University of Asia Pacific
Department of Civil Engineering
Mid Semester Examination Fall 2022 (Set 1)

Course #: CE 213 | Course Title: Mechanics of Solids II

Full Marks: 40 (= 4 × 10) | Time: 1 hour

Given R_0 = Last three digits of Registration #

1. Calculate equivalent polar moments of inertia (J_{eq}) of the cross-section shown in Fig. 1 by centerline dimensions

   [Given: $x = (1 + 0.002R_0)$ ft
   Wall thickness = 0.10 ft throughout].

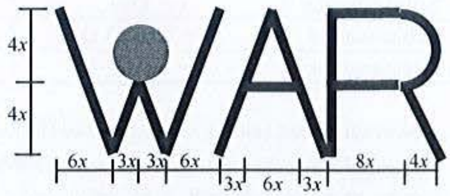


Fig. 1

2. Fig. 2(a) shows a freedom fighter using sten gun in the liberation war of 1971, while Fig. 2(b) shows a schematic view of forces acting on his left hand.

   At the center of section b (left of support) of his hand abc (whose cross-section is a 0.02^m-dia circle)

   (i) Calculate the normal stress and shear stress

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

   [Given: $W = (15 + 0.05R_0)$ N, $H = 10W$,
   $L_1 = (0.3 + 0.001R_0)^m$, $h_1 = 0.35L_1$].

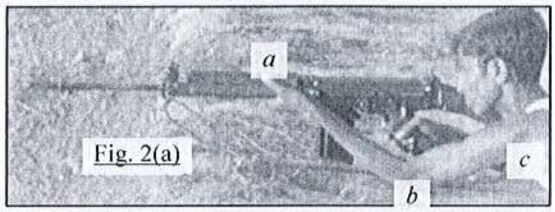


Fig. 2(a)

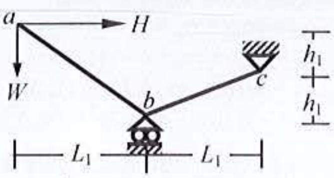


Fig. 2(b)

3. Fig. 3(a) shows the National Martyrs' Memorial in Savar, whose seven pairs of walls represent seven significant chapters of our independence struggle. Fig. 3(b) shows cross-section of the 50-m high final (and innermost) pair of walls.

   If it is subjected to horizontal force F (= 5000 + 20R_0) kN, as shown in Fig. 3(b), calculate the

   (i) Maximum combined normal stress (for biaxial bending)

   (ii) Principal stresses (σ_1, σ_2) (assuming τ_{xy} = Average shear stress)

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

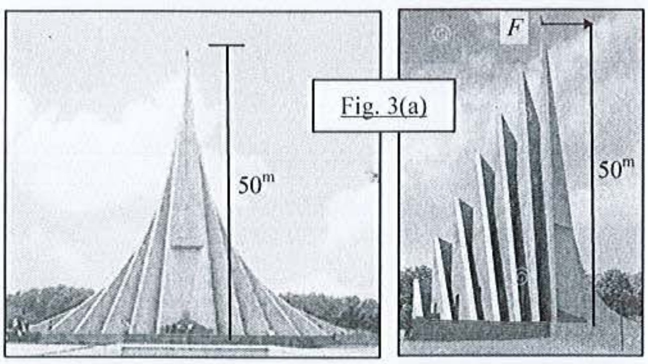


Fig. 3(a)

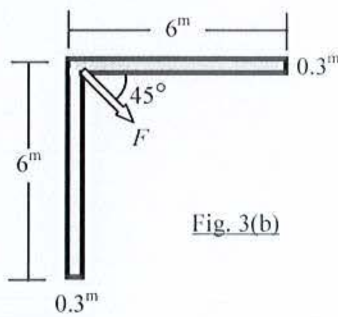


Fig. 3(b)

4. In Fig. 4, ABCDEF represents a ($20x \times 12x$) [where $x = (1 + 0.002R_0)$ ft] 'green' and 'red' flag used during the liberation war of 1971.

   It is supported on six identical helical springs (with shear modulus = 12000 ksi, coil diameter = 1″, mean radius = 6″, number of coils = 5) at A, B, C, D, E and F.

