and torsional shear stress at bolts to calculate the maximum allowable shear force *V* at the base-plate

    [Given: All lengths are in m,
    Allowable shear stress = 100 MPa].

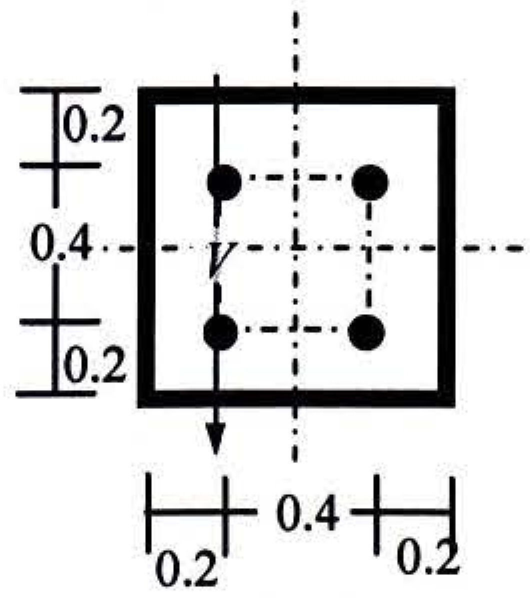


Fig. 9(a)

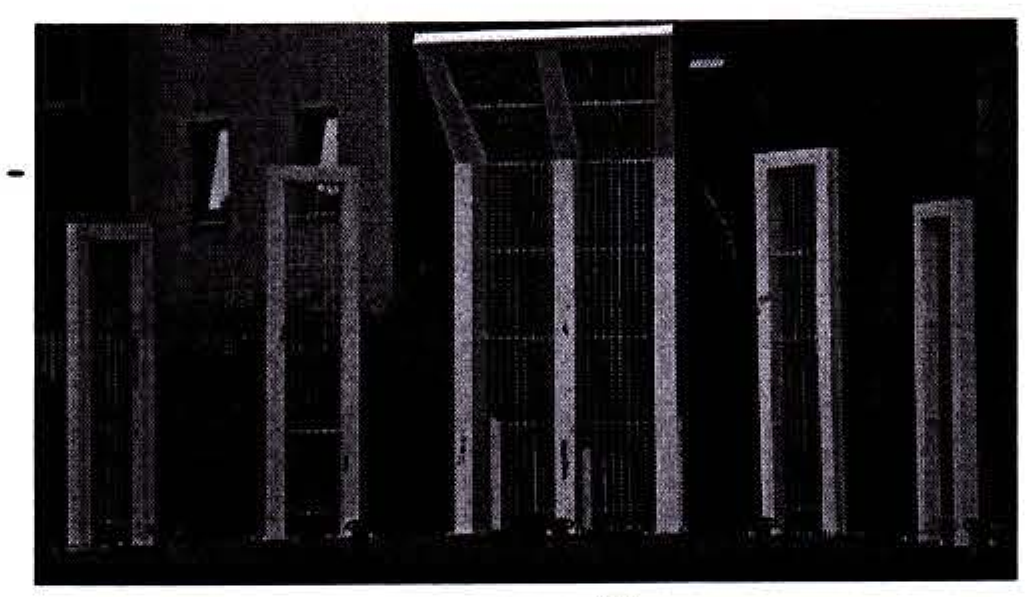


Fig. 9(b)

13. Fig. 10(a) shows a Shaheed Minar built at DU's Kola Bhobon on 21-Feb, 1953.

    In Fig. 10(b), it is represented by monument *abcdef* with five rectangular blocks, and is subjected to horizontal force F_x (= 2000 lb) shown in Figs. 10(a) and 10(b).

    Draw the Mohr's circle of stresses for the points *b* and f_0 of the monument.

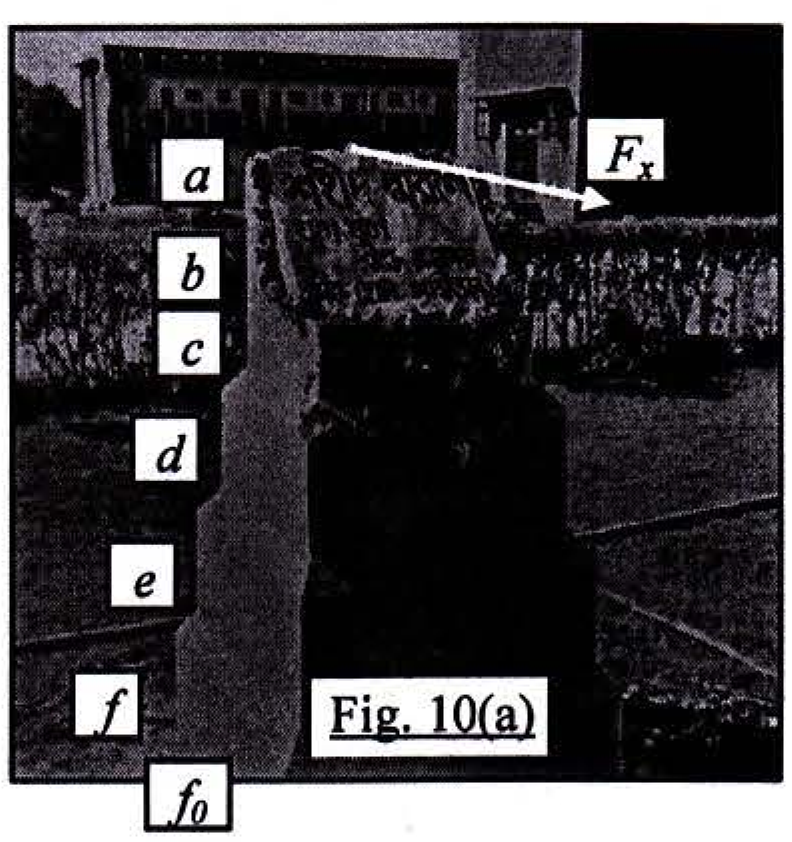


Fig. 10(a)

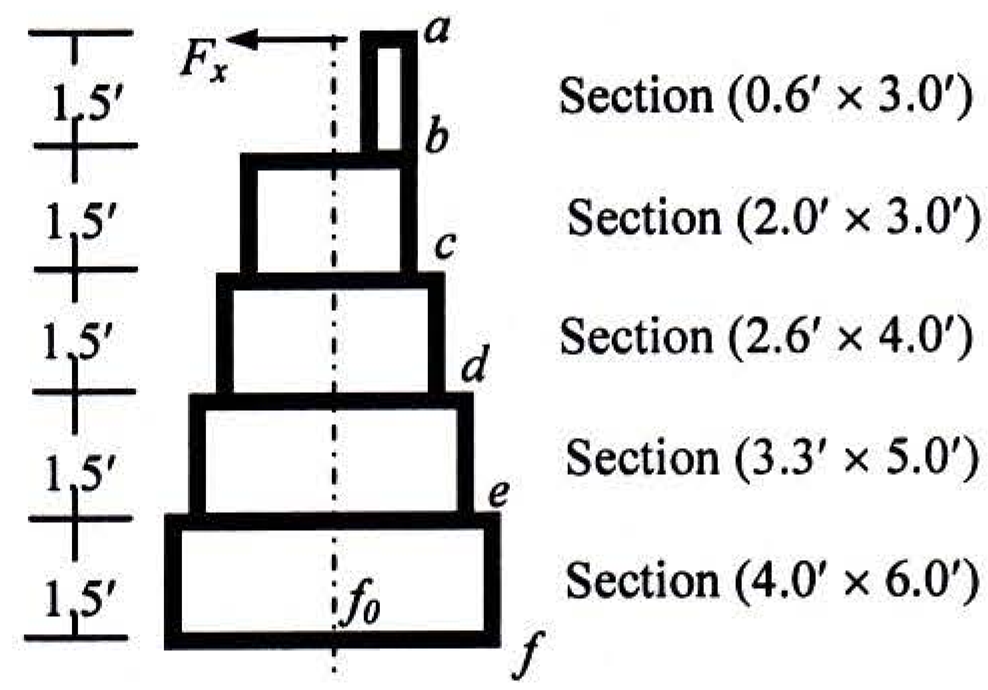


Fig 10(b)

14. Calculate equivalent polar moments of inertia (J_{eq}) for the cross-sections shown in Figs. 11(a)~(c) by centerline dimensions

    [Given:
    Wall thickness = 0.10′].

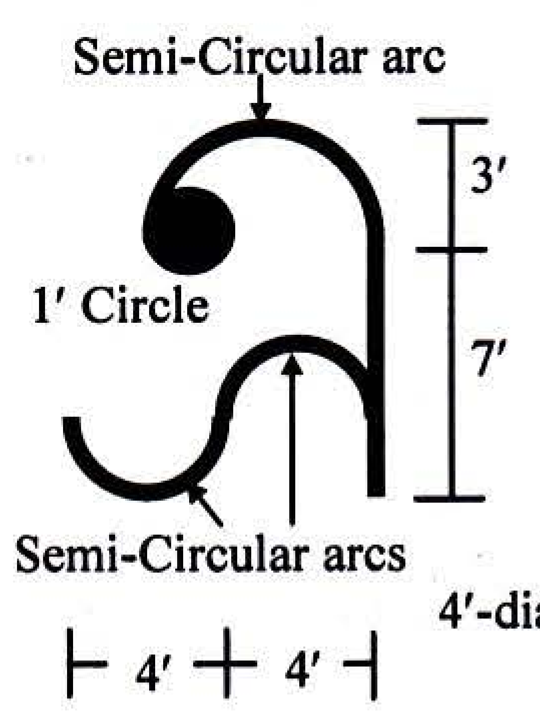


Fig. 11(a)

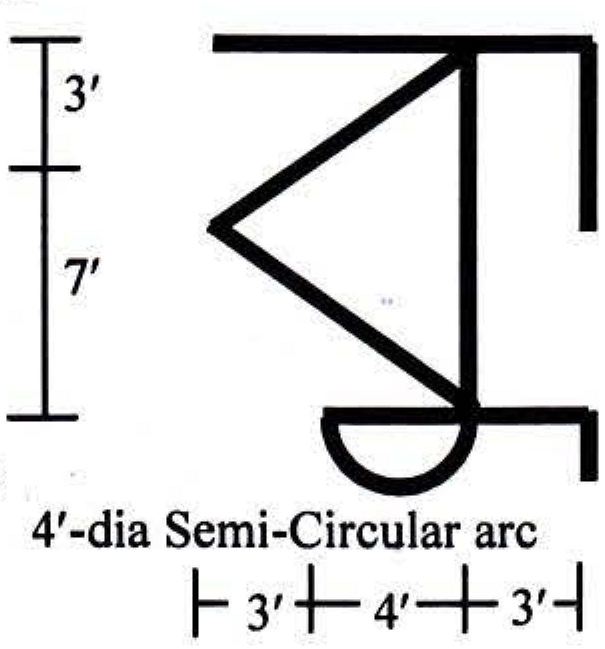


Fig. 11(b)

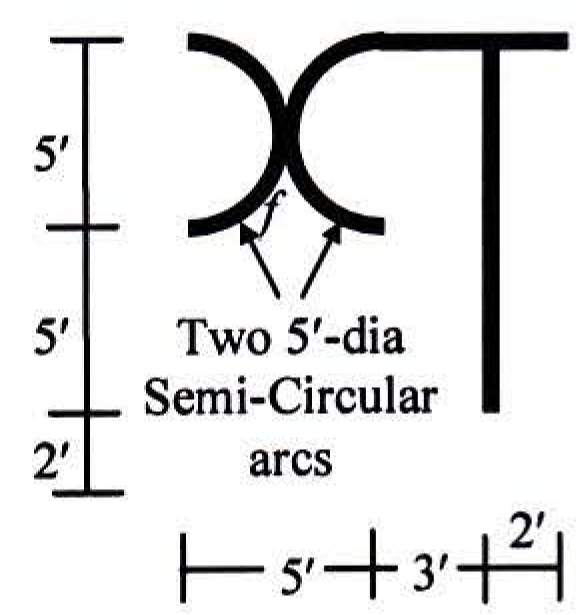


Fig. 11(c)

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2017 (Set 2)
Program: B. Sc. Engineering (Civil)

Course Title: Mechanics of Solids II | Credit Hours: 3.0 | Course Code: CE 213
Time: 3 hours | Full Marks: 100 (= 10 × 10)

[Answer **any 10 (ten)** of the following 14 questions]

1. Fig. 1 shows UAP-CE students working at SM Laboratory on the buckling test of a 0.75m-long perfectly straight simply supported steel column (of 0.005m-diameter). They find the column to buckle at a compressive load 90-N, when the transverse midspan deflection is 0.10m. Calculate the
   (i) Eccentricity (e) of the load and the resulting moment at column ends (due to the load)
   (ii) Plastic moment (M_p) of the column section [Given: $E = 210 \times 10^9$ Pa].

