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University of Asia Pacific
Department of Basic Sciences and Humanities
Semester Final Examination, Fall 2022
Program: B.Sc. Engineering (Civil)

Course Title: Principles of Economics
Time: 2 hours | Credit Hour: 2.00 | Course Code: ECN 201
Full Marks: 100

There are **six** questions. Answer any **four including** Q-1 and Q-2. All questions are of equal value. Figures in the right margin indicate marks.

1. Explain the criteria of LDC graduation. In case of Bangladesh, describe the benefits, challenges and give some policy suggestions regarding LDC graduation. 25

2. a) $U = X_1^2 X_2^2$. Price of X_1 is 4 tk, price of X_2 is 8 tk and income is 100 tk. Calculate the optimal value of X_1, X_2 and maximum utility. 15

   b) Explain the properties of indifference curve. 10

3. $P = 100 - 5Q$

   $C = 10 + 4Q^2$

   a) Calculate equilibrium price and quantity in case of perfect competition market. 15

   b) Explain different methods of calculating GDP. 10

OR

4. $P = 500 - 5Q$

   $C = 100 + 5Q^2$

   a) Calculate equilibrium price and quantity in case of perfect competition market. 15

   b) Explain different types of unemployment. 10

5. Explain gravity model and the reasons behind its exception. 25

OR

6. Explain absolute advantage theory and comparative advantage theory. 25

University of Asia Pacific
Department of Basic Sciences and Humanities
Final Examination, Fall-2022
Program: B.Sc. Engineering (Civil)

Course Title: Mathematics IV — Credit Hours: 3 — Course Code: MTH 203

Time: 3 Hours — Full Marks: 150

There are **EIGHT** questions. Answer **SIX** including questions **1, 2, 3 and 4**. All questions are of equal value. Figures in the right margin indicate marks.

1. (a) Solve: $[D^4 + (m^2 + n^2)D^2 + m^2n^2]y = 0.$ 5

   (b) Solve: $(2D^3 - 3D^2 + 1)y = e^x + 1.$ 10

   (c) Solve: $(D^3 - 3D^2 + 4D - 2)y = e^x + cosx.$ 10

2. (a) The population of a country is known to increase at a rate proportional to the number of inhabitants. If the population has doubled in 30 years, how long will it take to triple? 10

   (b) A body cools from 370^0C to 340^0C in 15 minutes in air. Room temperature of the body is 300^0C. When will the temperature of the body be 310^0C? 15

3. Find the Fourier series of e^{-2x} ; $-\pi \leq x \leq \pi$. 25

4. (a) Find the Fourier sine transform of $F(x) = 2x; 0 < x < 4$. 10

   (b) Find the Fourier series of x^2 on the interval [-2, 2]. 15

5. (a) Define Laplace transformation. Prove that $L\{\cosh at\} = \frac{s}{s^2-a^2}$. 10

   (b) State and prove first translation or shifting property. 15
   Find the Laplace transformation of the function $e^{3t}(2\cos 5t - 3\sin 5t)$.

OR

6. (a) State and prove the change of scale property. 10

   (b) Solve any two of the followings: 15

   (i) $L\{t^2 \sin 2t\}$ (ii) $L\{te^{2t} \cos t\}$ (iii) $L\{t(\sin at + e^{at})\}$

7. (a) Find the inverse Laplace transform of the followings: 10

(i) $\frac{6s-4}{s^2-4s+20}$ (ii) $\frac{1}{s^3(s^2+4)}$

(b) Using partial fraction, solve any one from the following problems. 15

(i) $L^{-1}\left\{\frac{2s^2-6s+5}{s^3-6s^2+11s-6}\right\}$ (ii) $L^{-1}\left\{\frac{2s+1}{(s+2)^2(s-1)^2}\right\}$

OR

8. (a) Using Laplace and inverse Laplace transformation, Solve the differential equation $F'(t) + F(t) = e^t; (0) = c$. 10

(b) A particle P of mass 2gm moves on X-axis and attracted toward origin O with a force numerically equal to 8. If it is initially at rest then $x = 10$. Find its position at any subsequent time assuming (i) no other force act, (ii) a damping force equal to 8 times the instantaneous velocity acts. 15

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2022
Program: B. Sc. Engineering (Civil)