   If the 'green' (outer) area weighs 5 lb/ft² and 'red' (inner) area weighs 10 lb/ft², calculate (for the Spring A) the

   (i) Force

   (ii) Deflection and maximum shear stress.

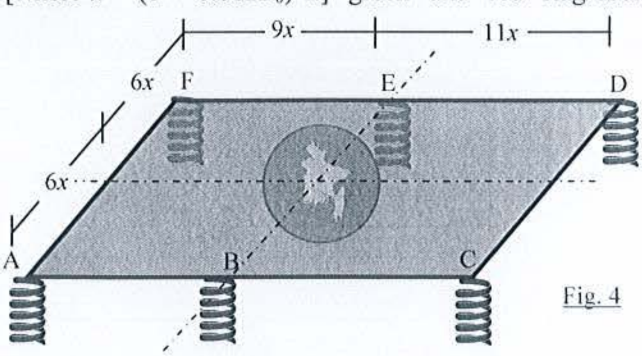


Fig. 4

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}
Solid Circular	$\tau = Tc/J$	$\pi d^4/32$
Thin-walled	$\tau = T/(2Ⓐ t)$	$4Ⓐ^2/(\int ds/t)$
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

* Normal Stress (along x-axis) due to Biaxial Bending (about y- and z-axis): $\sigma_x(y, z) = M_z\, y/I_z + M_y\, z/I_y$

* Normal Stress (along x-axis) due to Combined Axial Force (along x-axis) and Biaxial Bending (about y- and z-axis): $\sigma_x(y, z) = P/A + M_z\, y/I_z + M_y\, z/I_y$

* 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 of Stresses: Center (a, 0) = $[(\sigma_{xx} + \sigma_{yy})/2,\ 0]$ and radius $R = \sqrt{[\{(\sigma_{xx} - \sigma_{yy})/2\}^2 + (\tau_{xy})^2]}$

* To avoid Yielding
  Maximum Normal Stress Theory (Rankine): $|\sigma_1| < Y$ and $|\sigma_2| < Y$.
  Maximum Normal Strain Theory (St. Venant): $|\sigma_1 - \nu\sigma_2| < Y$ and $|\sigma_2 - \nu\sigma_1| < Y$.
  Maximum Shear Stress Theory (Tresca): $|\sigma_1 - \sigma_2| < Y$ and $|\sigma_1| < Y$ and $|\sigma_2| < Y$
  Maximum Distortion-Energy Theory (Von Mises): $(\sigma_1^2 + \sigma_2^2 - \sigma_1\sigma_2) < Y^2$

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

Course Title: Numerical Analysis and Computer Programming — Course Code: CE 205
Time: 1 hour — Credit Hour: 3.00 — Full Marks: 40

(There are 5 questions. Answer ALL of them.

Assume any reasonable value for missing data.)

1. The volume of a pentagonal prism is expressed by the equation.

$$V=\frac{1}{4}\sqrt{5(5+2\sqrt{5})}\,a^2h$$

Where, volume 'V'= 50m^3 and height 'h'=5m. Solve the equation for base edge 'a' between the interval [2,3] using Regula Falsi method, which is correct upto 3 decimal places. [10]

2. Solve the following equations using Gauss Elimination method.

$$2x+2y+4z = 18$$
$$x+3y+2z = 13$$
$$3x+y+3z = 14$$

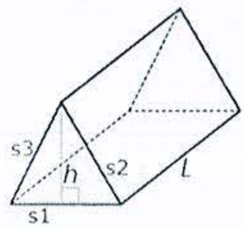
[10]

3. Determine numerically $\int_{0.1}^{1.3} 5xe^{-2x}dx$ using the Gauss Quadrature method with 4 points or n=4. [10]

Table 1: Gauss points and weight factors for integration

n	x_i	w_i
1	$x_1 = 0.0$	2.0
2	$x_1 = +0.5773502692$	1.0
	$x_2 = -0.5773502692$	1.0
3	$x_1 = +0.7745966692$	0.5555555556
	$x_2 = 0.0$	0.8888888889
	$x_3 = -0.7745966692$	0.5555555556
4	$x_1 = +0.8611363116$	0.3478548451
	$x_2 = +0.3399810436$	0.6521451549
	$x_3 = -0.3399810436$	0.6521451549
	$x_4 = -0.8611363116$	0.3478548451

4.



