

(3 Hours)

Total Marks :80

Note: 1) Question No.1 is compulsory

2) Attempt any Three from the remaining

Q1

- A) Find $L \left\{ \int_0^t e^{-u} u^n du \right\}$ 5
- B) Prove that $f(z) = e^z$ is analytic everywhere. Hence find $f'(z)$ 5
- C) Find half range sine series of $f(x) = x$ in $(0, \pi)$ 5
- D) If $A = [a_{ij}]$ is a matrix of order 3×3 such that $a_{ij} = \begin{cases} 1, & \text{if } i \neq j \\ 0, & \text{if } i = j \end{cases}$ 5

Find an eigen value of

- i) A
- ii) adjoint of A
- iii) $A^2 - 2A + 2I$

Q2

- A) If $L[f(t)] = \frac{1}{9s^2 - 3s + 1}$ then Find $L[te^t f(3t)]$ 6
- B) Find Fourier series for $f(x) = x$, if $0 < x < 2\pi$ and $f(x + 2\pi) = f(x)$ 6
- C) Find analytic function $f(z)$ in terms of z where $u = y^2 - x^2$ 8

Q3

- A) A string is stretched and fastened to two points distance l apart. Motion is started by displacing the string in the form $y = a \sin(\pi x / l)$ from which it is released at time $t=0$. Show that the displacement of a point at a distance x from one end at time t is given by $y = a \sin(\pi x / l) \cos(\pi ct / l)$ 6
- B) Prove that $u = e^x \cos y$ is harmonic function hence find it's harmonic conjugate function 6
- C) Find the Fourier Series for $f(x)$ in $(-\pi, \pi)$ where 8

$$f(x) = |x|$$

Q4

- A) Evaluate $\int_0^\infty \left[\frac{\cos 2t - \cos 4t}{t} \right] dt$ 6
- B) Find Inverse Laplace transform of $\frac{s+1}{(s-1)^2(s-2)}$ 6
- C) Is the matrix $A = \begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix}$ Diagonalizable? If so find the Diagonal form of A and transforming matrix of A 8

Q5

- A)** If $A=[a_{ij}]$ is a matrix of order 3×3 such that **6**
- $$a_{ij} = \begin{cases} 2, & \text{if } i = j \\ -1 & , \text{if } i + j = 3 \text{ or } 5 \\ 1, & \text{if } i + j = 4 \text{ and } i \neq j \end{cases}$$

Compute: $A^9 - 6A^8 - 9A^7 - 4A^6 + A^5 - 12A^4 - 18A^3 - 8A^2 + 2A + I$

- B)** Solve by Crank-Nicholson simplified formula $\frac{\partial^2 u}{\partial x^2} - 16 \frac{\partial u}{\partial t} = 0,$ **6**

$0 \leq x \leq 1$ subject to the condition $u(0, t) = 0, u(1, t) = 100t,$

$u(x, 0)=0$ $h=0.25$ for one-time step

- c)** Find inverse Laplace transform of (i) $\log[z^2 - 4]$ (ii) $\frac{s+2}{(s+16)^2}$ **8**

Q6

- A)** Find the Laplace Transform of $\int_0^t \cos(u)\sin(u)du$ **6**

- B)** Find the solution of **6**

$$4 \frac{\partial^2 u}{\partial x^2} - \frac{\partial u}{\partial t} = 0, 0 < x < 8, \quad u(x, 0) = 4x - \frac{1}{2}x^2, u(0,t)=0, u(8,t)=0$$

Taking $h = 1, k = \frac{1}{8}$ for $0 \leq t \leq 5/8$

Where h is the step length for x axis and k is the step size in time direction using Bender –Schmidt method

- C)** Find inverse Laplace transform of $\frac{1}{(s^2+16)((s^2+49)}$ using convolution theorem **8**

(3Hours)

