SRM VALLIAMMAI ENGINEERING COLLEGE

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF CIVIL ENGINEERING

M. E – STRUCTURAL ENGINEERING

QUESTION BANK

1917103 - THEORY OF ELASTICITY AND PLASTICITY

(Academic Year 2021 – 2022)

Prepared by

Mr. SATTAINATHAN SHARMA.A, Assistant Professor/ CIVIL

1917103 - THEORY OF ELASTICITY AND PLASTICITY
QUESTION BANK
I Year – I Semester

UNIT I
ELASTICITY

Analysis of stress and strain, Equilibrium equations - Compatibility equations - Stress strain relationship. Generalized Hooke's law.

PART- A

1	Define principal stress and give the formula.	BT 1	Remembering
2	Write the equilibrium equations in 2D.	BT 1	Remembering
3	State the relation between stress and strain.	BT 1	Remembering
4	Define spherical stress tensor.	BT 1	Remembering
5	Justify the displacement and strains are small in linear elasticity assumptions.	BT 1	Remembering
6	List out the assumptions of linear elasticity.	BT 1	Remembering
7	State generalized Hooke's law.	BT 2	Understanding
8	Explain strain tensor.	BT 2	Understanding
9	Explain Octahedral stresses.	BT 2	Understanding
10	Predict the equation of stress transformation law in 3-D.	BT 2	Understanding
11	Illustrate the formula for strain-stress law in matrix form.	BT 3	Applying
12	Define Cauchy stress principle.	BT 3	Applying
13	Define deviator stress tensor.	BT 3	Applying
14	Write the strain displacement relations.	BT 4	Analyzing
15	Discuss Lami's constants.	BT 4	Analyzing
16	Explain stress and strain invariants.	BT 4	Analyzing
17	Explain shear strain.	BT 4	Analyzing
18	The state of stress at a point is given by $\sigma_x=x^2y+20$; $\sigma_y=x^3z+y^2$; $\sigma_z=yz^2+10$; $\tau_{xy}=3x^2y$; $\tau_{yz}=yz$; $\tau_{zx}=zx$. Determine the body force (B_x,B_y,B_z) @ point P(1,2,3)	BT 5	Evaluating
19	Distinguish the state of stress and state of strain at a point.	BT 5	Evaluating
20	Elaborate the 3 Compatibility equations for the 3D system.	BT 2	Understanding
21	What are the elastic constants?	BT 5	Evaluating
22	Discuss about stress tensor.	BT 6	Creating
23	For a material E=210Gpa,ɤ=0.3,formulate lami's constant, shear modulus,and bulk density.	BT 6	Creating
24	What are stress tensors?	BT 6	Creating
25	List the applications of linear elasticity	BT 1	Remembering

PART-B

1.	When the stress tensor at a point with reference to axes *(x, y, z)* is given by the array, $\begin{bmatrix} 4 & 1 & 2 \\ 1 & 6 & 0 \\ 2 & 0 & 8 \end{bmatrix} \textit{MPa}$ Show that the stress invariants remain unchanged by transformation of the axes by 45^0about the *z*-axis.	BT 4	Analyzing

2.	The displacement components in a strained body are as follows: $u = 0.01xy + 0.02y^2$, $v = 0.02x^2+0.01z^3y$, $w = 0.01xy^2+0.05z^2$. determine the strain matrix at the point P (3,2,-5).	BT 3	Applying
3.	a) The stress field at a point with respect to x,y,z coordinate system is given by the array in MPa as 4 1 2 1 6 0 2 0 8 Show that by transformation of axis by 45^o about the Z axis in the anti-clockwise direction, the stress invariants remain unchanged. b) Given the state of stress at a point as below $\begin{bmatrix} 100 & 80 & 0 \\ 90 & -60 & 0 \\ 0 & 0 & 40 \end{bmatrix} \boldsymbol{kPa}$ Considering another set of coordinate axes, x¢ y¢ z¢ in which z¢ coincides with z and x¢ is rotated by 30^0 anticlockwise from x-axis, determine the stress components in the new co-ordinates system.	BT 3	Applying
4.	The stress tensor at a point is given by the following array $\begin{bmatrix} 50 & -20 & 40 \\ -20 & 20 & 10 \\ 40 & 10 & 30 \end{bmatrix} (kPa)$ Determine the stress-vectors on the plane whose unit normal has direction cosines 1/√2, ½, ½.	BT 3	Applying
5.	a) A body is subjected to three-dimensional forces and the state of stress at a point in it is represented as $\begin{bmatrix} 200 & 200 & 200 \\ 200 & -100 & 200 \\ 200 & 200 & -100 \end{bmatrix} MPa$ Determine the normal stress, shearing stress and resultant stress on the octahedral plane. b) The state of stress at a point is given as follows: $\sigma_x = -800\,kPa, \quad \sigma_y = 1200kPa, \quad \sigma_z = -400kPa$ $\tau_{xy} = 400kPa, \quad \tau_{yz} = -600kPa, \quad \tau_{zx} = 500kPa$ Determine (i) the stresses on a plane whose normal has direction cosines l=1/4 & m=1/2 (ii) the normal and shearing stresses on that plane	BT 5	Evaluating