A triangular prism has the following dimensions:
3 sides s1, s2, and s3; base height h and length L;
Now, create a code using C++ language that will return true if the sum of the sides is greater than both base height h and length L; it will return false if the sum of the sides is greater than either base height h and length L; Otherwise, it will return undetermined. [5]

5. Suppose, you are the owner of a construction company. You want to create a code for the laborer hiring purpose of a recent multistoried apartment construction project.
Given, the carrying rate of different components is as follows:
Stone chips: 1 laborer/10000kg; Sand: 1 laborer/20000kg; Cement: 1 laborer/200bag;
Now, create a code using C++ that will show the number of laborers needed on a particular day for the variable amount of stone chips, sand and cement carrying purpose. Also show the amount of bill payable each day for the hired laborers (laborer hiring cost is 800tk/day/laborer). [5]

University of Asia Pacific
Department of Civil Engineering
Midterm Examination Fall – 2022
B.Sc. in Civil Engineering

Course Title: Fluid Mechanics | Course Code: CE 221
Time: 1 hour | Credit Hour: 03 | Full Marks: 60

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

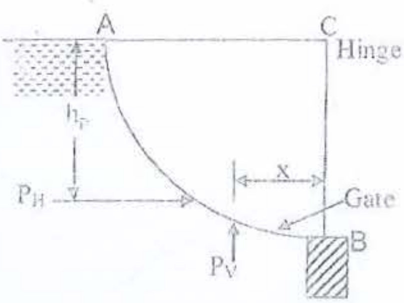
1. a) Define and mathematically explain convective acceleration and local acceleration in steady and unsteady fluid flow. 5

   b) Define different flow types for the following criterion (a) viscosity and velocity; (b) time; (c) space; (d) density (e) friction 10

2. a) Derive how pressure varies in only one direction in static fluid. 15

3. a) A fluid has a dynamic viscosity of 0.5 poise. Calculate the velocity gradient and the intensity of shear stress at the boundary. The fluid is filled between two parallel plates 5.0cm apart, and one plate is moving at a velocity of 1m/s while the other plate is stationary. The distribution of velocity is, $U = 100 - k(5-y)^2$. 8

   b) Find the total pressure force acting on the gate per meter length in the figure. The gate is a quadrant of a circle of radius 2m. Also, find out the angle of the total forcing with the horizontal and Prove that the resultant force passes through the hinge C. 15



   (c) King Hiero ordered a new crown to be made from pure gold. When he received the crown, he suspected that other metals had been used in its construction. Archimedes discovered that the crown required a force of 4.7 lb to suspend it when immersed in water, and that it displaced 18.9 in^3 of water. He concluded that the crown was not pure gold. Do you agree? Mathematically explain. 7

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

Course Title: Engineering Geology & Geomorphology — Course Code: CE 203

Time: 1 hour — Credit Hour: 3:00 — Full Marks: 40

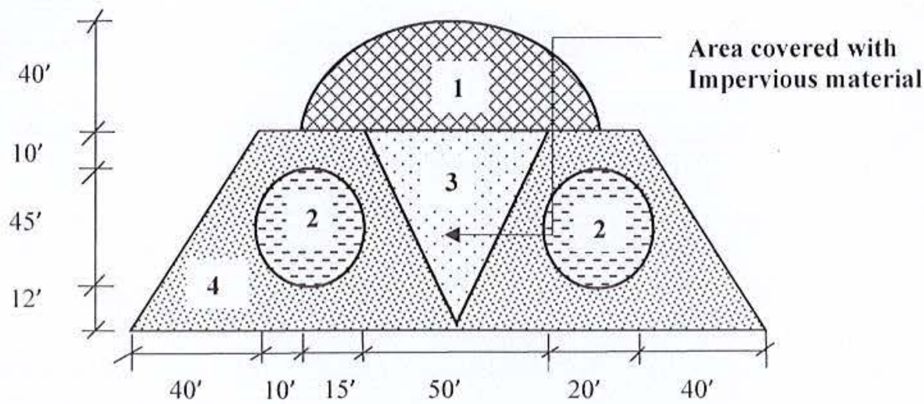
ANSWER TO ALL THE QUESTIONS

1. a) Define Metamorphism process. Explain the rock cycle with schematic diagram (no description is required) 1+5=6