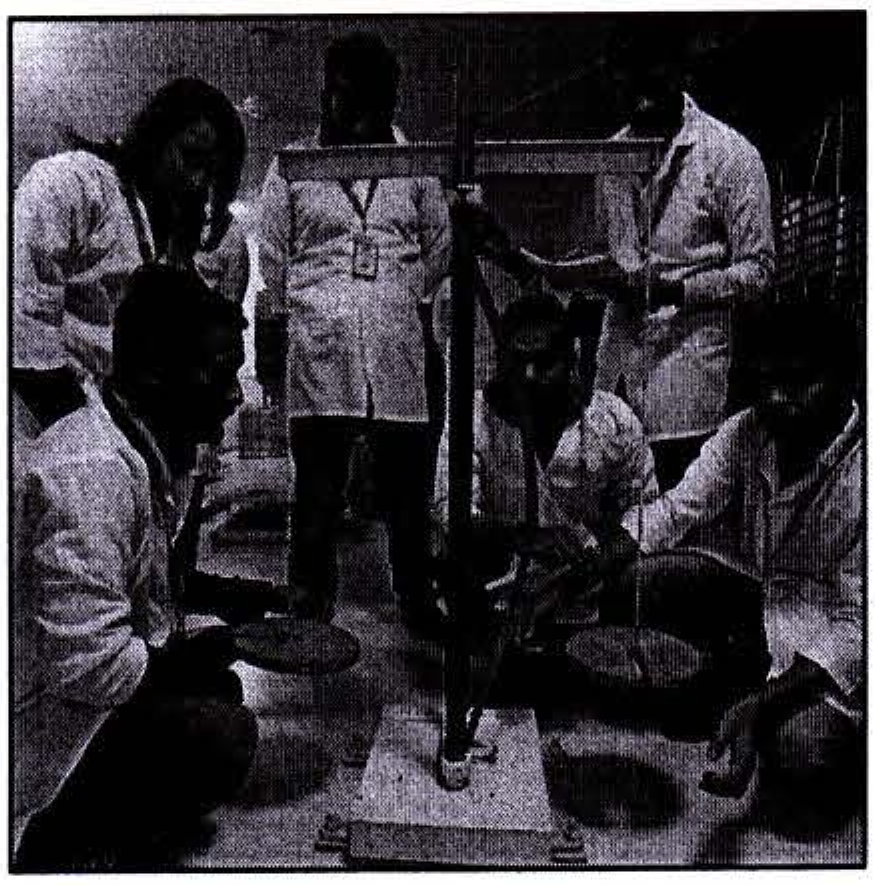


Fig. 1

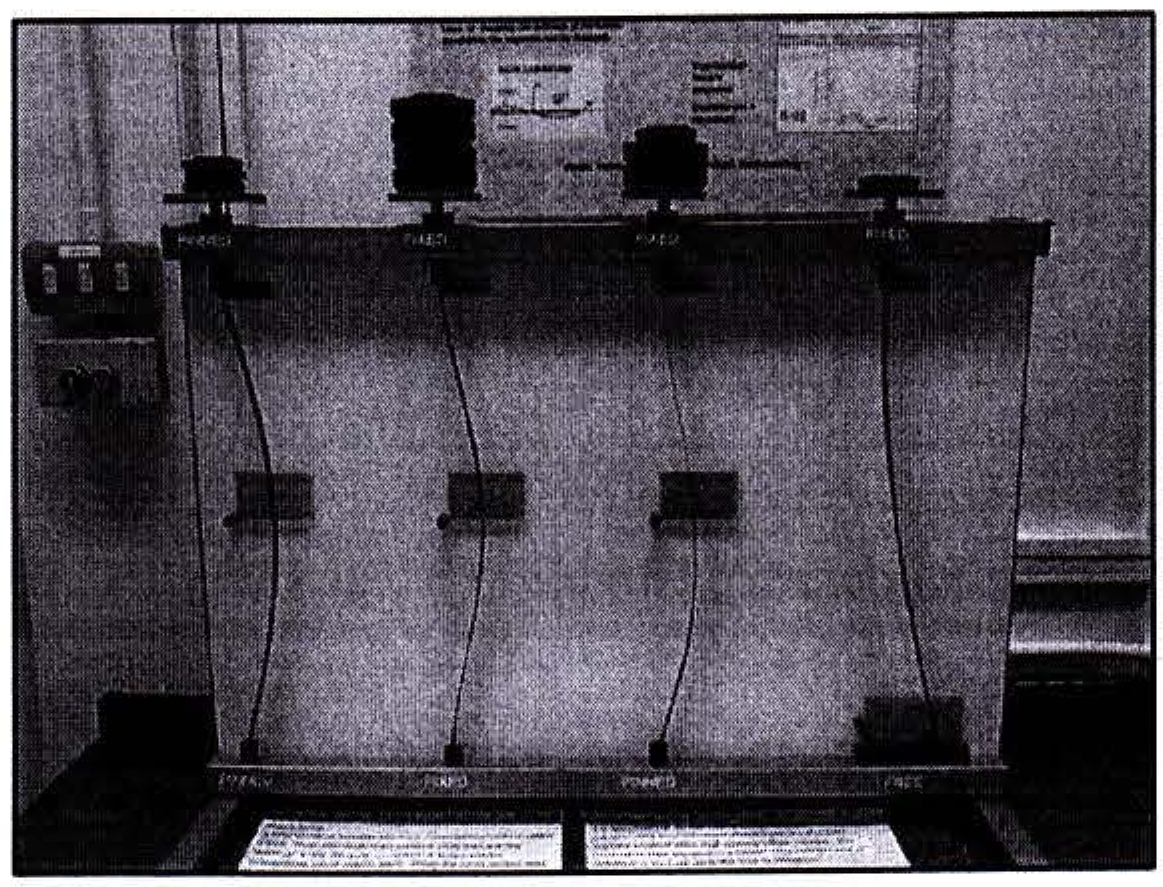


Fig. 2

2. Fig. 2 shows buckling test results of 30″-long columns (0.60″-diameter) of different support conditions (i.e. Col 1: Hinged-Hinged, Col 2: Fixed-Fixed, Col 3: Fixed-Hinged and Col 4: Fixed-Free).

   Use the AISC-ASD method to calculate the allowable compressive load for each column [Given: Yield strength $f_y = 25$ ksi, Modulus of elasticity $E = 29{,}000$ ksi].

3. A 12″-long cylindrical column (of 6″-diameter) and a (6″× 6″ × 6″) cubical column are both made of a nonlinear material with stress-strain relationship given by $\sigma = 3(1 - e^{-100\varepsilon})$, where σ is the compressive stress (ksi) and ε is the strain.

   Calculate the critical stresses for the columns, if they are both hinge-supported at each end.

4. Fig. 3 shows a professor (in Texas Tech, USA) sketching on white-board to calculate the maximum force P_{max} that can be applied on the steel frame drawn, including a 100″-long round bar AB of 1.5″-dia.

   If $\sigma_{Allowable}$ = 30 ksi, and E = 29,000 ksi, perform necessary calculations (i.e. axial force and bending moment for AB) using ASCE equation of *Moment Magnification Factor* to calculate P_{max}.

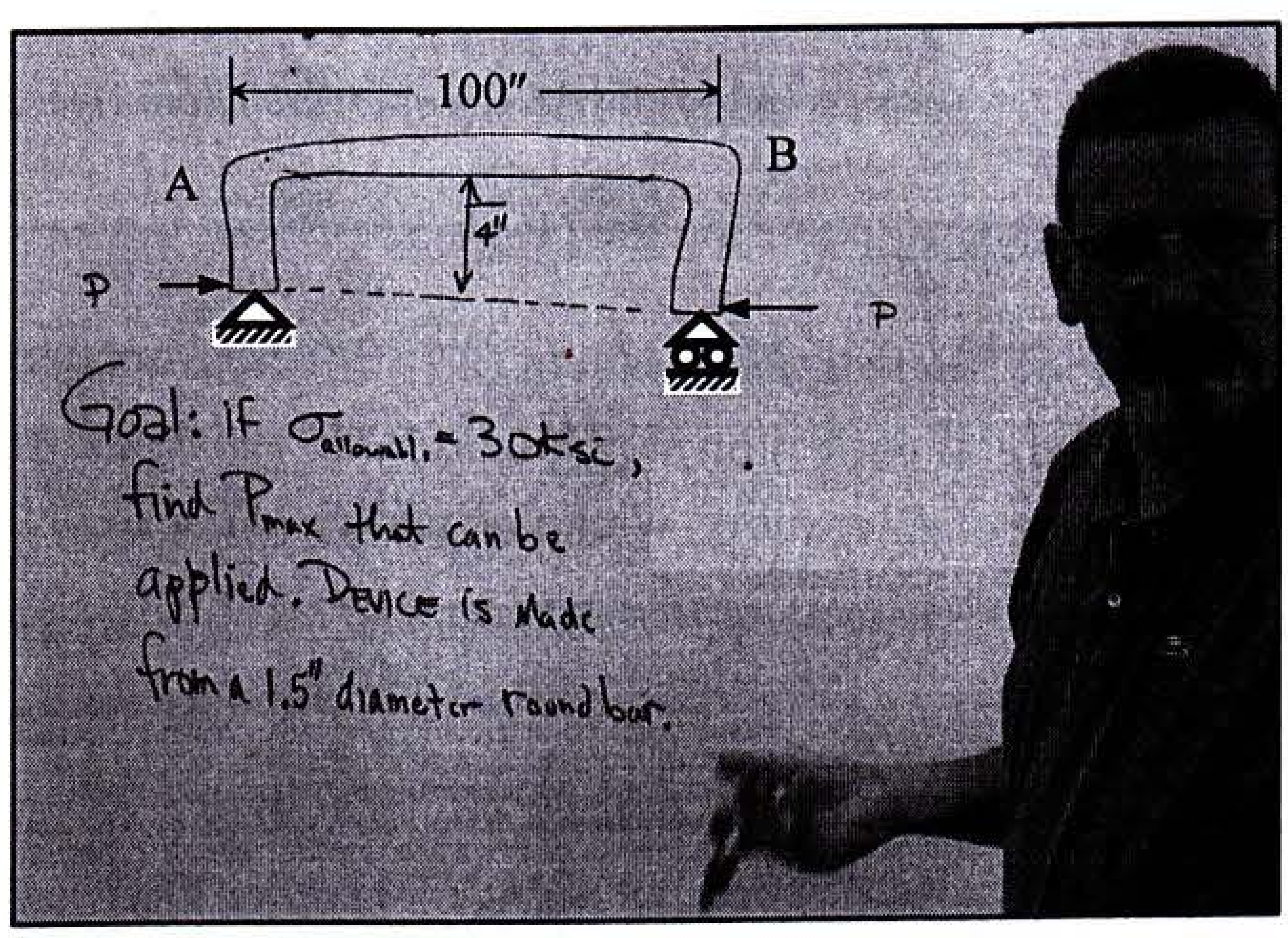


Fig. 3

5. (i) Briefly answer the following questions
   - Draw the axial force vs. transverse deflection graph of a column using Euler's formulation, and also show the modifications due to column imperfection and material nonlinearity.
   - Explain the difference between braced and unbraced columns and their corresponding range of values of the effective length factor (k).