Course: CE 203 | Course Title: Engineering Geology & Geomorphology
Full Marks: 120 | Credit Hours: 3.0 | Time: 3.0 hours

Answer all questions

1. (a) Discuss igneous rock. Giving examples distinguish between sedimentary and metamorphic rock. [5+6 =11]

   (b) Show two examples of metamorphic rocks that are generated from sedimentary rocks due to metamorphism. [3]

   (c) Define weathering and erosion. Mention (no description required) a few major physical and chemical weathering processes. [3+3 =6]

2. (a) Mention different geomorphic processes (no description required) based on origin. [3]

   (b) Draw neat sketch of a typical fold geometry showing its major elements. [4]

   (c) With the aid of neat sketches, discuss in short, two types of folds. [6]

   (d) Compare reverse and oblique faults with the aid of neat sketches. [7]

3. Briefly discuss, mention or draw sketches, as asked for, on **any four** of the following topics: - [5×4 = 20]

   (i) Classification of minerals with examples

   (ii) A few physical properties of minerals and distinction between Ferro-Magnesian and Non-Ferro-Magnesian Silicates.

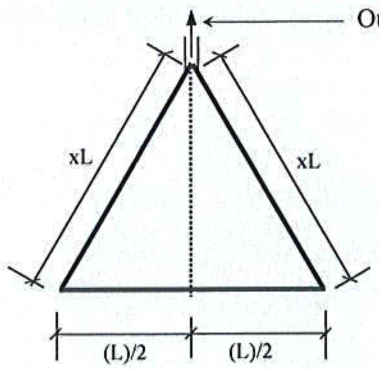
   (iii) Liquefaction

   (iv) Major earthquake parameters (geometric) with neat sketches

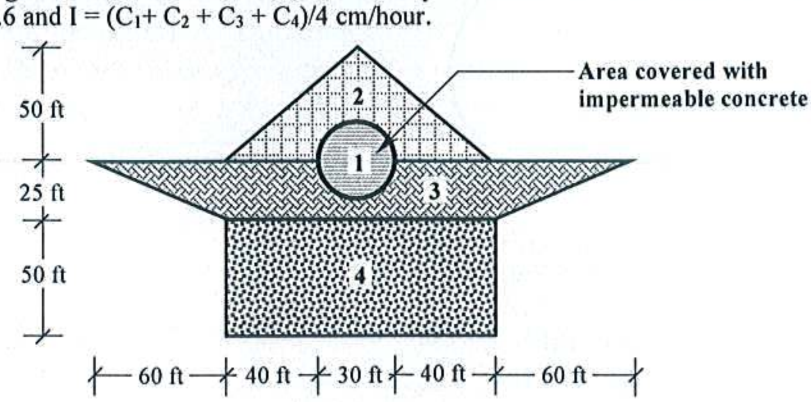
   (v) Modified Mercalli intensity scales of earthquake (VIII to XII)

4. (a) Mention the major factors affecting runoff. No description is required. [5]

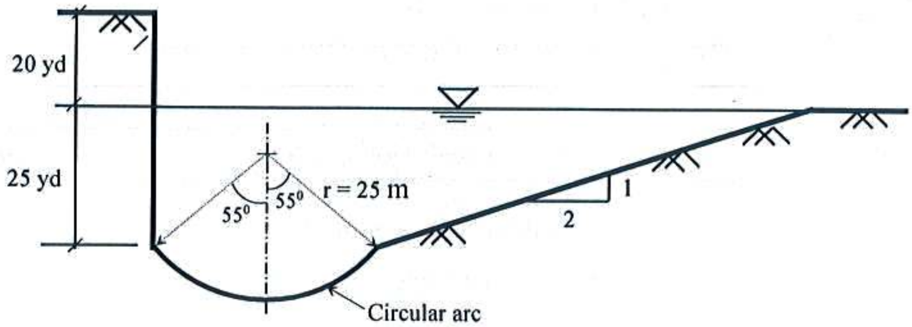
   (b) For the following basin, determine x (a constant factor) for maximum (peak) flow rate. Also, compute the FF and CC of the basin for maximum runoff. [11]



   (c) For the drainage area as shown below, calculate peak runoff in m^3/s. Use $C_2 = 0.7$, $C_3 = 0.4$ and $C_4 = 0.6$ and $I = (C_1 + C_2 + C_3 + C_4)/4$ cm/hour. [9]