6.	A rectangular bar of cross section 30mm x 25mm is subjected to an axial tensile force of 180kN. Calculate the normal, shear, and resultant stresses on a plane whose normal has the following direction cosines: i) $l = m = 1/\sqrt{2}$ and $n = 0$; ii) $l = m = n = 1/\sqrt{3}$	BT 5	Evaluating
7.	The Stress components at a point in a body are given by $\sigma_x = 3xy^2z + 2x$, $\tau_{xy} = 0$, $\sigma_y = 5xyz + 3y$, $\tau_{yz} = \tau_{xz} = 3xy^2z + 2xy$, $\sigma_z = x^2y + y^2z$ Determine whether these components of stress satisfy the equilibrium equations or not as the point (1, -1, 2). If not then determine the suitable body force required at this point so that these stress components are under equilibrium.	BT 5	Evaluating
8.	At a point in a given material, the three dimensional state of stress is given by $\sigma_x = \sigma_y = \sigma_z = 10N/mm^2, \tau_{xy} = 20N/mm^2$ **and** $\tau_{yz} = \tau_{zx} = 10N/mm^2$ Compute the principal planes if the corresponding principal stresses are $\sigma_1 = 37.3N/mm^2$, $\sigma_2 = -10N/mm^2$, $\sigma_3 = 2.7N/mm^2$	BT 3	Applying
9.	a) The displacement components in a strained body are as follows: $u = 0.01xy + 0.02y^2$, $v = 0.02x^2 + 0.01z^3y$, $w = 0.01xy^2 + 0.05z^2$. Determine the strain matrix at the point P (3,2,-5). b) The displacement field in a body is specified as $Ux = (x^2+3)x10^{-3}$ $Uy = (3y^2x)10^{-3}$. $Uz = (x+3x)\ 10^{-3}$. Determine the strain components at support whose coordinates are (1, 2, 3).	BT 4	Analyzing
10.	The strain components at a point with respect to xyz coordinate system are $\varepsilon_x = 0.10$, $\varepsilon_y = 0.20$, $\varepsilon_z = 0.30$, $\gamma_{xy} = \gamma_{yz} = \gamma_{zx} = 0.160$. if the coordinate axes are rotated about the z axis through 45° in the anticlockwise direction, determine the new strain components.	BT 3	Applying
11.	The state of strain at a point is given by $\varepsilon_x = 0.001$, $\varepsilon_y = -0.003$, $\varepsilon_z = 0$, $\gamma_{xy} = 0$, $\gamma_{yz} = 0.001$, $\gamma_{zx} = -0.004$. Determine the stress tensor at this point. Take $E = 210 \times 10^6 kN/m^2$. Poisson's ratio = 0.28. Also find Lame's constant.	BT 3	Applying
12.	The components of strain at a point is given by $\varepsilon_x = 0.15$, $\varepsilon_y = 0.25$, $\varepsilon_z = 0.40$, $\gamma_{xy} = 0.10$, $\gamma_{yz} = 1.05$, $\gamma_{zx} = 0.20$. (i) If the coordinate axis is rotated about z axis through 60° in the anticlockwise direction determine the new stress components. (ii) Also find the principal strain and its orientation.	BT 4	Analyzing
13.	The components of strain at a point in a body are as follows : $\varepsilon_x = 0.10$, $\varepsilon_y = -0.05$, $\varepsilon_z = 0.05$, $\gamma_{xy} = 0.3$, $\gamma_{yz} = 0.1$, $\gamma_{zx} = -0.08$. Determine the principal strains and the principal directions	BT 1	Remembering
14.	Explain the generalized Hooke's law for an isotropic material and prove that the elastic constants are two.	BT 2	Understanding