   (ii) For the beam loaded as shown in Fig. 4
   - Write the equation for the load $w(x)$ using singularity functions
   - Write boundary conditions
   - Draw qualitative deflected shape.

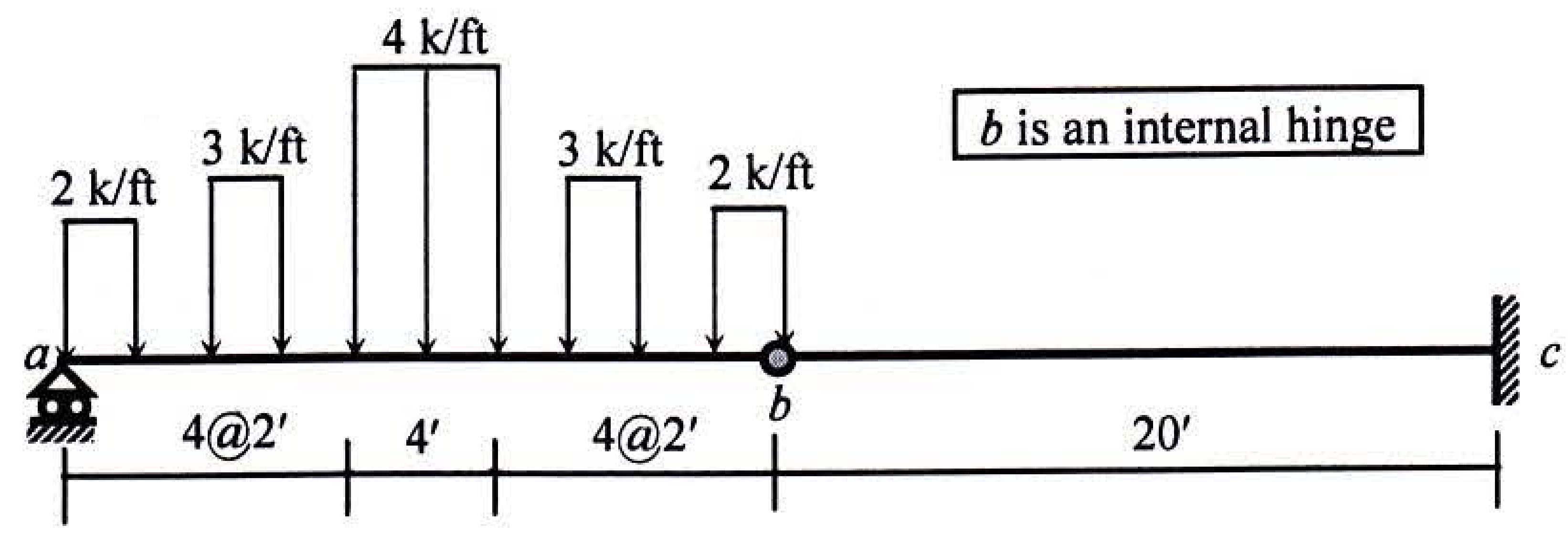


Fig. 4

6. The beam *abcde* is supported at *a*, *d* and *e* by helical springs, which are tested as shown in Fig. 5(b), resulting in a load-deflection graph shown in Fig. 5(c) [Given: EI = constant = 1000 k-ft^2].
   (i) Calculate the vertical reactions and defections at the springs if the beam supports monument *bfg* loaded as shown in Fig. 5(a).
   (ii) Use *Singularity Functions* to calculate the vertical deflection at *c*.

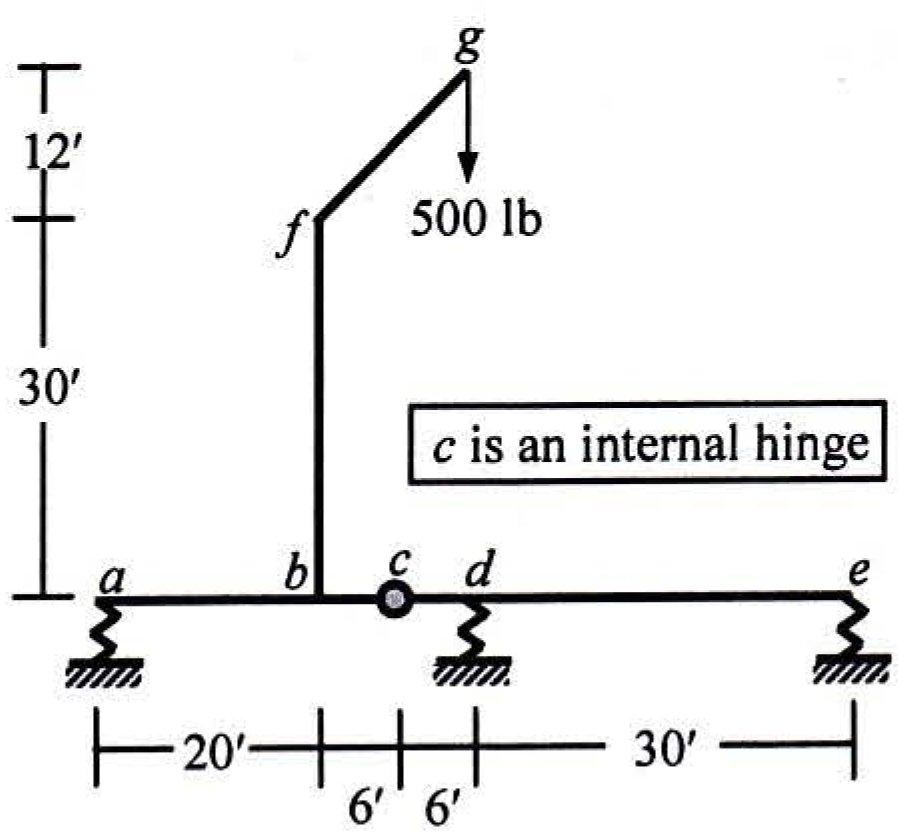


Fig. 5(a)

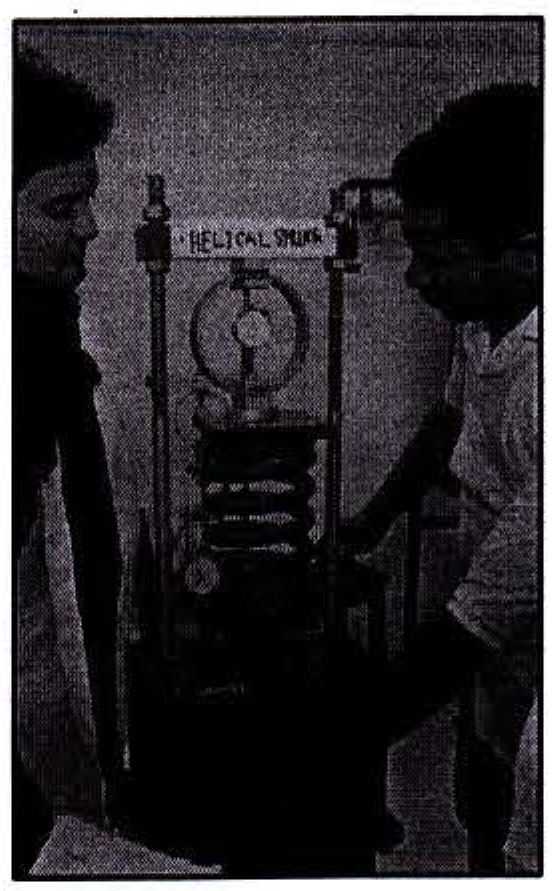


Fig. 5(b)

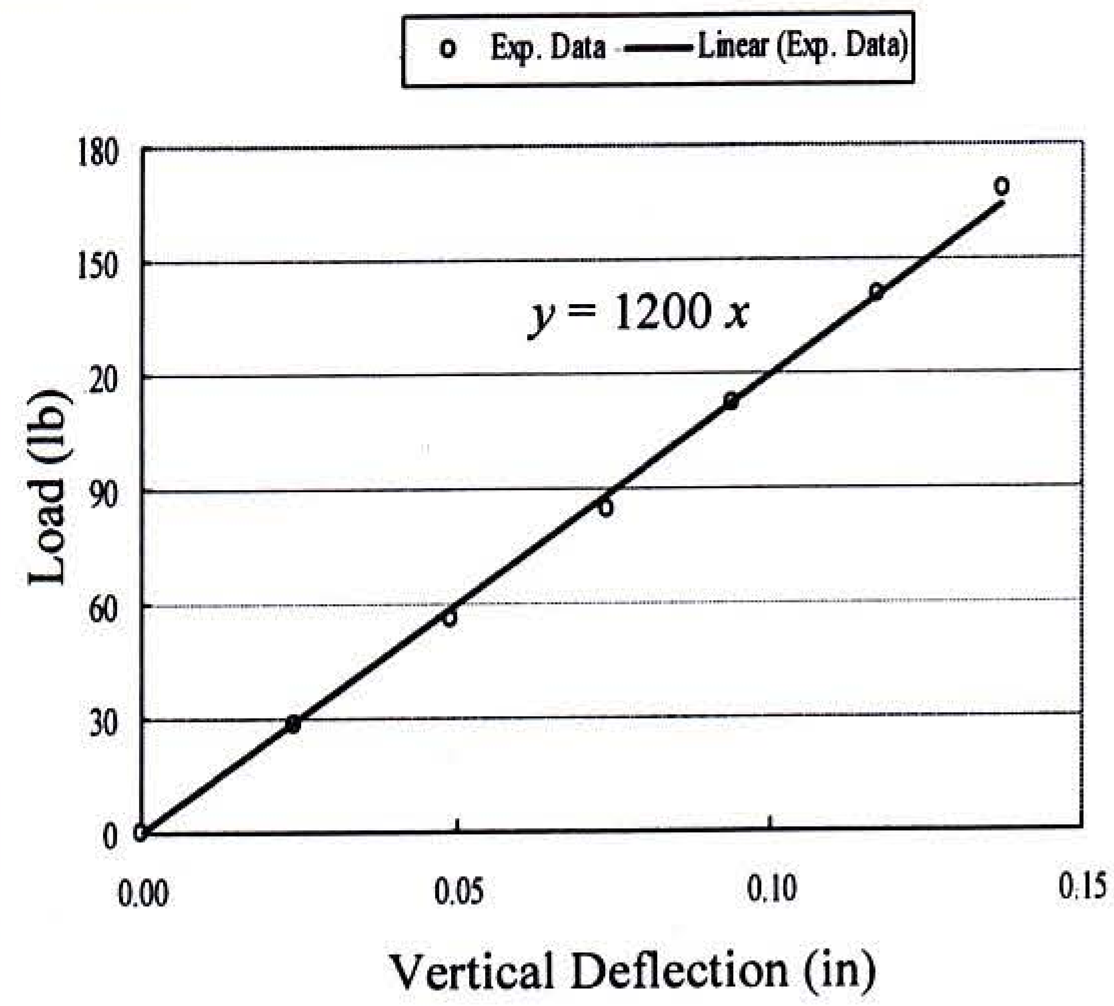


Fig. 5(c)

7. Answer Question 6 using the *Moment-Area Theorems*.

8. Answer Question 6 using the *Conjugate Beam Method*.

9. For the 48″-long timber beam of (2″ × 3″) cross-section loaded as shown in Fig. 6(a), 6(b), calculate the
   (i) Load P if deflection at point c is 0.15″ [Given: E = 2500 ksi]
   (ii) Value of EI required within ab and de [EI_{ab}, EI_{de}] in Fig. 6(c) to reduce deflection at c by 25%.