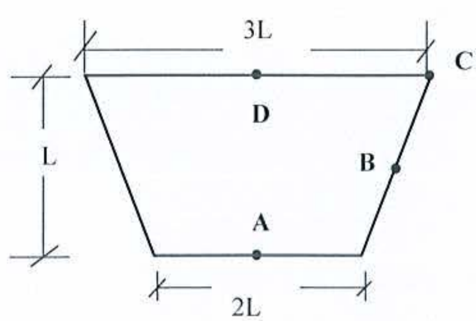
   b) Define geomorphic agent and give at least two examples of geomorphic agent. 1+2=3

   c) Explain the following mechanical disintegration processes: (i) wedging action of ice and (ii) spreading of roots of plants. 1.5+1.5=3

2. For the drainage area as shown below, calculate peak runoff in m^3/s. Use $C_1 = 0.8$, $C_2 = 0.5$ and $C_4 = 0.7$ and $I = (C_1 + C_2 + C_3 + C_4)/3$ cm/hour. 10



3. For the cases of the following basin, identify the ones for maximum and minimum runoffs. Justify your answer.
   Case 1: Outlet is at A
   Case 2: Outlet is at B
   Case 3: Outlet is at C
   Case 4: Outlet is at D.
   A, B, and D are the midpoints of the respective side of the trapezium. 8



4. a) Explain diastrophism. 1

b) Classify folding based on geometry (no description is required) and draw neat sketches of any two of them. 2+3=5

c) Distingush between normal fault and reverse fault with neat sketches. 4

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

Course Title: Mathematics-IV		Course Code: MTH 203
Credit: 3.00	Time: 1.00 Hour	Full Marks: 60

There are FOUR (4) questions. Answer THREE (3) questions including Q1 and Q2. Figures given in the right margin indicate the marks of the respective questions.

1. (a) Transfer the following function to an ordinary differential equation by elimination of function $y = c(c-x)^2$. Where c is constant. **10**

   (b) Solve the linear differential equation $x^4 \frac{dy}{dx} + 2x^3 y = 1$. **10**

2. (a) Using variable separation solve $x(e^y + 4)dx + e^{x+y}dy = 0$. **10**

   (b) Solve the differential equation by variable separation with substitution method $\frac{dy}{dx} = (x+y)^2$. **10**

3. (a) Solve the homogeneous differential equation $y^2 + x^2 \frac{dy}{dx} = xy \frac{dy}{dx}$. **10**

   (b) Prove that the following differential equation is exact and solve it. **10**

$$xdx + ydy = \frac{xdy - ydx}{x^2 + y^2}.$$

OR

4. (a) Is the differential equation exact or not? If it is not exact then solve it by using METHOD-III $(y + \frac{1}{3}y^3 + \frac{1}{2}x^2)dx + \frac{1}{4}(x + xy^2)dy = 0$. **10**

   (b) Is the differential equation exact or not? If it is not exact then solve it by using METHOD-II $y(1+xy)dx + x(1-xy)dy = 0$. **10**

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

Course Title: Principles of Economics | Course Code: ECN 201
Time: 1 hour | Credit Hour: 2.00 | Full Marks: 40

There are **three** Questions. Answer any **two including Q-1**. All questions are of equal value. Figures in the right margin indicate marks.

1. $P = 100 - 2Q$

$P = 50 + Q$

a) Calculate the equilibrium price and quantity. **5**

b) Explain the impact of increase in input price on equilibrium price and quantity with the help of appropriate graph. **5**

c) Find out the consumer surplus, producer surplus and total surplus from the given equations. **10**

2.

Q	P
10	5
15	10
25	12
40	20

a) Calculate price elasticity and give interpretation. **10**

b) When demand is price elastic, a price increase decreases total revenue. --Explain. **10**

OR

3.

Q	P
5	10
10	15
15	30
20	40

a) Calculate price elasticity and give interpretation. **10**

b) When demand is price elastic, a price decrease increases total revenue. --Explain. **10**