Total Marks :80

- N.B.** (1) Question No. 1 is compulsory.
(2) Attempt any three questions form remaining five questions.
(3) Draw neat sketches wherever necessary.
(4) Figures to the right indicate full marks.
(5) Answer each and every question combined manner in order.
1. (a) Write the identifying properties of the following minerals. 5
(i) Talc
(ii) Smoky Quartz
(iii) Gypsum
(iv) Hematite
(v) Biotite Mica
- (b) Write two examples of the following 5
(i) Clastic Sedimentary rock
(ii) Igneous Intrusion
(iii) Inequigranular Texture
(iv) Luster of the Mineral
(v) Metamorphic Rock
- (c) Draw the labeled diagram 10
(i) Parts of the Fold
(ii) Normal Fault
(iii) Perched water table
(iv) Angular unconformity
(v) Parts of Dam
2. (a) Describe various types of weathering with examples.Explain the 10
significance of weathering.
(b) Explain the geological action of wind with different landforms. 10
3. (a) State the different types of classification of igneous rock. Explain 10
the importance of any two igneous rock.
(b) Explain major structures of Sedimentary rock with diagram. 10
4. (a) Explain the factors of metamorphism and the type of 10
metamorphism associated with each factor ?
(b) Differentiate between Horst and Graben. 4
(c) A coal seam is exposed on a level ground. It dips northward. Its 6
width of outcrop is 180m. A borehole sunk from its upper bedding
plane touches the lower bedding plane at a depth of 105m.
Determine its true thickness and amount of inclination. (Scale
1cm = 50 m)

- 5 (a) Write short notes on (any 2) 10
 (i) Types of plate boundaries
 (ii) Meander and Oxbow Lake
 (iii) Confined aquifer
 (iv) Suitable Geological Structures for Dam construction
 (v) Principles of stratigraphy

- (b) Classify the rocks according to Geomechanics classification for a Rock having UCS of 180 Mpa and RQD of 65 % with average spacing of discontinuity of 1000 mm which is slightly rough in nature and highly weathered. The strike is perpendicular to the tunnel axis and drive with dips at an angle of 35° . Also 8 lit/min groundwater inflows the tunnel length per 10 m. State the condition of rocks for tunnel construction .(Note: Table containing RMR parameters should be provided to solve the question). 10

6. (a) State precautionary measures in earthquake prone area while construction of a building. 5
 (b) What is central and fissure type of eruption ? 5
 (c) What is Run, core recovery and RQD? Calculate the value of Core Recovery and RQD from the following data. Mention your opinion. 10

Total Run = 2 m.

Sr.No.	Length of core sample (in cm)	Nature of joints at lower end of core sample
1	9	N
2	11	N
3	8	N
4	9	M
5	12	N
6	7	M
7	20	N
8	5	N
9	8	M
10	6	N
11	40	N
12	30	N
13	5	N
14	3	M
15	9	N

Time: 3 Hours

Max. Marks: 80

Note:

1. Q. No.1 is compulsory.
2. Attempt any three (03) out of the remaining questions.
3. All questions carry equal marks.
4. Draw neat Sketches/Diagrams, wherever necessary.

Q1. Solve the following:

20 marks

It is proposed to construct a Residential Bungalow as (G+1) R.C.C framed structure, on a plot of **100 m.X50 m., with Floor-Floor height of 3.0 m.**

The following are the requirements:

- (i) Living Room Cum Dining = 22 Sq.m.
- (ii) Drawing Room = 20 Sq.m.
- (iii) Master's Bed Room (with A.T) = 22 Sq.m.
- (iv) Kitchen = 12 Sq.m.
- (v) Dining = 14 Sq.m.
- (vi) Bed Room = 16 Sq.m.
- (vii) Guest Room = 16 Sq.m.

Provide Toilets, passages etc. as per the Bye-laws. Draw the following with a suitable scale:

- (a) Draw the **Ground Floor plan** (with walls) - 15Marks
- (b) Draw **Single line plan** of the first floor. - 05 Marks

Q2. Draw the following :

- A** Draw the Sectional Elevation of the building as designed and drawn in Q.1. - **10 Marks**
- B** Draw Foundation Plan & Section of one footing for building in Q.No.1 - **10 Marks**

Q3. Solve the following :

20 Marks

Plan, Design and draw a **High School** , with the following facilities as (G+1) R.C.C framed structure. **Assume Floor-Floor height = 3.0 m.**

- (i) Entrance & Enquiry = 40 Sq.m
- (ii) Assembly Hall = 200 Sq.m
- (iii) Canteen = 60 Sq.m
- (iv) Principal's Cabin = 30 Sq.m
- (v) Class Rooms = 08 No. (Each 60 Sq.)
- (vi) Library= 60 Sq.m.
- (viii) LABS= 3 No. (Each 60 Sq.m)
- (ix) Computer Room = 60 Sq.m
- Store Room = 40 Sq. m.