PART C			
1	Compose the compatibility equation in 3-D Cartesian co-ordinates.	BT 6	Creating
2	The rectangular stress components at a point in a three dimensional stress system are as follows. $\sigma_x = 20N/mm^2$ $\sigma_y = -40N/mm^2$ $\sigma_z = 80N/mm^2$ $\tau_{xy} = 40N/mm^2$ $\tau_{yz} = -60N/mm^2$ $\tau_{zx} = 20N/mm^2$ Determine the principal stresses at the given point.	BT 3	Applying
3	Illustrate the differential equation of equilibrium in 3-D rectangular co-ordinates.	BT 4	Analyzing
4	The state-of-stress at a point with reference to axes *(x, y, z)* is given by the following array of terms $\begin{bmatrix} 9 & 6 & 3 \\ 6 & 5 & 2 \\ 3 & 2 & 4 \end{bmatrix} MPa$ Determine the principal stresses and principal directions.	BT 5	Evaluating
UNIT-II FORMULATION AND SOLUTION OF ELASTICITY PROBLEMS			
Methods of formulation of elasticity problems, methods of solution of elasticity problems, Plane stress and plane strain - Simple two dimensional problems in Cartesian and Polar Co- ordinates.			
PART-A			
1.	What are the equilibrium equations of plane stress problem?	BT 1	Remembering
2.	What are the equations of plane elasticity problems?	BT 1	Remembering
3.	Define Airy's Stress function.	BT 1	Remembering
4.	What are Cartesian coordinates?	BT 1	Remembering
5.	Write down the polynomial of the second degree.	BT 1	Remembering
6.	What are the various methods for elastic solutions?	BT 1	Remembering
7.	Describe plane strain problem with examples. .	BT 2	Understanding
8.	Define stress concentration factor	BT 2	Understanding
9.	Define plane stress.	BT 1	Remembering
10.	Express the stress compatibility equation for plane stress and plane Strain case.	BT 2	Understanding
11.	State the stress field represented by the Airy's stress function $\Phi = Ax(y^3-y)$.	BT 3	Applying
12.	Write the expression for bi harmonic equation in polar coordinates.	BT 3	Applying
13.	What are Cartesian co-ordinates?	BT 1	Remembering
14.	Write the equilibrium equation in 2-D element in polar coordinates.	BT 4	Analyzing
15.	What are conjugate biharmonic equations?	BT 1	Remembering
16.	Differentiate 2D and 3D problems.	BT 4	Analyzing
17.	Show that 3rd degree polynomial satisfies the governing equations.	BT 4	Analyzing
18.	Outline the general solution of compatibility equation.	BT 5	Evaluating
19.	Give examples for plane stress problems.	BT 5	Evaluating
20.	Outline about axis-symmetry problem	BT 5	Evaluating
21.	How the Airy's stress function satisfied?	BT 5	Evaluating
22.	State plane strain.	BT 1	Remembering
23.	What are polar coordinates?	BT 1	Remembering

24.	Compose the 3-D equilibrium equation in polar co-ordinates.	BT 6	Creating
25.	Invent the stress components for the following stress function. $\Phi = Axy^3/6 + Bxy$	BT 6	Creating