Fig. 6(a)

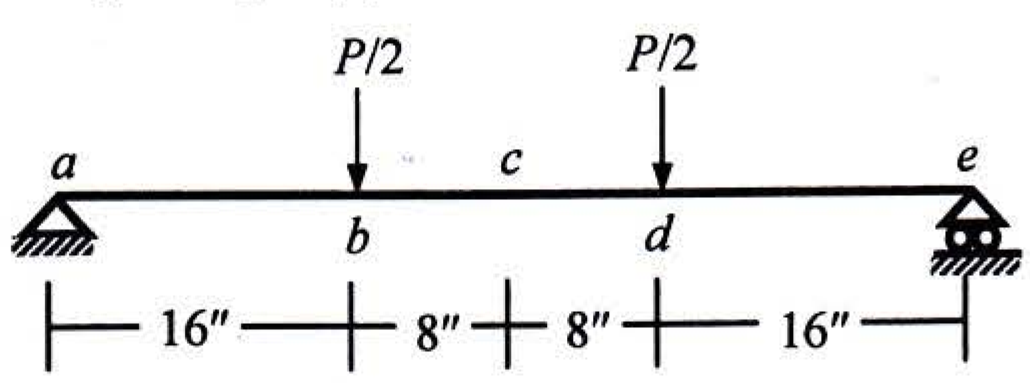


Fig. 6(b)

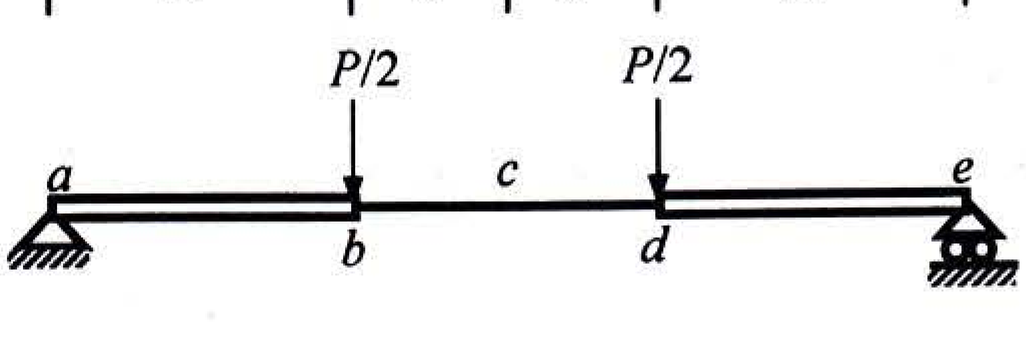


Fig. 6(c)

10. Fig. 7(a) shows test arrangement on a 15″-long cantilever beam AB, while Fig. 7(b) shows the cross-section and loading condition at free-end.

For point B (at fixed-end of beam), calculate the

(ii) Normal stress σ_{xx} and shear stress τ_{xy}

(ii) Yield strength of material required to avoid yielding (according to Tresca).

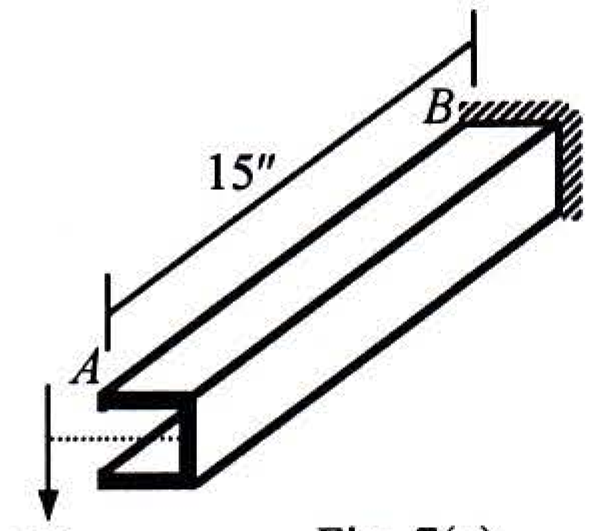


Fig. 7(a)

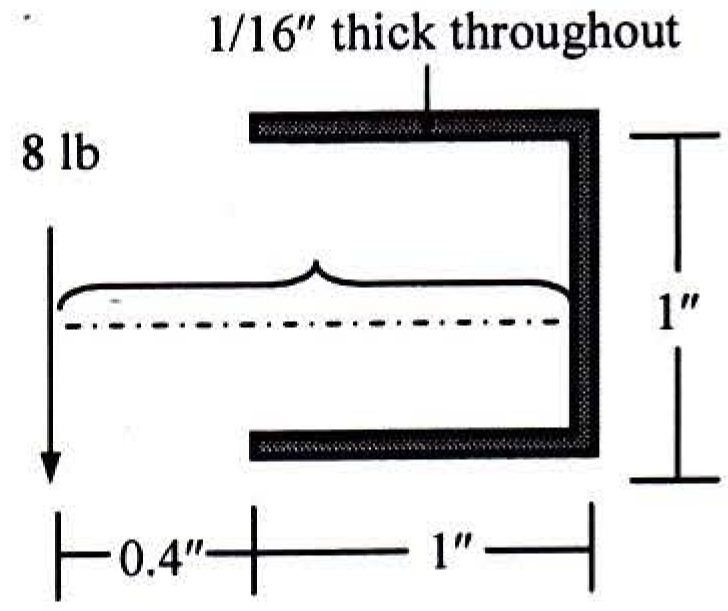


Fig. 7(b)

11. Fig. 8(a) represents a simplified schematic diagram of the middle tower and supporting footing (with centroidal axis at $\bar{y} = 0.84'$) of the Saheed Minar in Tokyo, Japan, shown in Fig. 8(b).

If the tower weighs 1000 lb and the footing is 5″ thick, calculate the horizontal force H (e.g. due to earthquake) acting 4′ above ground required to overturn the structure.

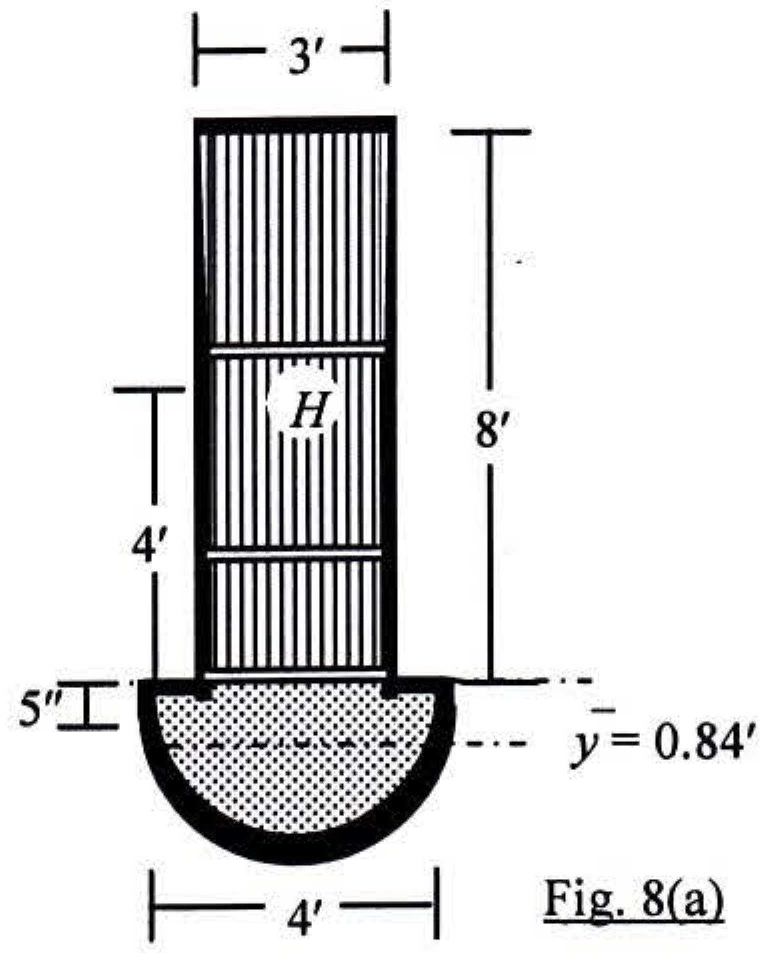


Fig. 8(a)


Fig. 8(b)

12. Fig. 9(a) shows a steel base-plate (with four 1″-dia steel bolts) supporting a tower of a Saheed Minar at London, UK, shown in Fig. 9(b).

Consider direct shear and torsional shear stress at bolts to calculate the maximum allowable shear force V at the base-plate [Given: Allowable shear stress = 20 ksi].

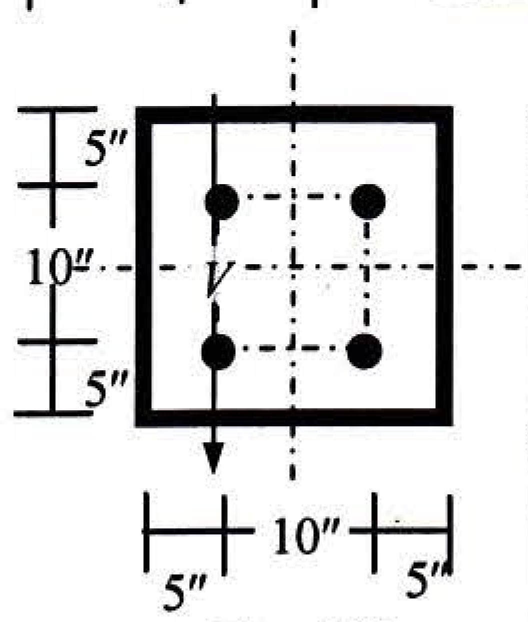


Fig. 9(a)

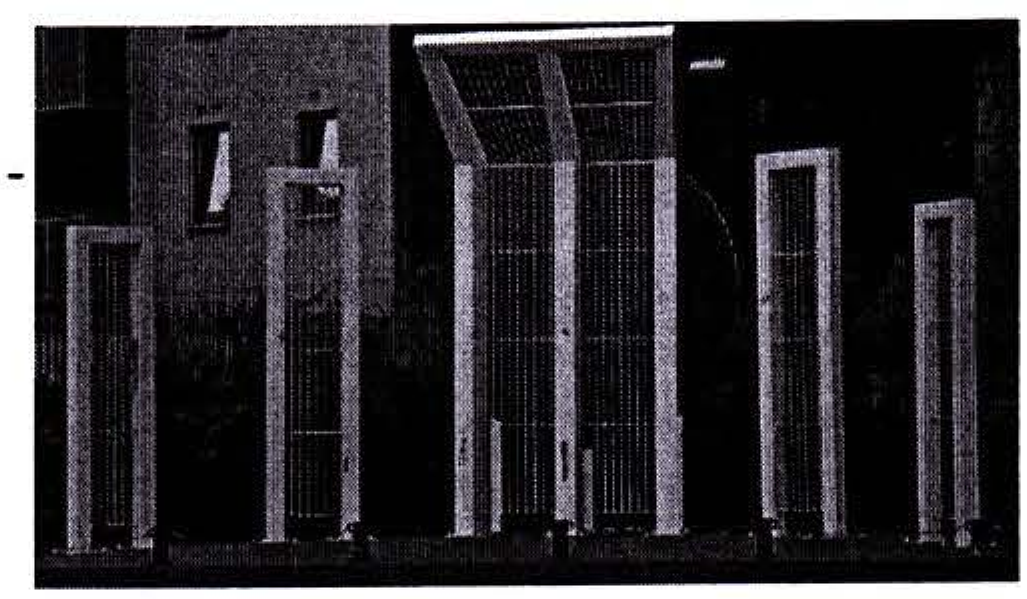


Fig. 9(b)

13. Fig. 10(a) shows a Shaheed Minar built at DU's Kola Bhobon on 21-Feb, 1953.

In Fig. 10(b), it is represented by monument *abcdef* with five rectangular blocks, and is subjected to horizontal force F_x (= 50 kN) shown in Figs. 10(a) and 10(b).