Provide Common Toilets(separate for Boys & Girls), passages etc. as per the Bye-laws. Draw the following with a suitable scale:

- (a) **GROUND FLOOR PLAN** (with walls) - **15 Marks**
- (b) **First Floor LINE Plan(Single Line Plan)** - **05 Marks**

- Q4. Solve the following :** **10 marks each**
- A** Draw SITE PLAN & Roof Plan , you have proposed for Building in Q.No.1
 - B** Draw the Front Elevation for the building , you have proposed in Q.No.1
- Q.5 Solve the following :**
- A** Explain & Draw sketches for all types of STAIRCASES used for Residential & Public buildings. **-10 Marks**
 - B** Draw **One-Point Perspective** for a Building with (50 m.X 30 m._Overall dimensions). Provide Door on one side, windows on all sides. Assume the remaining data. **-10 Marks**
- Q6. Write Short Notes on the following** **(4x5 = 20)**
- A** Sun-path diagram & Wind-rose diagrams for Building Design , with sketches
 - B** Principles of Town Planning in a CITY
 - C** Slum Clearance & Re-Development of Buildings
 - D** Principles of Planning for Residential Buildings

Duration : 3 Hrs.

[Total Marks: 80]

Instructions to the Candidates :

- Question No. 1 is **compulsory**. Answer any **three** out of the remaining five questions.
- Draw neat sketches wherever necessary. **Assume** suitable data, if required & state it clearly.

- Q.1** Answer **any four**. **20**
- (a) A rectangular block of height 250 mm has a C/S of (50 mm x 40 mm). It has to support an axial compressive load P. Young's modulus of the material is 95000 N/mm². Determine the largest load P which can be applied so that the normal stress must not exceed 80 N/mm² & the decrease in the height of the block should be at the most 0.3 mm. **05**
- (b) Derive an expression for the strain energy of an element subjected to a gradually applied axial load. **05**
- (c) What do you mean by core or kernel of a section? Locate core of a hollow circular section with an external diameter of 300 mm and a thickness of 25 mm. **05**
- (d) What are the assumptions of pure torsion theory? **05**
- (e) State the assumptions of pure bending theory. **05**
- Q.2** (a) For the beam in fig. 1, draw SFD & BMD. A is the fixed end, there is an internal hinge at C & F is a roller support. **08**

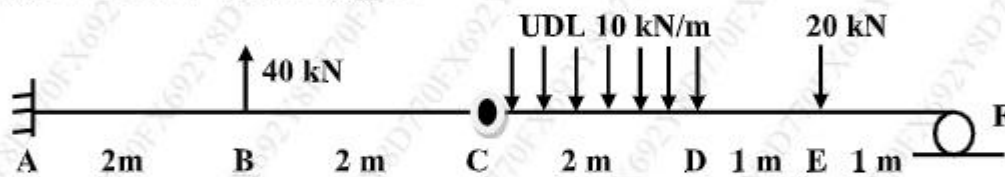
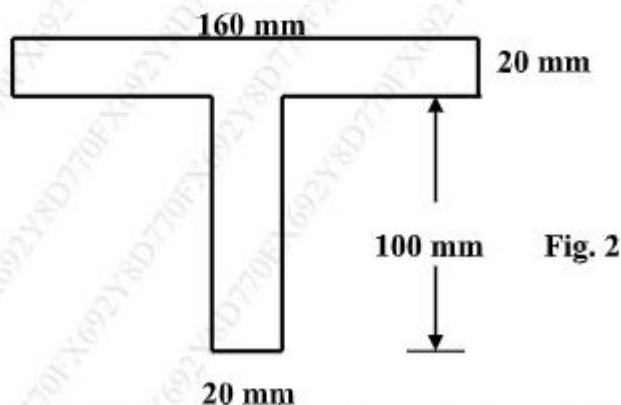


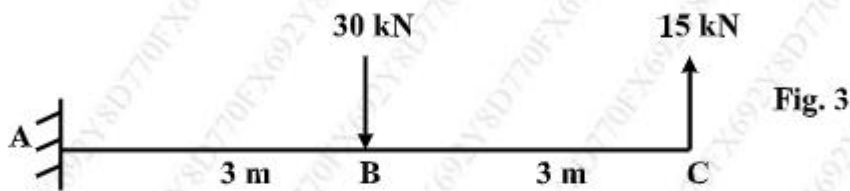
Fig. 1

- (b) The C/S of a T-beam is shown in fig. 2. The permissible bending stress is 190 MPa. If the section is simply supported over a span of 4.3 m, how much UDL can it carry safely? Flange is (160 mm x 20 mm) & web is (100 mm x 20 mm). **08**