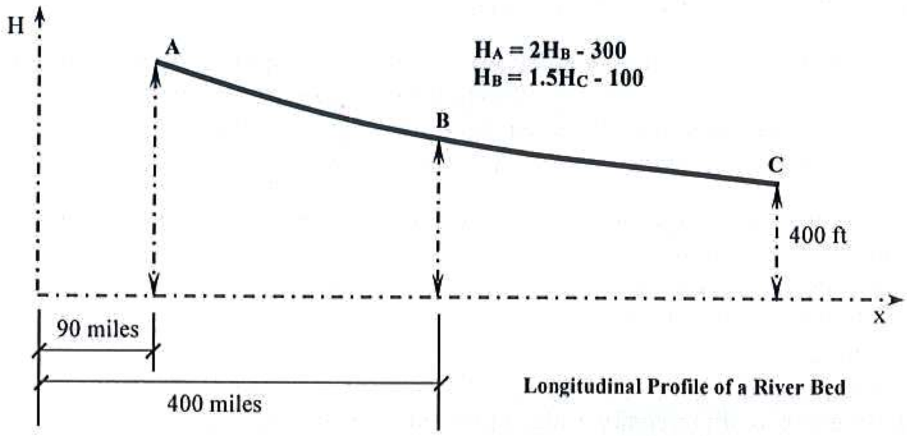


5. (a) Cross-sectional profile of a channel section is shown below. The gradient of the channels bed is 6.33×10^{-4}. Calculate the traction pressure developed along the channel. [10]

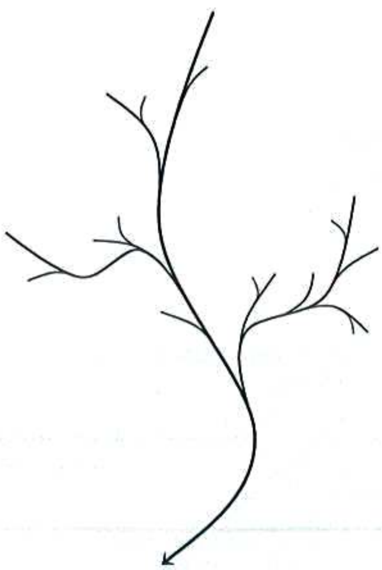


X-Sectional Profile of Channel

(b) From the following figure, calculate the horizontal distance between locations B and C. [5]



6. (a) Mention factors affecting drainage pattern. Also, mention different types of patterns. [3 + 2 = 5]
(b) Draw a neat sketch of a typical valley. Mention the ways valleys are widened. [2 + 4 = 6]
(c) Rank the streams of the following drainage basin having a total catchment area of 4,000 square miles. The results of the survey are summarized in the table below. [9]



Steam Rank	Average Length (km)
1	6.0
2	17.1
3	42.9
4	96.7

Calculate the following parameters:
(i) Average Bifurcation Ratio (ABR)
(ii) Average Length Ratio (ALR)
(iii) Stream Frequency (SF)
(iv) Drainage Density (DD)

University of Asia Pacific
Department of Civil Engineering
Final Examination, Fall 2022
Program: B.Sc. Engineering (Civil)

Course Title: Numerical Analysis and Computer Programming — Course Code: CE 205
Time: 3 hour — Credit Hour: 3.00 — Full Marks: 100

(Answer ALL the questions)

1. In environmental engineering, the equation used to compute the oxygen level C (in mg/L) in a river downstream from a sewage discharge is expressed by

$$C = 10\text{-}20(e^{-0.15x} - e^{-0.5x})$$

Where x is the distance downstream in kilometers. Now, use Secant Method to calculate the distance x where the concentration of oxygen level C falls to a reading of 0 mg/L. As an initial guess, assume that your solution lies within x=1 km and x=2 km. Perform 4 iterations to find the solution. **[10]**

2. Analyze the data provided in the following table, and determine the discharge (Q) when time (t) is 25s. Use Lagrange interpolating polynomial formula.

Time, t (s)	0	15	20	40	55
Discharge Q (m^3/s)	0	2.5	4	6.5	7

[10]

3. Following database is obtained for a cyclist participating in a cycling marathon. Now, determine a parabolic equation of the form $y=a+bx+cx^2$ by analyzing the following data. Also, calculate velocity of the cyclist at t=15s.