Draw the Mohr's circle of stresses for the points b and f_0 of the monument.

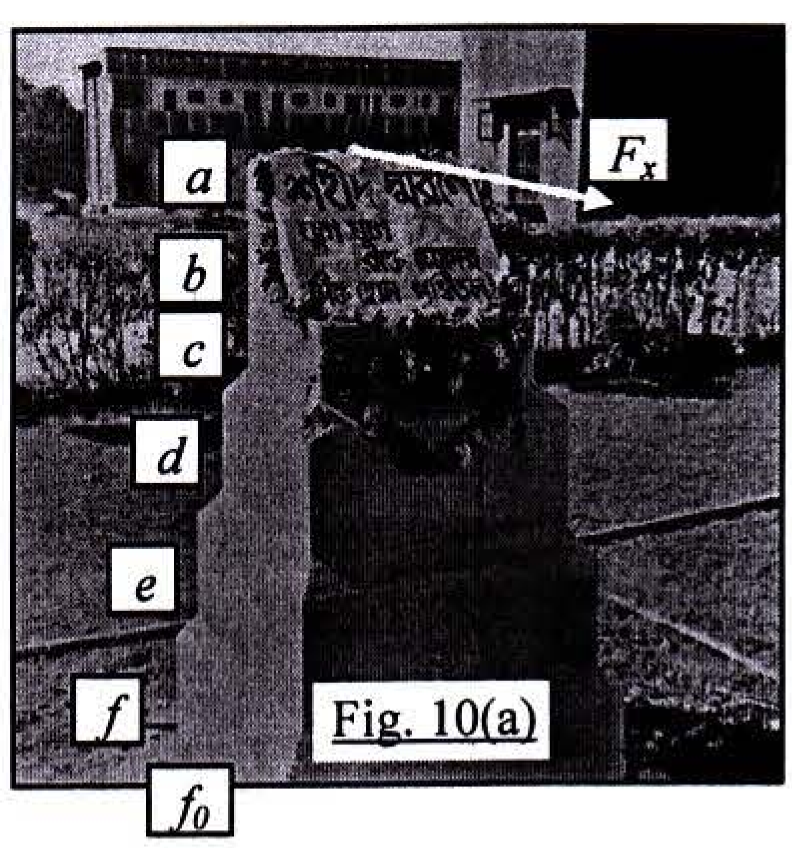


Fig. 10(a)

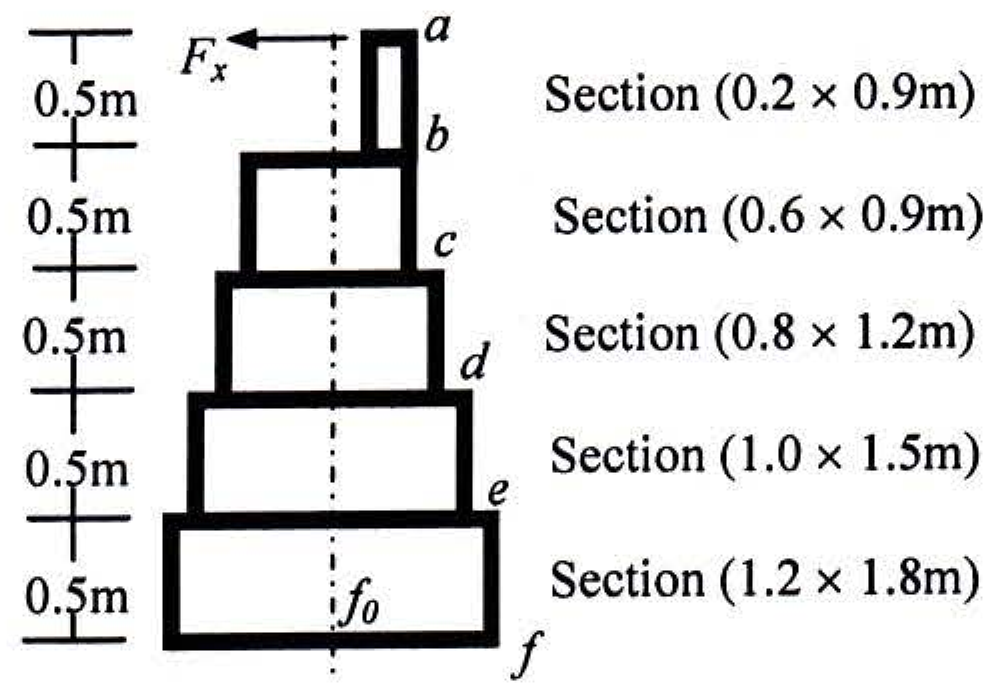


Fig 10(b)

14. Calculate equivalent polar moments of inertia (J_{eq}) for the cross-sections shown in Figs. 11(a)~(c) by centerline dimensions

[Given:
Wall thickness = 0.10′].

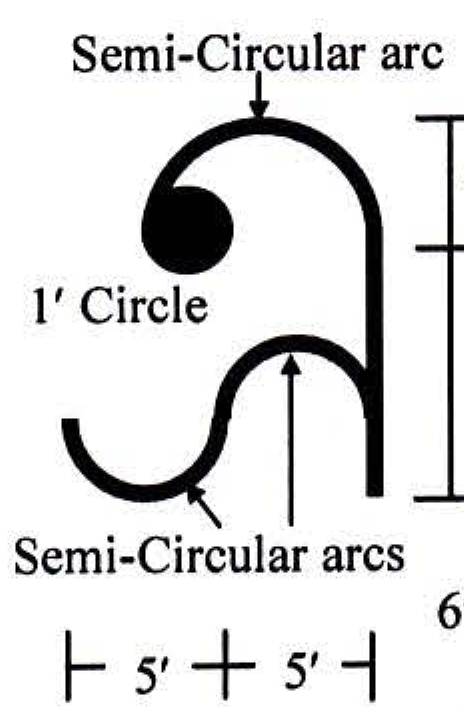


Fig. 11(a)

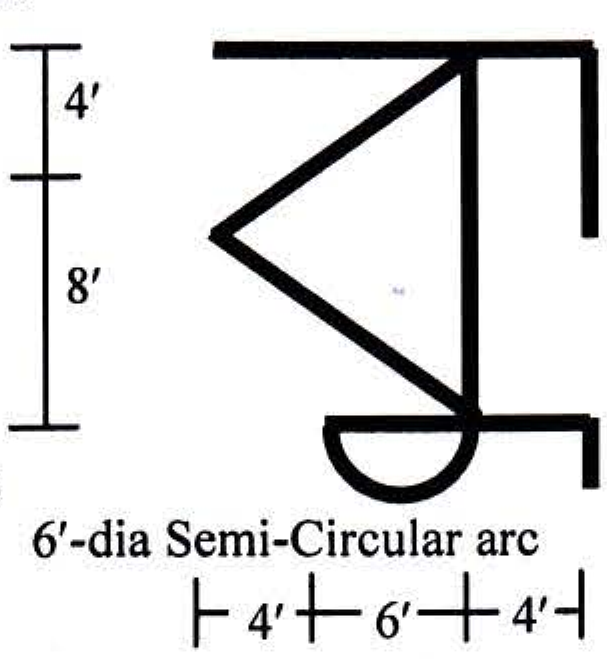


Fig. 11(b)

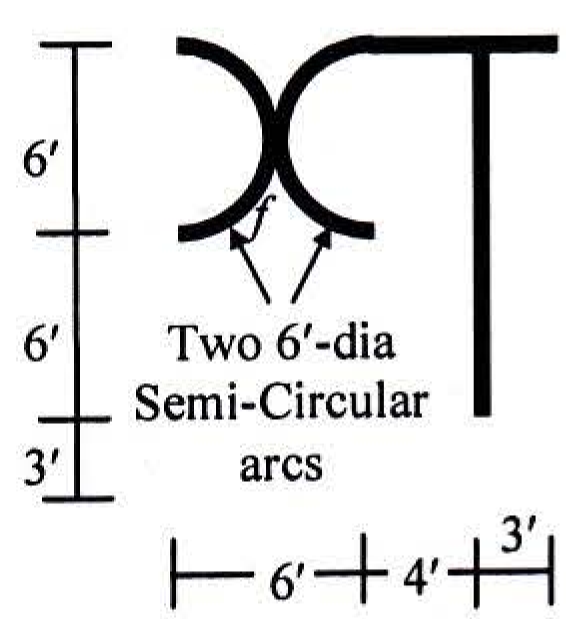


Fig. 11(c)

List of Useful Formulae for CE 213

* Torsional Rotation $\phi_B - \phi_A = \int (T/J_{eq}G)\,dx$, and $= (TL/J_{eq}G)$, if T, J_{eq} and G are constants

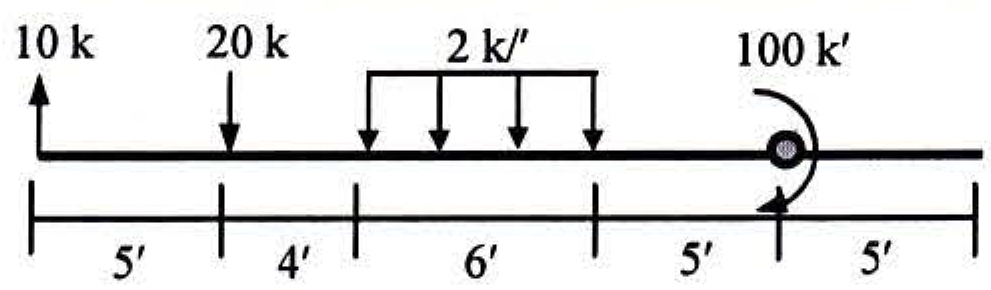
Section	Torsional Shear Stress	J_{eq}
Circular	$\tau = Tc/J$	$\pi d^4/32$
Thin-walled	$\tau = T/(2A\,t)$	$4A^2/(\int ds/t)$
Rectangular	$\tau = T/(\alpha b t^2)$	$\beta b t^3$

b/t	1.0	1.5	2.0	3.0	6.0	10.0	∞
α	0.208	0.231	0.246	0.267	0.299	0.312	0.333
β	0.141	0.196	0.229	0.263	0.299	0.312	0.333

* Biaxial Bending Stress: $\sigma_x(z, y) = M_z\, y/I_z + M_y\, z/I_y$
* Combined Axial Stress and Biaxial Bending Stress: $\sigma_z(x,y) = -P/A - M_x\, y/I_x - M_y\, x/I_y$
* Corner points of the kern of a Rectangular Area are (b/6, 0), (0, h/6), (–b/6, 0), (0, –h/6)
* Maximum shear stress on a Helical spring: $\tau_{max} = \tau_{direct} + \tau_{torsion} = P/A + Tr/J = P/A\,(1 + 2R/r)$
* Stiffness of a Helical spring is $k = Gd^4/(64R^3N)$