PART-B			
1.	State plane stress and plane strain. Discuss the plane stress and plane strain for two dimensional problems with illustrations.	BT 1	Remembering
2.	Explain plane strain problem with example & give all basic equation	BT 1	Remembering
3.	Show that the following Airy's stress functions and examine the stress distribution represented by them: a) $\phi = Ax^2 + By^2$, b) $\phi = Ax^3$, c) $\phi = A(x^4 - 3x^2y^2)$	BT 2	Understanding
4.	A large thin plate is subjected to certain boundary conditions on its thin edges (with zero stress vector on its large faces) leading to the stress function $\phi = Ax^2y^3 - By^5$. 1. Use the biharmonic equation to express A in terms of B 2. Calculate all the stress components 3. Calculate all the strain components in terms of E, B and μ 4. Find the volumetric strain 5. Check if the compatibility equation is satisfied 6. check if the equilibrium equation is satisfied.	BT 3	Applying
5.	A very thick component has the same boundary conditions on any given cross-section, leading to the following stress function. $\phi = x^5 - xy^4 - 4x^3y^2$ 1. Check if this is a valid stress function 2. Calculate all the stress components ($\mu = 0.25$) 3. Calculate all the strain components 4. Find the displacements	BT 3	Applying
6.	Show that for a simply supported beam, length 2L, depth 2a and unit width, loaded by a concentrated load W at the centre, the stress function satisfying the loading condition is **$\boldsymbol{\phi = b/6xy^2 + cxy}$**. the positive direction of y being upwards, and x = 0 at midspan	BT 2	Understanding
7.	Investigate what problem of plane stress is satisfied by the stress function $\phi = \frac{3F}{4d}\left[xy - \frac{xy^3}{3d^2}\right] + \frac{p}{2}y^2$ applied to the region included in y = 0, y = d, x = 0 on the side x positive.	BT 5	Evaluating
8.	A thick cylinder of inner radius 10cm and outer radius 15cm is subjected to an internal pressure of 12MPa. Determine the radial and hoop stresses in the cylinder at the inner and outer surfaces.	BT 5	Evaluating

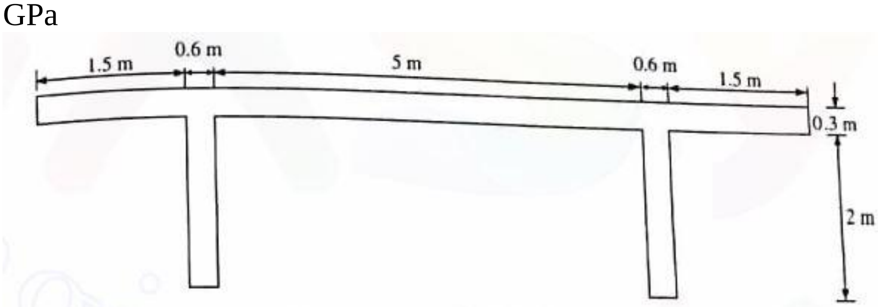
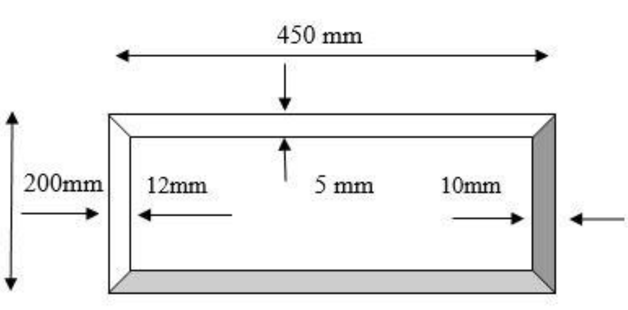
Prepared by
Mr. SATTAINATHAN SHARMA A/ Assistant Professor- Civil Department