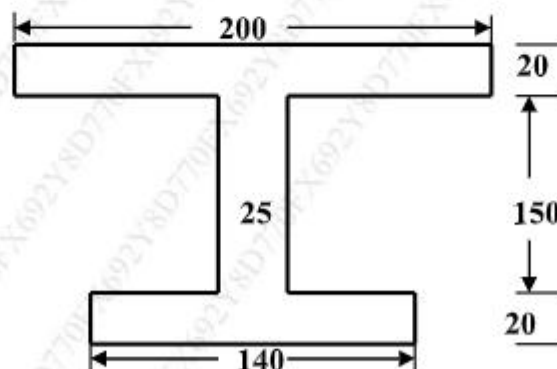


- (c) A metal block of 100 mm² C/S area carries an axial tensile force of 12 kN. For a plane inclined at 30° with the direction of applied load, calculate normal stress and shear stress. Also calculate maximum shear stress. **04**

- Q.3 (a) A hollow circular shaft having internal diameter 0.75 times its external diameter transmits a power of 320 kW at a speed of 230 RPM. The maximum torque is 15% greater than the mean torque. Shear stress is not to exceed 80 MPa and angle of twist in length of 4 m is not to exceed 2.5° . Calculate external and internal diameters. Take modulus of rigidity = 85GPa. 08
- (b) A cylindrical shell of internal diameter 2 m and 3.8 m length is subjected to an internal fluid pressure of 3.5 MPa. If the permissible circumferential stress is 165 MPa, what should be the shell thickness? Also determine longitudinal stress, maximum shear stress and change in volume of the shell. Assume $E = 2 \times 10^5$ MPa & Poisson's ratio = 0.24. 08
- (c) For the cantilever beam of fig. 3, determine slope and deflection at the free end C, using Macaulay's double integration method. EI is constant for the beam. 04



- Q.4 (a) A vertical steel bar 25 mm diameter and 1.8 m. long is provided with a collar at the lower end. Find the maximum weight 'W' that can be dropped through a height of 140 mm over the collar, if the maximum permissible tensile stress in steel bar is 150 MPa. Take modulus of elasticity as 2×10^5 N/mm². 08
- (b) A hollow steel column of 4.2 m length has an outer diameter of 200 mm & thickness of 25 mm. It is fixed at both the ends. Determine Rankine's crippling load. Compare it with the Euler's crippling load. Take $E = 2.1 \times 10^5$ MPa, crushing stress = 360 MPa & Rankine's constant = (1/7450). 08
- (c) Explain virtual work principle & Castigliano's theorems. 04
- Q.5 (a) An I-section of fig. 4 is subjected to a shear force of 200 kN. Draw the shear stress distribution diagram. All the dimensions are in mm. 08



- (b) A masonry pier of fig. 5 is subjected to a vertical load of $P = 55$ kN. Find the stresses developed at each corner of the pier. The load has an eccentricity of 0.6 m with reference to both the axes X & Y. 08

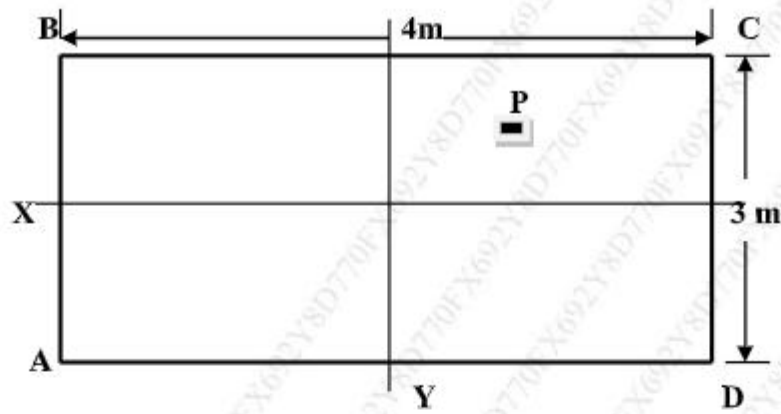


Fig. 5

- (c) Three different materials designated as A, B & C are tested in tension in universal testing machine. Each specimen has a diameter of 13 mm & gauge length of 50 mm. At the failure, the distances between gauge marks were 53 mm, 62 mm & 70 mm respectively. At the failure C/S, diameters were 12 mm, 10 mm & 6.5 mm respectively. Determine the percentage elongation & percentage reduction in C/S area of each specimen & then using your own judgment, classify each material as ductile or brittle.