* $\sigma_{xx}' = (\sigma_{xx} + \sigma_{yy})/2 + \{(\sigma_{xx} - \sigma_{yy})/2\}\cos 2\theta + (\tau_{xy})\sin 2\theta = (\sigma_{xx} + \sigma_{yy})/2 + \sqrt{[\{(\sigma_{xx} - \sigma_{yy})/2\}^2 + (\tau_{xy})^2]}\cos(2\theta - \alpha)$
  $\tau_{xy}' = -\{(\sigma_{xx} - \sigma_{yy})/2\}\sin 2\theta + (\tau_{xy})\cos 2\theta = \tau_{xy}' = -\sqrt{[\{(\sigma_{xx} - \sigma_{yy})/2\}^2 + (\tau_{xy})^2]}\sin(2\theta - \alpha)$
  where $\tan\alpha = 2\,\tau_{xy}/(\sigma_{xx} - \sigma_{yy})$
* $\sigma_{xx(max)} = (\sigma_{xx} + \sigma_{yy})/2 + \sqrt{[\{(\sigma_{xx} - \sigma_{yy})/2\}^2 + (\tau_{xy})^2]}$; when $\theta = \alpha/2,\ \alpha/2 + 180°$
  $\sigma_{xx(min)} = (\sigma_{xx} + \sigma_{yy})/2 - \sqrt{[\{(\sigma_{xx} - \sigma_{yy})/2\}^2 + (\tau_{xy})^2]}$; when $\theta = \alpha/2 \pm 90°$
* $\tau_{xy(max)} = \sqrt{[\{(\sigma_{xx} - \sigma_{yy})/2\}^2 + (\tau_{xy})^2]}$; when $\theta = \alpha/2 - 45°,\ \alpha/2 + 135°$
  $\tau_{xy(min)} = -\sqrt{[\{(\sigma_{xx} - \sigma_{yy})/2\}^2 + (\tau_{xy})^2]}$; when $\theta = \alpha/2 + 45°,\ \alpha/2 - 135°$
* Mohr's Circle: Center $(a, 0) = [(\sigma_{xx} + \sigma_{yy})/2, 0]$ and radius $R = \sqrt{[\{(\sigma_{xx} - \sigma_{yy})/2\}^2 + (\tau_{xy})^2]}$
* For Yielding to take place
  - Maximum Normal Stress Theory (Rankine): $|\sigma_1| \geq Y$, or $|\sigma_2| \geq Y$.
  - Maximum Normal Strain Theory (St. Venant): $|\sigma_1 - \nu\sigma_2| \geq Y$, or $|\sigma_2 - \nu\sigma_1| \geq Y$.
  - Maximum Shear Stress Theory (Tresca): $|\sigma_1 - \sigma_2| \geq Y$, $|\sigma_1| \geq Y$, or $|\sigma_2| \geq Y$
  - Maximum Distortion-Energy Theory (Von Mises): $\sigma_1^2 + \sigma_2^2 - \sigma_1\sigma_2 \geq Y^2$

* $M(x) = EI\,\kappa \cong EI\, d^2v/dx^2$
* $w(x) \cong EI\, d^4v/dx^4$, $V(x) = \int w(x)\,dx \cong EI\, d^3v/dx^3$, $M(x) = \int V(x)\,dx \cong EI\, d^2v/dx^2$
  $S(x) = \int M(x)\,dx \cong EI\, dv/dx \cong EI\,\theta(x)$, $D(x) = \int S(x)\,dx \cong EI\, v(x)$
* Singularity Functions for Common Loadings



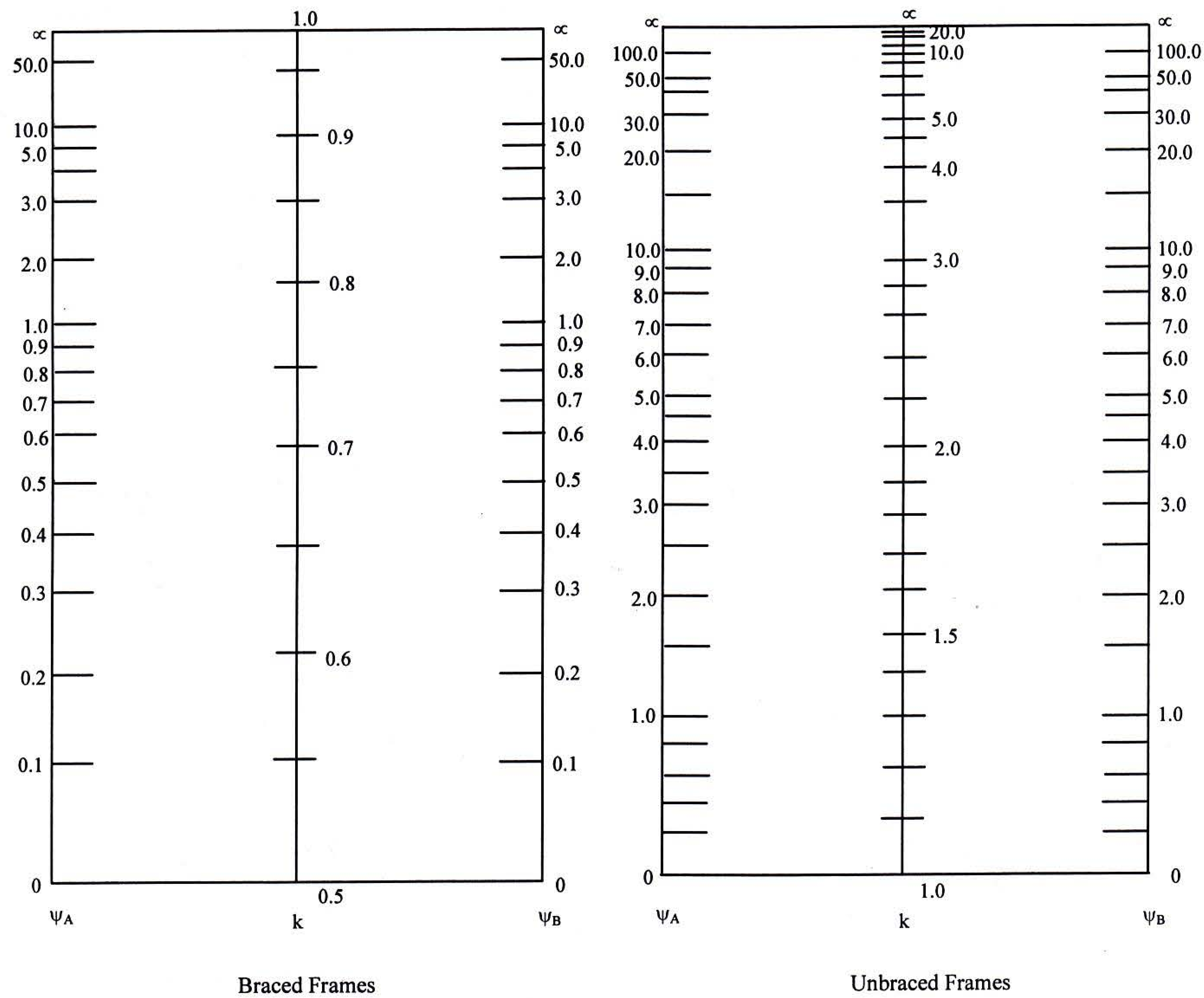
$w(x) = 10\langle x-0\rangle^{-1}_{\bullet} - 20\langle x-5\rangle^{-1}_{\bullet} - 2\langle x-9\rangle^{0} + 2\langle x-15\rangle^{0}$
$+ 100\langle x-20\rangle^{-2}_{\bullet} + C_\theta\langle x-20\rangle^{-3}_{\bullet}$

* First Moment-Area Theorem: $\theta_B - \theta_A = \int (M/EI)\,dx$
* Second Moment-Area Theorem: $(x_B - x_A)\,\theta_B - v_B + v_A = \int x\,(M/EI)\,dx$
* Conjugate Beam Method

Original Beam	Free End	Fixed End	Hinge/Roller End	Internal Support	Internal Hinge
Conjugate Beam	Fixed End	Free End	Hinge/Roller End	Internal Hinge	Internal Support

* Euler Buckling Load: $P_{cr} = \pi^2 EI_{min}/(kL)^2$
* Effect of Initial Imperfection: $v(x) = v_{0i}/[1-P/P_{cr}]\sin(\pi x/L) \Rightarrow v(L/2) = v_{0i}/[1-P/P_{cr}]$
* Effect of Load Eccentricity: $\lambda^2 = P/EI \Rightarrow v(L/2) = e\,[\sec\lambda L/2 - 1] = e\,[\sec\{(\pi/2)\sqrt{(P/P_{cr})}\} - 1]$
* Effect of Material Nonlinearity: $P_{cr} = \pi^2 E_t I/L^2 \Rightarrow \sigma_{cr} = \pi^2 E_t/\eta^2$
* Eccentric Loading with Elasto-plastic Material:
  $v(L/2) = e\,[\sec\{(\pi/2)\sqrt{(P/P_{cr})}\} - 1]$ for the elastic range; and
  $v(L/2) = M_p/P - e$, for the plastic range
* k = 1.0 for Hinge-Hinged Beam, 0.7 for Hinge-Fixed Beam, 0.5 for Fixed-Fixed Beam, 2.0 for Cantilever Beam
* In general, k can be obtained from ψ_A and ψ_B for braced and unbraced frames
  Using approximate formulae (Salama, 2014)
  For braced frame, $k \cong \{3\,\psi_A\psi_B + 1.4\,(\psi_A + \psi_B) + 0.64\}/\{3\psi_A\,\psi_B + 2.0\,(\psi_A + \psi_B) + 1.28\}$
  For unbraced frame, $k \cong \sqrt{[\{1.6\,\psi_A\psi_B + 4.0\,(\psi_A + \psi_B) + 7.5\}/(\psi_A + \psi_B + 7.5)]}$
* AISC-ASD Method, $\eta = L_e/r_{min}$, and $\eta_c = \pi\sqrt{(2E/f_y)}$
  If $\eta \leq \eta_c$, $\sigma_{all} = f_y\,[1 - 0.5\,(\eta/\eta_c)^2]/FS$, where $FS = [5/3 + 3/8\,(\eta/\eta_c) - 1/8\,(\eta/\eta_c)^3]$
  If $\eta > \eta_c$, $\sigma_{all} = (\pi^2 E/\eta^2)/FS$, where FS = Factor of safety = 23/12 = 1.92
* Moment magnification factor for a Simply Supported Beam
  For concentrated load at midspan of $= [\tan(\lambda L/2)/(\lambda L/2)]$, subjected to end moments only $= [\sec(\lambda L/2)]$
  Under UDL $= 2\,[\sec(\lambda L/2) - 1]/(\lambda L/2)^2$, according to AISC code $= 1/(1 - P/P_{cr})$

Alignment Charts for Effective Length Factors k



ψ = Ratio of ΣEI/L of compression members to ΣEI/L of flexural members in a plane at one end of a compression member
k = Effective length factor

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

Course Title: Fluid Mechanics | Course Code: CE 221
Time- 3 hours | Full marks: 120

There are EIGHT (8) questions. Answer any SIX (6).
(Assume any missing data.)
Marks Distribution [6*20=120]

1. (a) Describe different the branches of fluid mechanics. [4]
   (b) Write down short notes of following items i) Density; ii) Specific weight; iii) Specific volume; and iv) Specific gravity. [8]
   (c) Derive the formula for Newton's equation of viscosity with the net sketch. [8]

2. (a) Define flow net, mean velocity and stagnant point. [4]
   (b) Define the following i) path line; ii) Stream line; iii) stream tube and iv) streak line. [8]
   (c) Derive acceleration equation for unsteady flow. Define the convective and local acceleration from the derived equation. Mention in which case, there is no local acceleration. [8]

3. (a) Derive the impulse-momentum equation for a fluid system. [10]
   (b) Find the horizontal thrust of water by each meter of the width of the sluice gate as shown in Figure: 01. Neglect friction. [10]