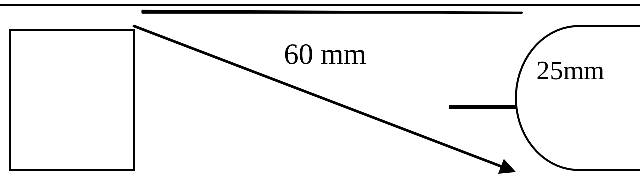
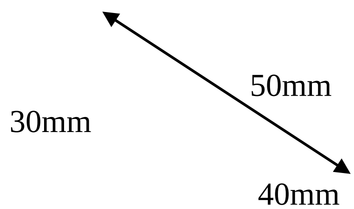
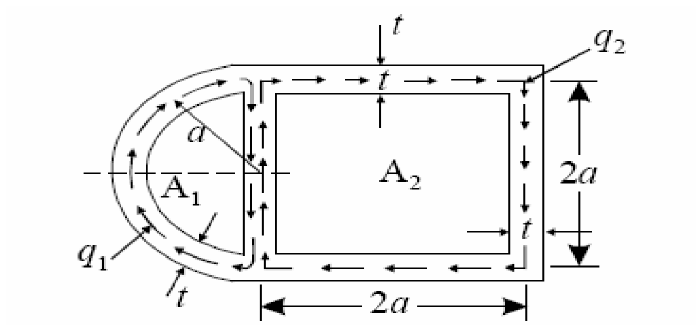
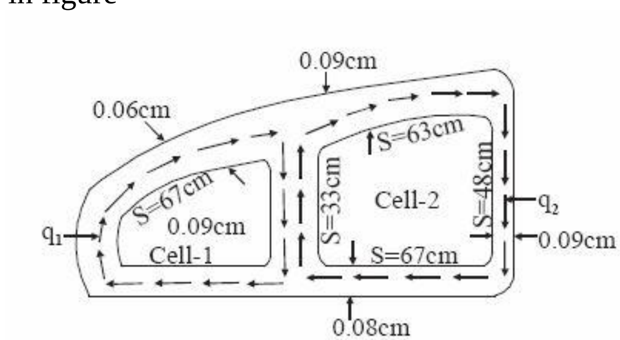
9.	Derive the equilibrium equation of 2D problems in polar coordinates	BT 1	Remembering
10.	Discuss about axis symmetric problems.	BT 1	Remembering
11.	Derive the coordinates for two dimensional biharmoic equations in polar coordinates	BT 1	Remembering
12.	Show that airy's stress function $\phi=A(xy^3-(3/4)\,xyh^2$represents stress distribution in a cantilever beam loaded at free end with load P.Find the value of A if $\tau_{xy}=0$ at $y=\pm h/2$ where b and h are width and depth respectively.	BT 5	Evaluating
13.	Explain the state of stress at a point. Give the Solutions of two-dimensional problems by the usage of polynomials.	BT 1	Remembering
14.	Determine the stress fields that axis from the following stress functions i) $\phi=cy^2$ ii) $\phi=Ax^2+Bxy+cxy^2$ iii) $\phi=Ax^3+Bx^2y+Cxy+Dy^3$	BT 5	Evaluating

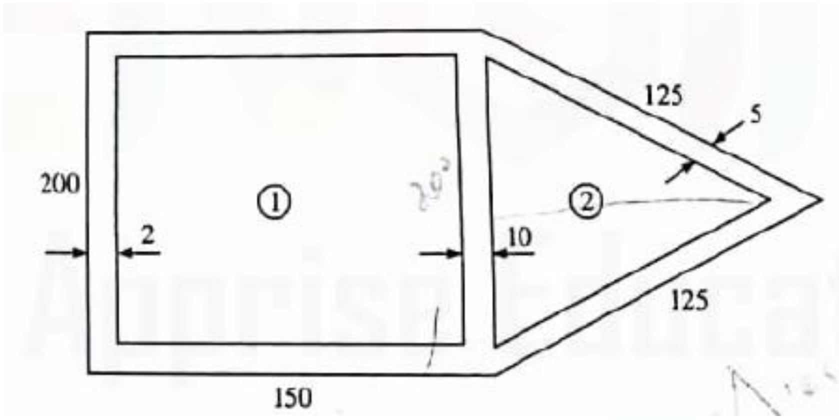
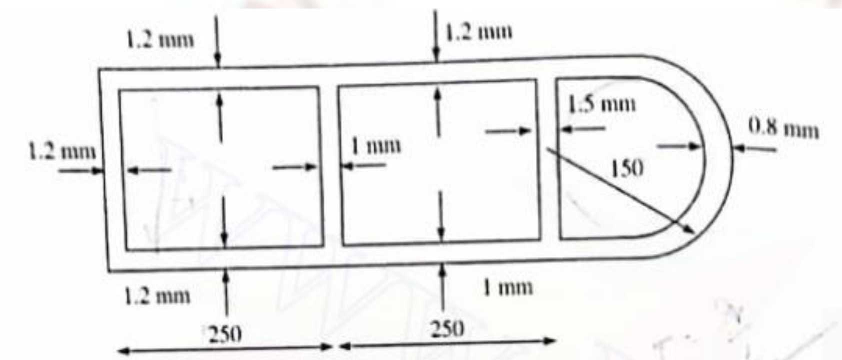
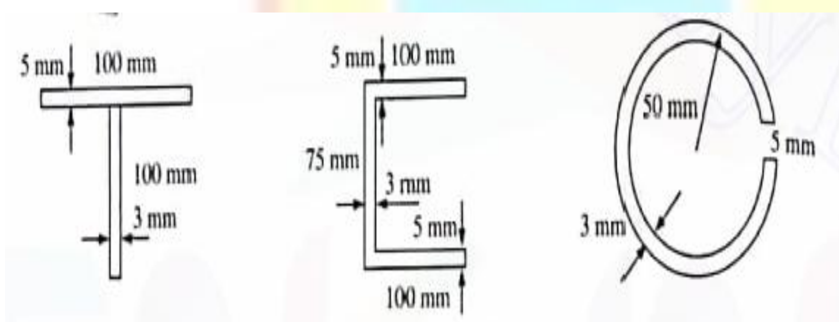
PART-C			
1.	Describe the deflection equation for the bending of a cantilever loaded (point load) at the end in terms of Cartesian coordinates.	BT 1	Remembering
2.	Describe the deflection equation for bending a simply supported beam uniformly loaded over the entire span in terms of Cartesian coordinates.		
3.	Show the following stress function satisfies the boundary function in a beam of rectangular cross section of width 2h and depth d under a total shear force, W. $\varphi=[\,(W/2hd^3)xy^2(3d-2y)\,]$.	BT 3	Applying
4.	$\phi=-\left(\frac{F}{d^3}\right)xz^2(3d-2z)$ Determine the stress components and sketch their variations in a region included in z =0, z = d, x = 0, on the side x positive.	BT 2	Understanding