04



Fig. 6

- Q.6 (a) For a rectangular block in fig. 7, Determine the change in each dimension and change in volume. Young's modulus is 190 GPa and Poisson's ratio is 0.27.

08

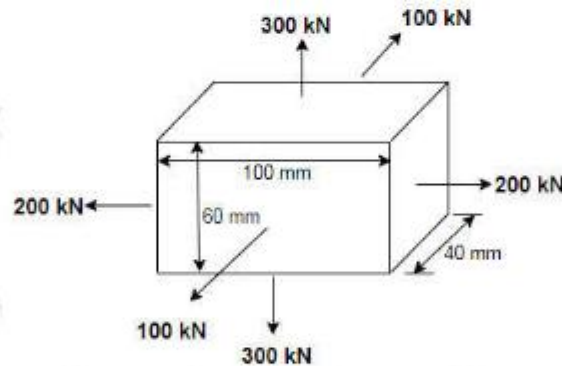


Fig. 7

- (b) For the beam in fig. 8, draw SFD & BMD. If C/S is (80 mm wide x 120 mm deep), find the maximum bending stress.

08

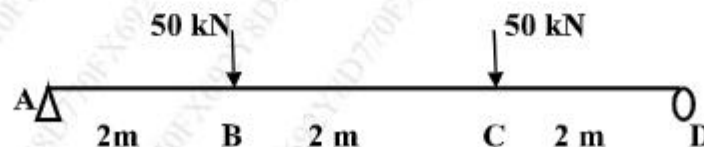


Fig. 8

- (c) A 3 m. long cantilever beam carries a UDL of w /unit run on its entire span. The slope at the free end is 1° . Determine the deflection at the free end. EI is constant for beam.

04

Duration: 3 hours

Total marks: 80

NOTE:

- Q1 is compulsory.
- Attempt any three from remaining five questions
- Assume suitable data wherever required

Q1 Answer any four from following:

- Explain the terms- specific volume, specific gravity, viscosity, surface tension and capillarity [5]
- Define Mach number and also explain subsonic, sonic and supersonic flows. [5]
- Explain different types of fluid flow [5]
- State Bernoulli's theorem for steady flow of an incompressible fluid and derive expression for Bernoulli's equation from first principle. [5]
- A stone weighs 400 N in air and when submerged in water, it weighs 225N. Calculate the volume of stone and its specific gravity [5]

Q2

- A square plate 1 m x 1m slides over an inclined plane making an angle of 22° with horizontal. The gap between the plate and the plane is 1mm and is filled with oil of viscosity 7.5 poise. Find the weight of the plate when it slides down the plane at constant velocity of 0.2 m/s. [10]
- Determine total pressure force and location of centre of pressure on an isosceles triangular plate of base 4m and altitude 4m when it is immersed in an oil of specific gravity 0.9 when
 - the base of the plate coincides with the free surface of the oil
 - the base of plate makes 30° with water surface [10]

Q3

- Sketch and explain working of Orificemeter and Pitot tube [10]
- A horizontal Venturimeter with inlet diameter 10 cm and throat 5 cm is used to measure rate of flow of oil of specific gravity 0.8. The discharge of oil through the venturimeter is 60 litres per sec. Find the reading of the oil- mercury differential manometer. Take $C_d = 0.98$ [10]

Q4

- a) Differentiate between – Stream function and velocity potential function [5]
- b) Differentiate between – Lagrangian method and Eulerian method [5]
- c) If for a two-dimensional potential flow, the velocity potential function is given by $\Phi = x(2y-1)$, determine the velocity at the point (3,4). Determine also the value of stream function ψ at that point. [10]

Q5

- a) Differentiate between notches and weirs. Define velocity approach and explain how does it affect the discharge over a weir [10]
- b) Derive an expression for discharge through a rectangular notch. Also find the discharge of water flowing over a rectangular notch of 2m length when the constant head over the notch is 280 mm. Take $C_d = 0.6$ [10]

Q6.

- a) What are the conditions of equilibrium of floating and submerged bodies [10]
- b) An aeroplane is flying at 1000 km/hr through still air having a pressure of 78.5 kN/m² (abs) and temperature -8° C. Calculate on stagnation point on the nose of plane a) stagnation pressure b) stagnation temperature c) stagnation density. Take $R = 287 \text{ J/kg}^\circ \text{K}$ and $k = 1.4$ [10]