Time (s)	1	7	13	19
Velocity (m/s)	0.5	2.7	3.6	6

[9+1]

4. Following is a differential equation:

$$\frac{dy}{dx} - y^2 = x; \qquad \text{where } y(0)=1$$

a) Solve the equation using Euler's method to get y (0.4) [Use step size h=0.1] **[10]**

b) Solve the equation using Second Order Runge kutta method to get y (0.4) [Use step size h=0.2] **[10]**

c) Compare the results to state which one is the more efficient method. **[3]**

5. For the cantilever beam, calculate the upward reaction force (for **one-third** of the span starting from the left) using the following equation: $\mathbf{y = 3x^2 + 2e^x + 5}$, where, x is the distance from the left and y is the reaction (shown in Fig. 1). Use the following methods:

a) Using Simpson's rule with 6 panels. **[10]**

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

c) Compare the results to state which one gives a more accurate result. **[3]**

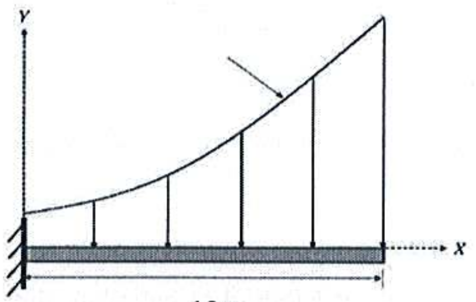


Fig. 1

Table 1: Gauss points and weight factors for integration.

n	x_i	w_i
4	X_1= +0.86114	0.34785
	X_2= +0.33998	0.65215
	X_3= -0.33998	0.65215
	X_4= -0.86114	0.34785

6. Create a program using C++ coding language that will display the cube of the number upto a given integer ($1^3+2^3+3^3+\ldots\ldots+n^3$). **[10]**

7. Suppose, you are the owner of the construction company "Court of Owls". You want to track the weekly payable bill for your ongoing projects. You have total 4 ongoing projects. You hire construction laborers on weekly basis and distribute them to 4 projects. Each labor works at the rate of 130tk/hr. If the weekly payable bills of all the workers exceed 1,50,000 tk, then only 75% of the total payable amounts are given to the workers. The rest will be paid the next week. Now, create a code using C++ language that will show the total amount of bill payable by you on a certain week. Assume each labor works for 8hr/day and 5 days/week. **[14]**

Relevant Formulae:

$$x_{n+1} = x_n - f(x_n)\left[\frac{x_n - x_{n-1}}{f(x_n) - f(x_{n-1})}\right]$$

$$\sum y = na + b\sum x + c\sum x^2$$

$$\sum xy = a\sum x + b\sum x^2 + c\sum x^3$$

$$\sum x^2 y = a\sum x^2 + b\sum x^3 + c\sum x^4$$

Department of Civil Engineering
Final Examination Fall 2022
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. Given: R_0 = Last three digits of Registration #]

1. Calculate the equivalent polar moments of inertia (J_{eq}) for the cross-sections shown in Figs. 1(a)~(c) by centerline dimensions

   [Given: $x = (1 + 0.01R_0)'$, Wall thickness = 0.10′].

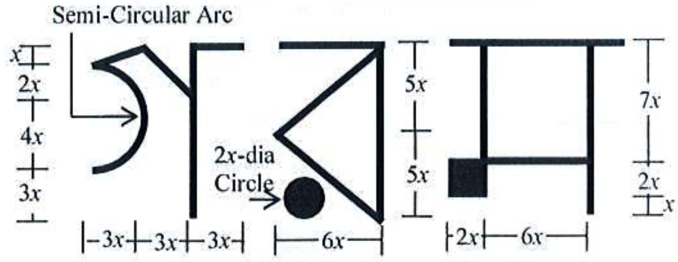


Fig. 1(a) Fig. 1(b) Fig. 1(c)

2. Fig. 2(a) shows a monkey drinking water from a bottle [of total weight W], while Fig. 2(b) shows a schematic view of forces acting on its left hand.

   At the center of section B (a 0.5″-dia circle) for forehand AB of the hand ABC

   (i) Calculate the axial stress and shear stress

   (ii) Show the stresses in Mohr's circle of stresses

   [Given: $W = (1 + 0.01R_0)$ lb,

   $x_1 = y_1 = (7 + 0.02R_0)''$, $z_1 = 0.5x_1$].