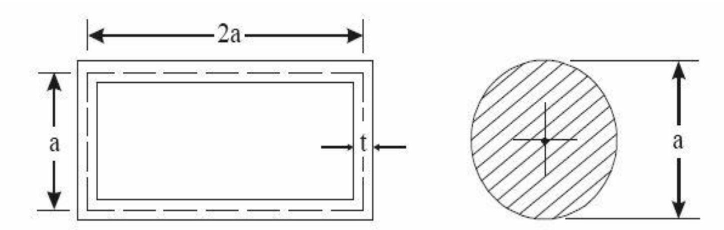
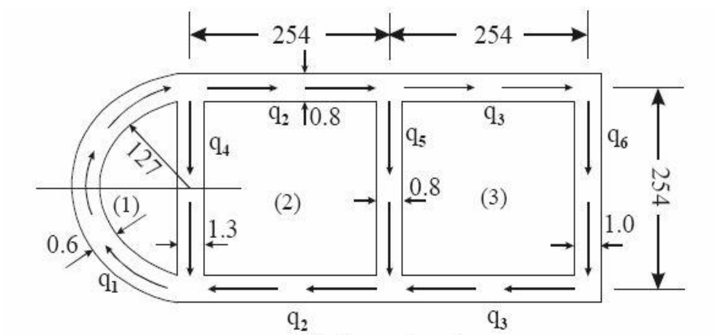
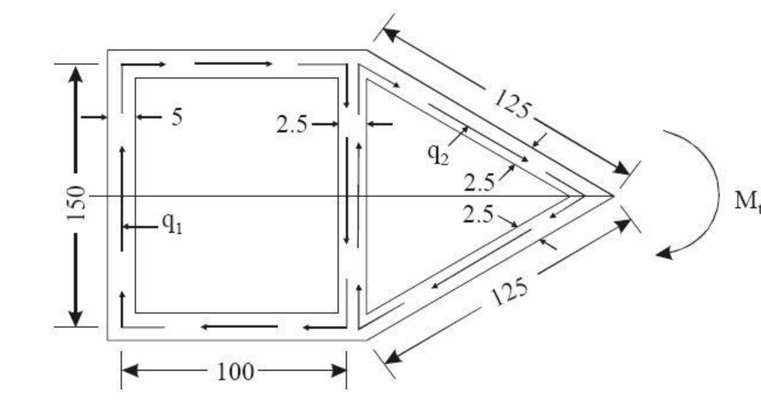
Prepared by
Mr. SATTAINATHAN SHARMA A/ Assistant Professor- Civil Department