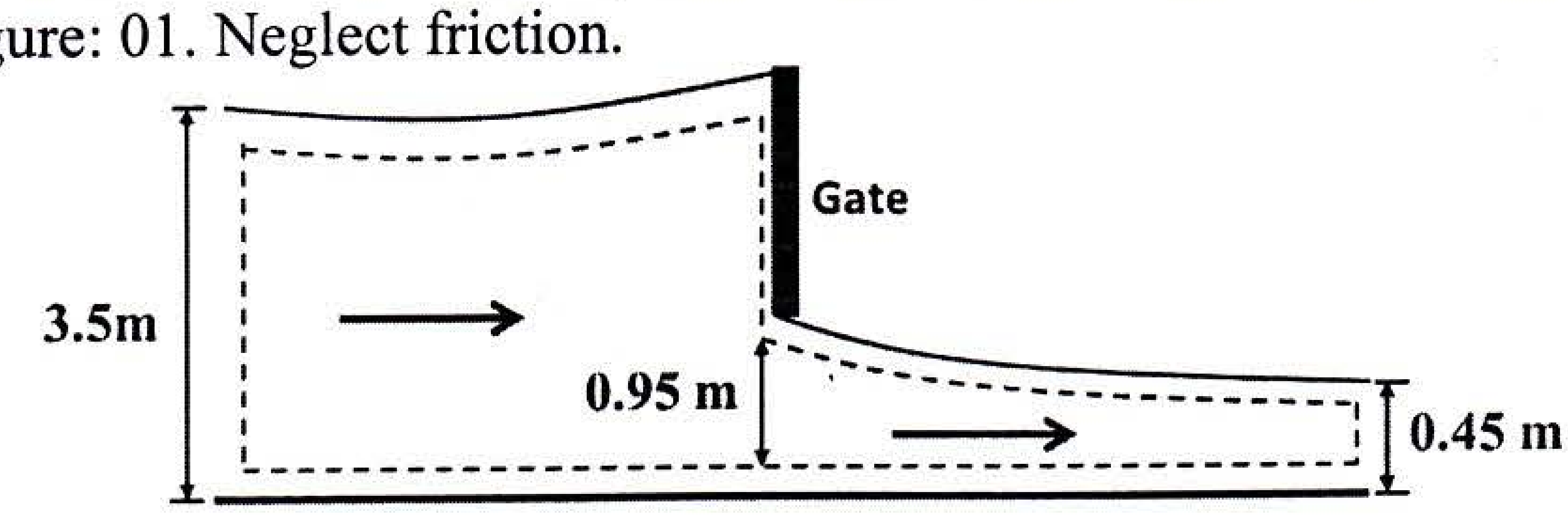


Figure: 01

4. (a) Derive the expression for the normal force. When a jet of water strikes stationary plate as shown in Figure:02. [4]

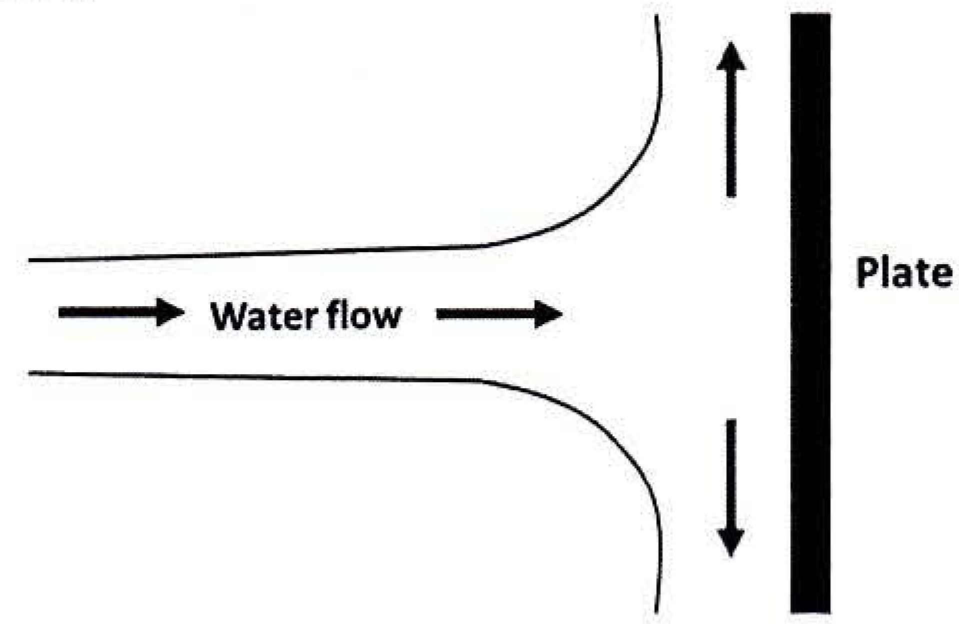


Figure: 02

(b) Define steam and potential function with a mathematical expression. [8]

(c) In a flow, the velocity vector is given by $V = 3.5\,xi + 6\,yj - 7zk$. Determine the equation of the streamline passing through a point $M(1,4\,,5)$. [8]

5. (a) Which device is used for measuring the differences in pressure? [2]

(b) Which one is the most elementary device for measuring the pressure? Discuss the reasons behind its limited use. [1+2]

(c) Which device is used for measuring the atmospheric pressure? Which liquid is employed usually in the device and why? [1+2]

(d) For the inclined-tube manometer in Fig:03, the pressure in pipe A is 60 KN/m^2.The fluid in both A and B is water and the gage fluid in the manometer has a specific gravity of 2.6.What is the pressure in the pipe B corresponding to the differential reading shown? [12]

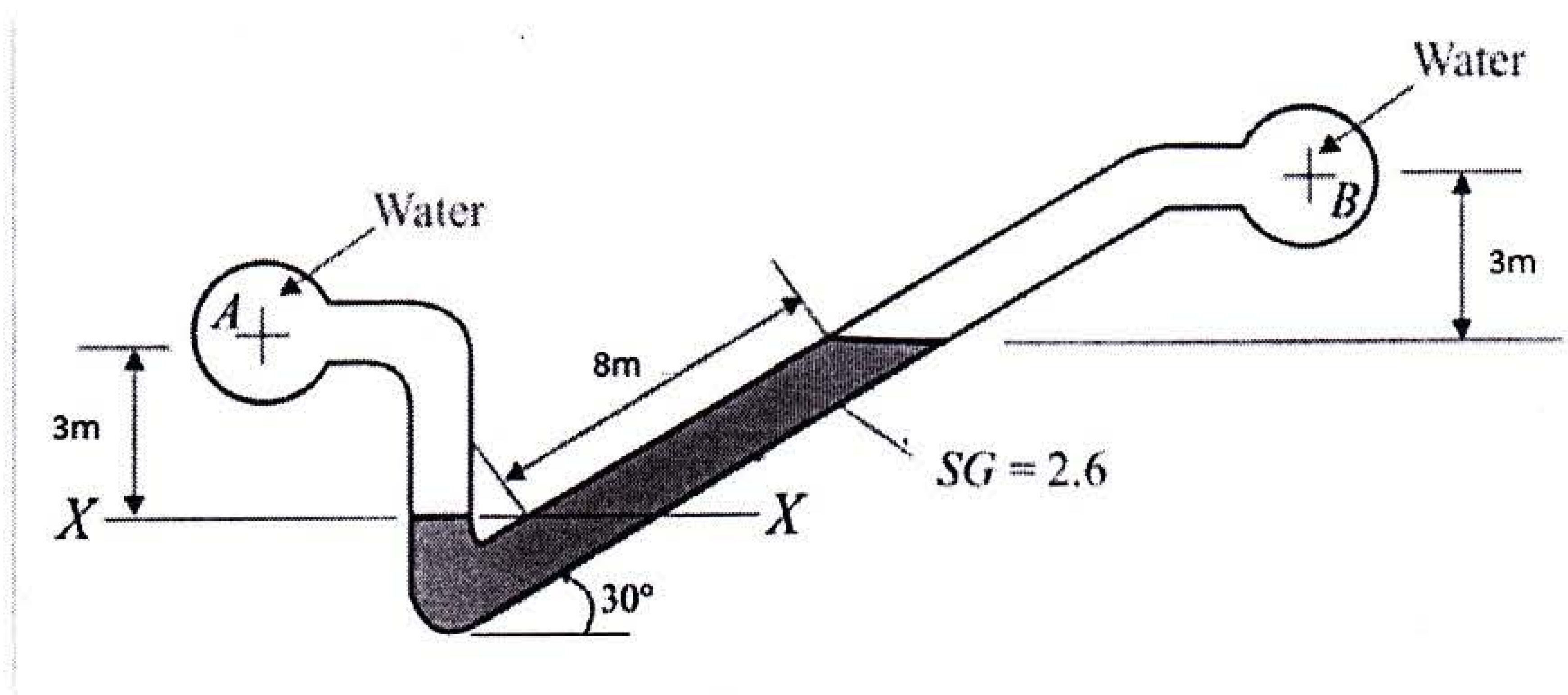


Figure: 03

6. (a) Derive the Darcy-Weisbach formula for pipe friction. [Equation for shear stress is given in the list of necessary equation list attached along with the question paper. You do not need to prove that part] [6]

(b) Establish the equivalent length equation in case of pipes in series connection. [3]

(c) Find out the value of the friction factor when the flow is transitional using equation provided in list of necessary equations list attached along with the question paper. [1]

(d) The following information's are given for the parallel pipe connection with three pipes shown in Fig:04 **[10]**
$L_1 = 0.9$ km, $d_1 = 300$ mm, $f_1 = 0.021$; $L_2 = 0.6$ km, $d_2 = 200$ mm, $f_2 = 0.018$; $L_3 =$ 1.2 km m, $d_3 = 400$ mm, $f_3 = 0.019$.
The head loss between A and B is 12 m. Determine the rate of the flow in Liters/sec.

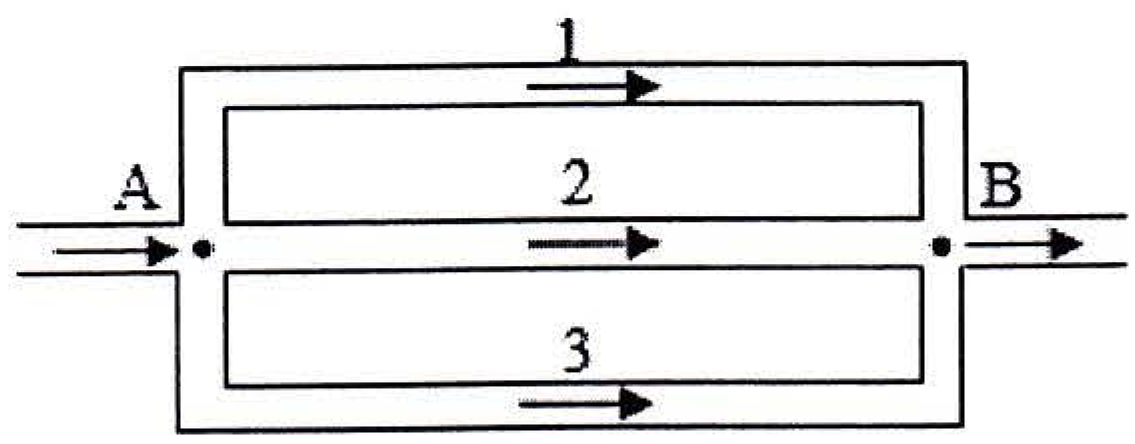


Figure: 04

7. (a) State and prove Bernoulli's Theorem. **[1+7]**
(b) Two tanks A and C are connected by a pipe 100 m. long shown in Fig: 05. The first 70 m has a diameter of 3 cm and then the pipe is suddenly reduced to 2 cm for the remaining 30 m. f= 0.005 and the coefficient of contraction at all sudden changes of area is 0.58. Find all the head losses including that at the sharp-edged pipe entry at A. Find the flow in m^3/s. Draw in Hydraulic Gradient diagram and Energy Gradient Diagram. **[12]**