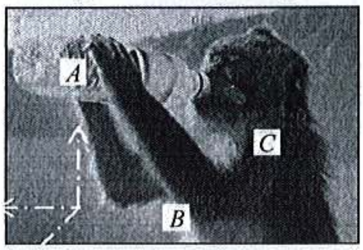


Fig. 2(a)

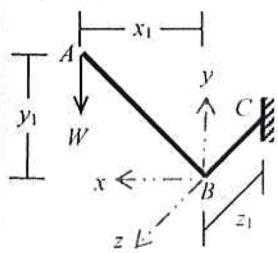


Fig. 2(b)

3. In member BC of the monkey's hand ABC [Fig. 2(b)] loaded as described in Question 2, calculate the

   (i) Maximum bending stress and torsional shear stress (on the 0.5″-dia circle)

   (ii) Principal stresses (σ_1, σ_2)

   (iii) Yield Strength (Y) required to avoid yielding (according to Tresca yield criteria).

4. Fig. 3 shows a cantilever hand-fan ABC fixed at base C. It is subjected to wind pressure perpendicular to the surface, approximated by a distributed wind-force f_0 = 100 lb/ft (acting at O) over the length AB.

   If $D_0 = (6 + 0.02R_0)''$, calculate the maximum torsional rotation of the fan if its handle is made of circular sections AB (diameter = 0.20″) and BC (diameter = 0.30″), with G = 1000 ksi.

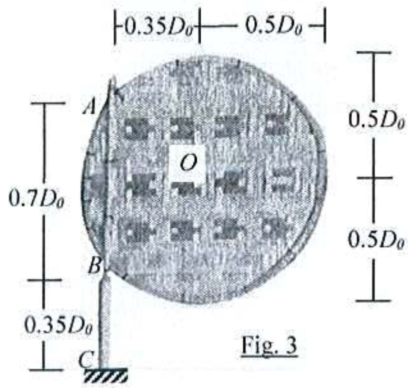


Fig. 3

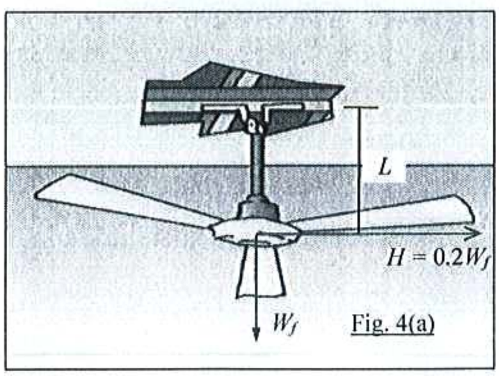


Fig. 4(a)

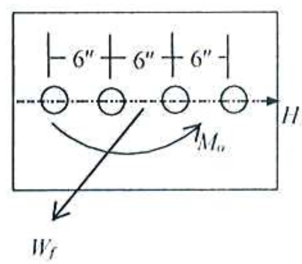


Fig. 4(b)

5. Fig. 4(a) shows the forces (weight $W_f = (70 + 0.1R_0)$ lb and centrifugal force $H = 0.2W_f$) acting on a ceiling fan of length $L = (20 + 0.1R_0)''$. Fig. 4(b) shows its support arrangement consisting of four bolts (each of 0.25″-dia) subjected to normal force W_f, shear force H and overturning moment M_o (= $H \times L$). Calculate the resulting maximum normal stress and shear stress in the bolts.

6. Fig. 5 shows a baby tiger [weighing $w_0 = (30 + 0.1R_0)$ lb/ft] licking an ice-cream cake [which weighs $W_1 = (10 + R_0/20)$ lb] on the beam *abcd.*

Use *Singularity Functions* to calculate

(i) The value of *EI* to make *b* deflect 0.10″ vertically

(ii) Rotation at *a*, for the *EI* calculated in (i).