UNIT-III TORSION OF NON CIRCULAR SECTION			
Introduction, general solution of torsion problems, boundary conditions, stress function method - Torsion of non-circular sections, Prandtl's membrane analogy, Torsion of thin walled open and closed sections - Thin walled multiple cell closed sections.			
PART-A			
1.	What is the effect of torsion in circular shafts?	BT 1	Remembering
2.	Write the equation for the twist of thin walled tube, ϴ?	BT 1	Remembering
3.	Define shear flow,Q.	BT 1	Remembering
4.	Write the torsional equation of prismatic bar.	BT 1	Remembering
5.	Write the basic assumptions in St.Venant"s Theory of torsion.	BT 1	Remembering
6.	Give the the assumptions associated with the elementary approach.	BT 1	Remembering
7.	If the warping function $\Psi = 20/y^2 - 6x^2y$ for a non-circular section under torsion, determine τ_{xz} at the point (-6, 4).	BT 3	Applying
8.	With a neat sketch represent the shear stress flow in a thin T Section under torsion.	BT 2	Understanding
9.	Tabulate analogy between Torsion and Membrane Problems.	BT 2	Understanding
10.	Write the equation for torsion of elliptical cross section bar.	BT 2	Understanding
11.	What is membrane analogy?	BT 3	Applying
12.	If the warping function $\Psi = 30/y^3 - 4x^2y$ for a non-circular section under torsion, determine τ_{xz} at the point (10, -4).	BT 3	Applying
13.	Write short notes on prandtl's membrane analogy.	BT 3	Applying
14.	Explain briefly about St.Venant"s Theory of torsion.	BT 4	Analyzing
15.	Illustrate the max.shear stress and angle of twist per unit length of a thin rectangular section of size b×d.	BT 4	Analyzing
16.	Find the angle of twist per unit length of a bar of an equilateral triangular c/s of side 20mm when the bar is subjected to a twisting moment. If the maximum shear stress induced is 5 N/mm^2, find the value of maximum twisting moment.	BT 4	Analyzing
17.	Deduce and show, Which section has zero wrapping constant.	BT 5	Evaluating
18.	List the analogous quantities in membrane analogy.	BT 5	Evaluating
19.	Discuss the torsional resistances of thin walled closed and open sections.	BT 6	Creating
20.	Give the expression for angle of twist for a thin wall hollow section.	BT 3	Applying
21.	Give the Poisson's equation.	BT 1	Remembering
22.	Explain Bredt – Batho formula.	BT 5	Evaluating
23.	Write down the formula for maximum shear stress and angle of twist for torsion of rectangular sections.	BT 5	Evaluating
24.	Compose the equation of torsional rigidity related to torsion of elliptical cross- section bar.	BT 6	Creating
25.	Compose the Laplace equation.	BT 6	Creating

<table>
<tr><th colspan="4">PART-B</th></tr>
<tr><td>1.</td><td>Derive the expression for shear stress of a bar with circular cross section subjected to a torque T</td><td>BT 3</td><td>Applying</td></tr>
<tr><td>2.</td><td>Arrive at the expression for torsion of narrow rectangular strip.</td><td>BT 3</td><td>Applying</td></tr>
<tr><td>3.</td><td>Derive the expression for shear stress and warping constant of a bar with rectangular cross section subjected to a torque T. Also obtain the torsional constants (k1,k2,k3) depending upon on aspect ratio of the sections.</td><td>BT 3</td><td>Applying</td></tr>
<tr><td>4.</td><td>If the allowable shear stress is 60 Mpa, Determine the torque that can be applied to each of the copper bars (Pandtl stress function) of size
(i) 50mm x 50mm
(ii) 70mm x 45mm
(iii)25mm x 60mm
Also find the angle of twist. Take G=48 Gpa</td><td>BT 5</td><td>Evaluating</td></tr>
<tr><td>5.</td><td>Determine the tortional rigidity of the concrete double T-Section as shown below. Also find the maximum shear stress and tortional deformation when a load of 1200kN acts on the Web. Take G=12 GPa

</td><td>BT 5</td><td>Evaluating</td></tr>
<tr><td>6.</td><td>Derive the expression for angle of twist and shear stress of a bar with multiple connected thin-walled sections subjected to a torque.</td><td>BT 3</td><td>Applying</td></tr>
<tr><td>7.</td><td>A brass tube of rectangular cross-section is subjected to a torque of 60 kNm along its longitudinal axis. Determine the shearing stresses and angle of twist. Take G=40 GPa.