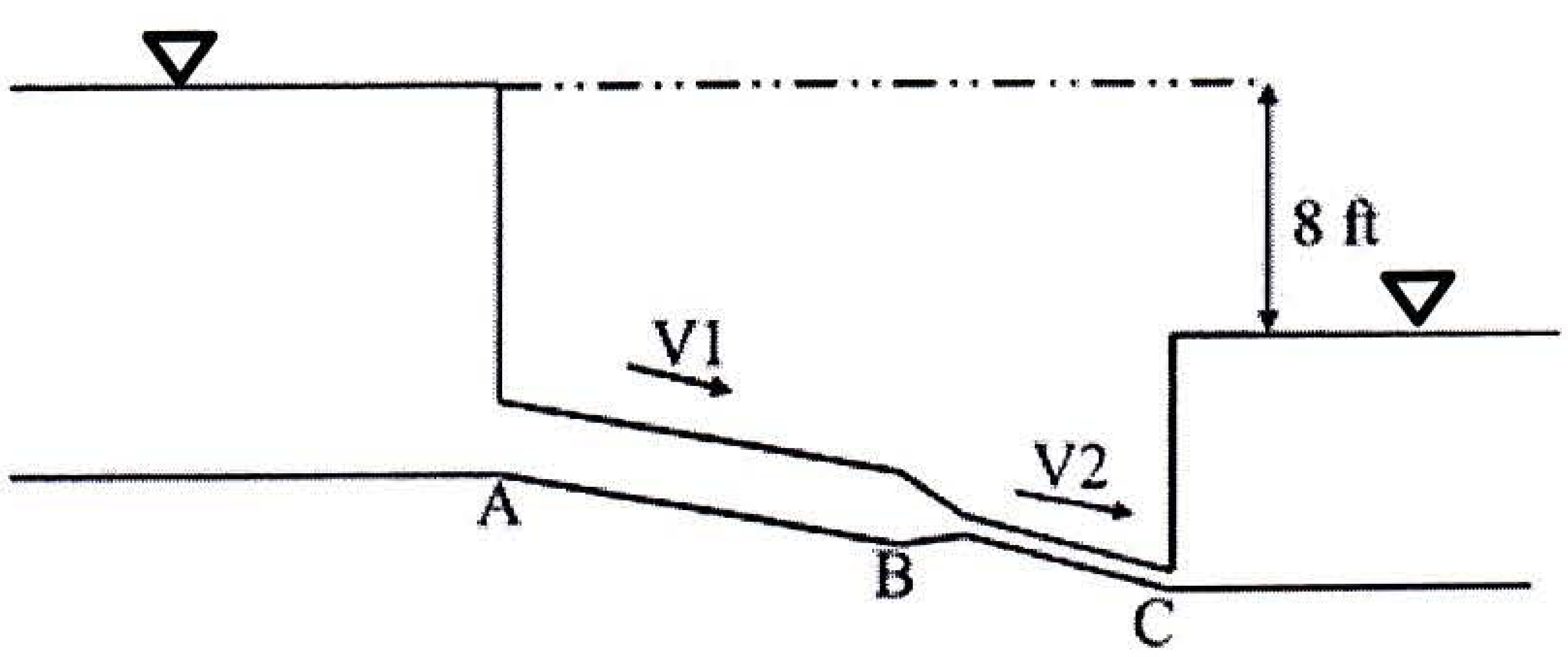


Figure: 05

8. (a) Write a short note on Critical Reynolds Number. [3]

(b) Find head loss in 250 m of 1.5m diameter smooth concrete pipe carrying 7.50 m^3/s of water at 10°C using Mannings formula.(Manning coefficient =0.013) [4]

(c) Two reservoirs with a difference in water surface elevation of 12 m are connected by a pipeline ABC which consists of two pipes AB and BC joined in series shown in Fig:06. Pipe AB is 30 cm in diameter and 45 m long. Pipe BC is 15 cm in diameter and 35m long. Find out the flow through the pipeline ABC. Neglect all the minor losses. Absolute roughness for the pipe AB is (e=2 mm) and absolute roughness for the pipe BC is (e=0.3mm). What difference in the reservoir elevation is necessary to have a discharge of 50 L/s in the pipeline? [Kinematic viscosity of water is given=$1*10^{-6}$ m^2/s at 20°C] [10+3]

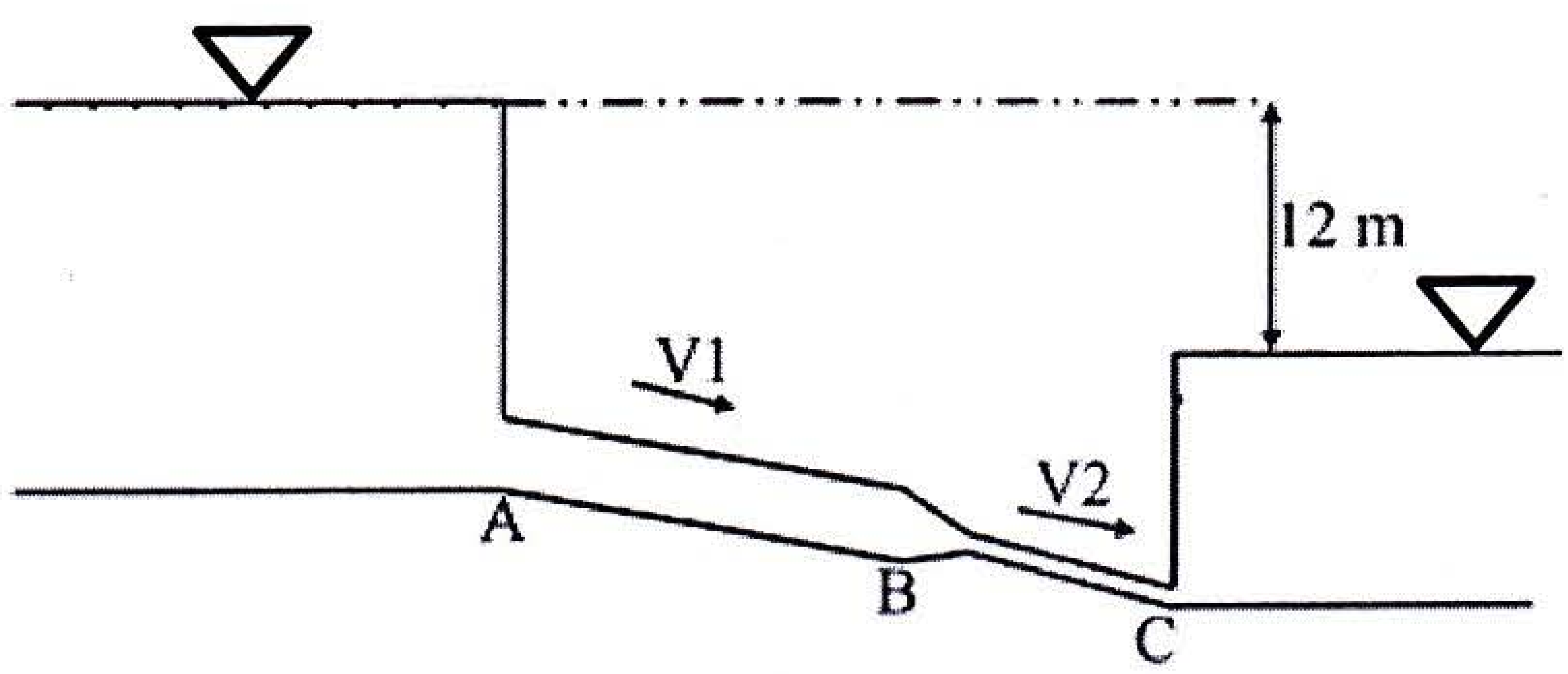


Figure: 06

List of Necessary equations

$$\frac{1}{\sqrt{f}} = -2\log\left(\frac{k}{3.7D} + \frac{2.51}{R_e\sqrt{f}}\right)$$

$$\frac{1}{\sqrt{f}} = 2\log\left(\frac{R_e\sqrt{f}}{2.51}\right)$$

$$\frac{1}{\sqrt{f}} = 2\log\left(3.7\frac{D}{k}\right)$$

$$Shear\ stress = c_f\left(\frac{\rho V^2}{2}\right)$$

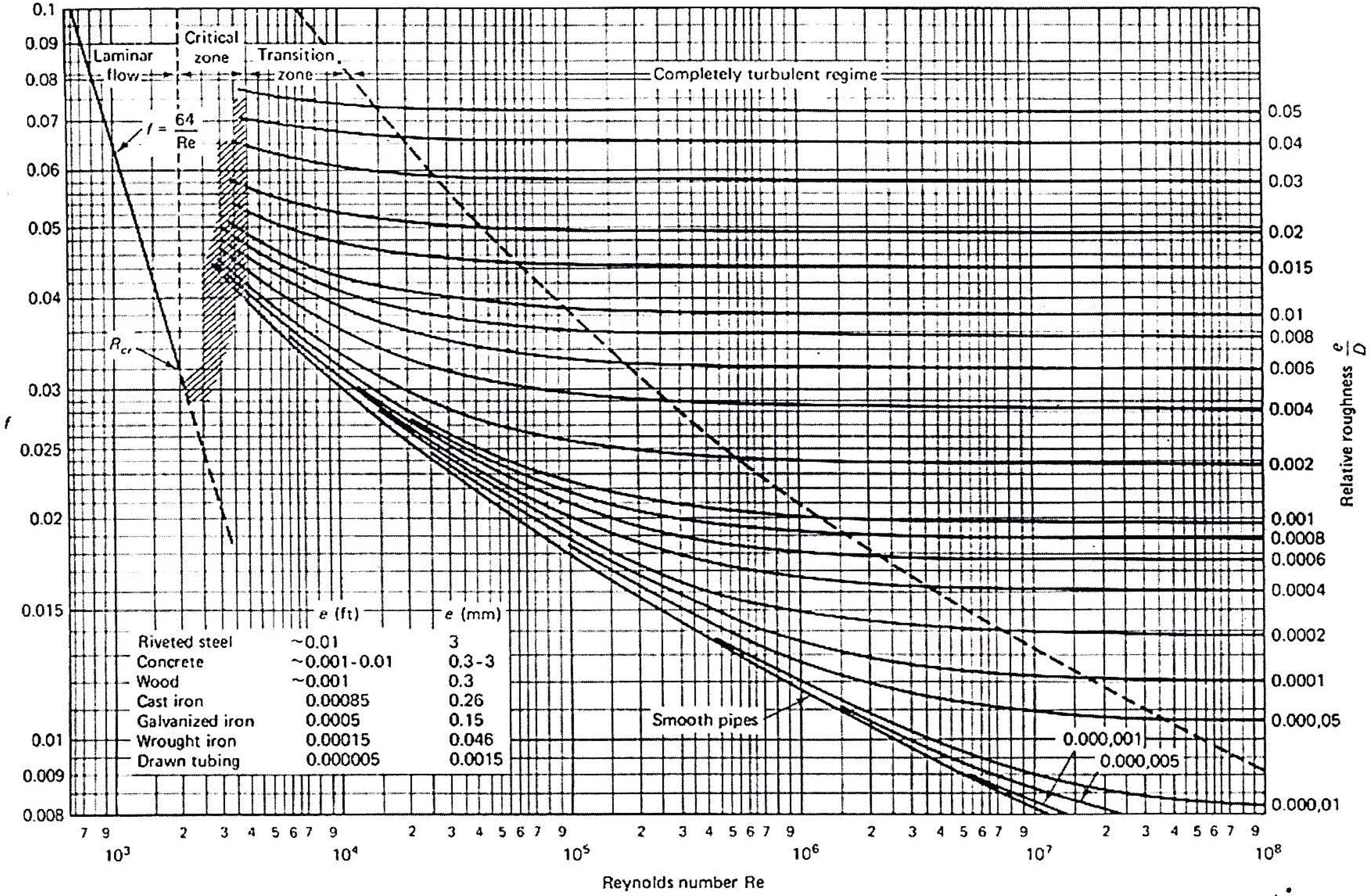


Figure 7.13 Moody diagram. (From L. F. Moody, *Trans. ASME*, Vol. 66, 1944.)