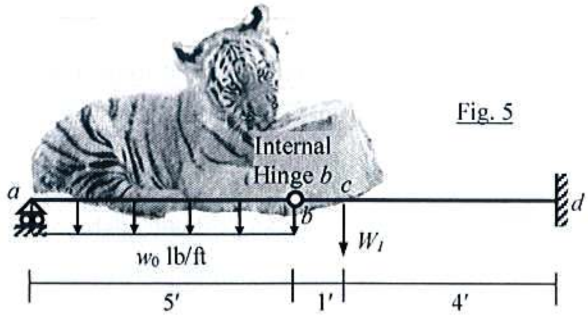


Fig. 5

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

8. Fig. 6(a) shows a two-span beam deflected by the extension (due to fire) of its middle column.

Fig. 6(b) is a simplified model of the beam *abc*, weighing $w_0 = (1 + 0.01R_0)$ k/ft, undergoing settlement of 1-ft of the support *b*.

Given $L_0 = (20 + 0.1R_0)$ ft and $EI = (20 + 0.1R_0)$ k-ft², use *Singularity Functions* to calculate the

(i) Reaction at support *a*

(ii) Rotation at support *a*.

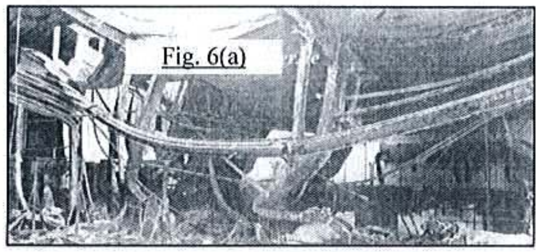


Fig. 6(a)

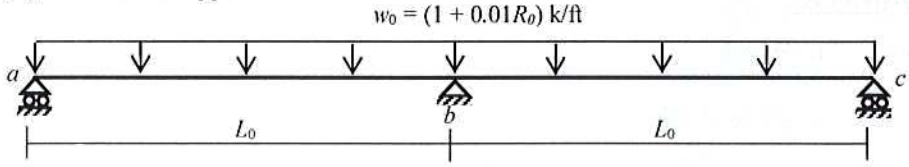


Fig. 6(b)

9. Answer Question 8 using the *Moment-Area Theorems.*

10. (i) The following equation represents deflected shape of beam of length L [$= (10 + 0.1R_0)$ ft].

$EI\, v(x) = D(x) = -\langle x - L/2\rangle^3 + 0.25\, x^4/L + C_3\, x + C_4$

- Calculate the deflection and slope at $x = 0$, $L/2$ and L
- Draw the qualitative deflected shape of the beam

(ii) (a) Explain why the ψ factor is taken as infinity (∞) at hinged end and zero at fixed end.

(b) Use Salama (2014) to calculate the effective length factor (k) of a cantilever column.

11. Fig. 7(a) shows a steel railway-line buckled (due to thermal expansion at high temperature) while Fig. 7(b) shows its cross-section.

Given: Length $L_0 = (2 + 0.01R_0)$ m, Modulus of elasticity $E = 210$ GPa, calculate the

(i) Axial Force (P) required to deflect the line $\Delta_0 = 0.6L_0$, if its initial imperfection was $\Delta_i = \Delta_0/10$

(ii) Eccentricity (e) required to deflect the line the same amount (Δ_0) due to the same axial force (P).

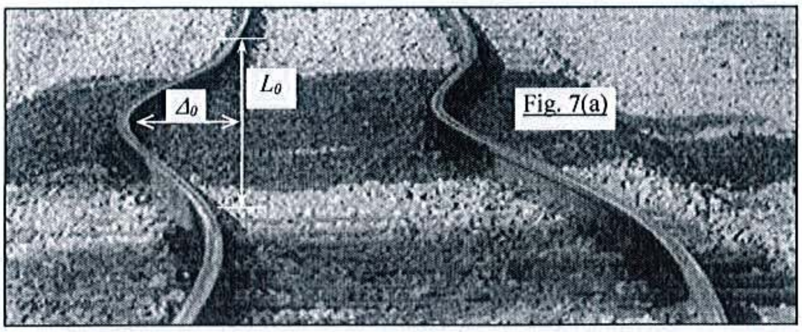


Fig. 7(a)

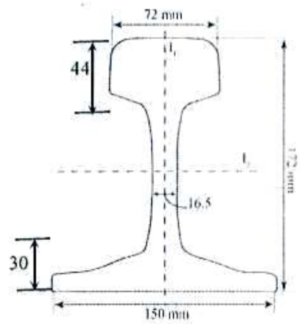


Fig. 7(b)

12. Calculate the allowable compressive force P for the railway-line (shown in Fig. 7(a), 7(b) and described in Question 11) if it is made of steel with stress-strain relationship

$\sigma = 1500(\varepsilon)^{0.5}$, where σ is the compressive stress (MPa) and ε is strain.

13. Use the AISC-ASD method to calculate the allowable compressive force P for the railway-line shown in Fig. 7(a), 7(b) and described in Question 11; given $f_y = (250 + 0.5R_0)$ MPa.

14. The air-conditioner [shown in Fig. 8(a)] weighs $W = (400 + R_0)$ N, whose support condition is approximated by Fig. 8(b).

Calculate the

(i) Axial Force in the beam *abc*.

(ii) Euler buckling force of the simply supported beam *abc* for it to have a *Moment Magnification Factor* (*MMF*) equal to 1.20 (using the AISC equation) and corresponding value of I_{min}

[Given: $E = 200$ GPa].

(iii) *MMF* if *abc* catches fire and its *E* decreases to 40 GPa.

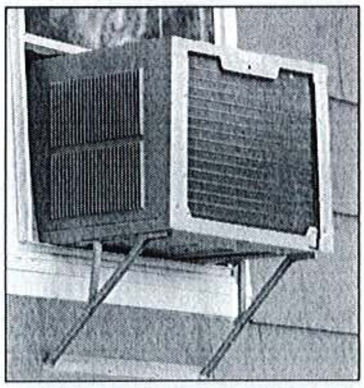


Fig. 8(a)

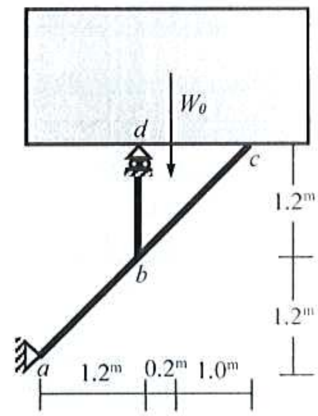


Fig. 8(b)

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

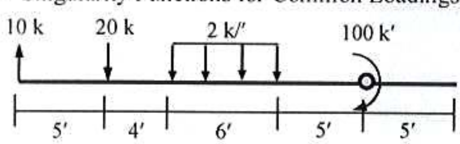
Section	Torsional Shear Stress	J_{eq}
Circular	$\tau = Tc/J$	$\pi d^4/32$
Thin-walled	$\tau = T/(2\textcircled{A}\, t)$	$4\textcircled{A}^2/(\oint ds/t)$
Rectangular	$\tau = T/(\alpha b t^2)$	$\beta b t^3$

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



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

* 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 $= 1/(1 - P/P_{cr})$

University of Asia Pacific
Department of Civil Engineering
Final Examination, Fall 2022
B.Sc. Engineering (Civil)

Course Title: Fluid Mechanics **Credit Hour: 03** **Course Code: CE 221**
Time: 3 hours **Full Marks: 100**

<u>There are 3 questions. Please answer them accordingly.</u>
[Assume reasonable data if and when needed]

1.	**a)**	Explain why and how a jet entering a system acts on the system in the direction in which the jet is traveling and vice versa.	**6**
	b)	What is viscous sub-layer? How do we define hydraulically smooth and rough surface in fluid mechanics?	**6**
	c)	Write down the General Energy Equation for Steady Flow and briefly explain each term in the equation.	**5**
	d)	Briefly discuss and mathematically express Reynolds and Froude using similitude analysis.	**8**
2.	**a)**	Prove that the shear stress linearly increases from the center to the wall and velocity profile follows a parabolic function in a circular pipe. Consequently, derive the Hagen Poiseulle Law for a circular pipe.	**15**
	b)	Derive an expression for drag force exerted on a moving sphere through a viscous liquid using dimensional analysis.	**10**
3	**a)**	A pipeline with a pump leads to a nozzle as shown in **Figure 1**. Find the flow rate when pump at B develops a head of 25m. The the head loss in pipe 1 and pipe 2 can be expressed by $\mathbf{h_{L1} = 5V_1^2/2g}$ and $\mathbf{h_{L2} = 15V_2^2/2g}$, respectively. Draw the hydraulic grade and energy line.	**10**
	b)	In **Figure 2**, the pipes A, B and C are 600m of 15 cm diameter, 480m of 10 cm diameter and 1200m of 20cm diameter, respectively. Find the flow rate at each pipes and the pressure at point P. The friction factors (f) in pipes A, B and C are 0.020, 0.032 and 0.024, respectively.	**10**
	c)	Water at 20°C flows in a 60cm diameter commercial steel pipe. If the energy gradient is 0.006, determine the flow rate. Also, find the nominal thickness of the viscous sublayer and flow zone.	**10**
	d)	A 6cm diameter water jet with a velocity of 36m/s impinges on one of a series of blade of the Pelton Wheel. The blade and wheel are moving at a velocity of 18m/s. $\beta = 150$ and relative velocity, $V2 = 0.9V1$ due to friction loss. Compute (a) the force exerted by the water on the vane and (b) loss of power due to friction.	**10**
	e)	Find the most reasonable flow distribution within the pipe network given in **Figure 3**. Assume convenient n values for simple analysis.	**10**

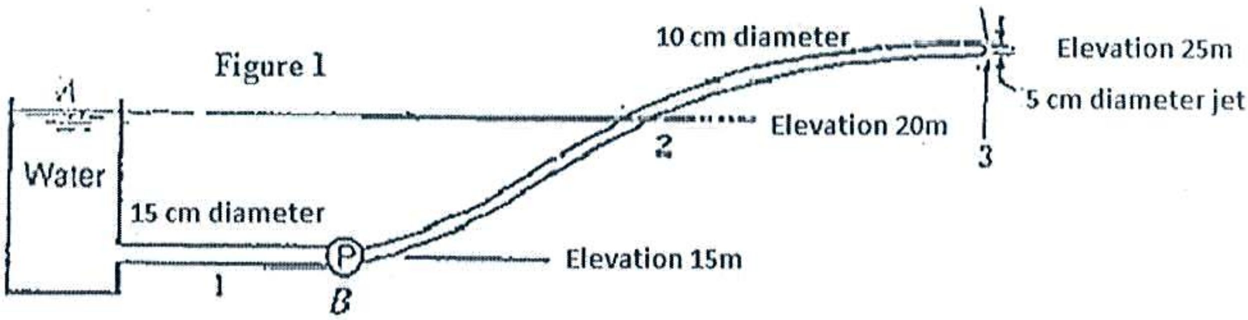


Figure 2

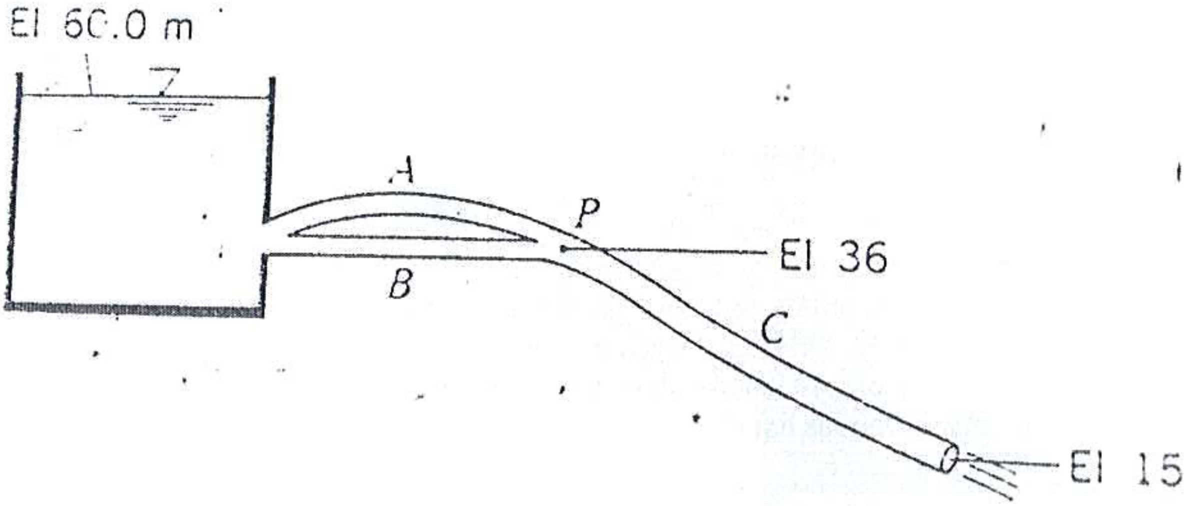


Figure 3