</td><td>BT 5</td><td>Evaluating</td></tr>
<tr><td>8.</td><td>(i) A thin-walled member 1.75 m long and 6 mm thick has the cross-section as shown below. Find the Maximun torque which can be carried by the section if the angle of twist is limited to 9^0. What will be the maximum shear stress when this maximun torque is applied. Take G = 80 GPa.</td><td>BT 5</td><td>Evaluating</td></tr>
</table>

	 (ii) A thin-walled member 2m long and 10 mm thick has the cross-section as shown in figure below. Determine the torque that can be applied and the angle of twist achieved if the shear stress is limited to 50 MPa. Take G = 50GPa 		
9.	Discuss about Prandtl's membrane analogy.	BT 2	Understanding
10.	A thin walled steel section shown in figure is subjected to a twisting moment T. Calculate the shear stresses in the walls and the angle of twist per unit length of the box. 	BT 5	Evaluating
11.	The figure below shows a two-cell tubular section as formed by a conventional airfoil shape, and having one interior web. An external torque of 10,000 Nm is acting in a clockwise direction. Determine the internal shear flow distribution. The cell areas are as follows: A1 = 680 cm^2 A2 = 2000 cm^2. The peripheral lengths are indicated in figure 	BT 5	Evaluating

12.	Determine the shear stress and angle of twist of the multi-cell given inn figure subjected to torque 12 kNm. Gb = 90 GPa.  All the dimensions are in mm		
13.	The figure shows a tubular sections with three cells. Determine the shear stresses in the walls of the section with a torque of 110 kNm. 	BT 5	Evaluating
14.	Find the following for the respective sections shown in figure below with shear stress restricted to 135 MPa and G as 70 GPa. (i) Torsional constant (ii) Torque (iii)Angle of twist 		

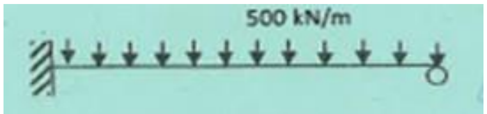
PART-C			
1	Derive the expression for shear stress and warping constant of a bar with elliptical cross section subjected to a torque T	BT 3	Applying
2	A thin walled box section having dimensions 2a x a x t is to be compared with a solid circular section of diameter as shown in the figure. Determine the thickness t so that the two sections have: (a) Same maximum shear stress for the same torque. (b) The same stiffness.  	BT 4	Analyzing
3	A tubular section having three cells as shown in the figure is subjected to a torque of 121 kN-m. Determine the shear stresses developed in the walls of the section.  All dimensions in mm	BT 3	Applying
4.	A two-cell tube as shown in the figure is subjected to a torque of 12kN-m. Determine the Shear Stress in each part and angle of twist per metre length. Take modulus of rigidity of the material as 93 kN/mm^2.  All dimensions in mm	BT 6	Creating

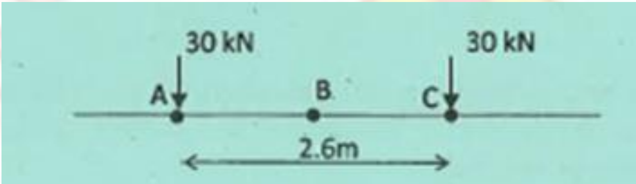
Prepared by

Mr. SATTAINATHAN SHARMA A/ Assistant Professor- Civil Department

UNIT-IV BEAMS ON ELASTIC FOUNDATIONS			
Beams on Elastic foundation – Methods of analysis – Elastic line method – Idealization of soil medium – Winkler model – Infinite beams – Semi infinite and finite beams – Rigid and flexible – Uniform cross section – Point load and udl.			
PART-A			
1.	What are the two analytical models on Elastic Foundation?	BT 1	Remembering
2.	What is Foundation Modulus?	BT 1	Remembering
3.	What are the two kind of boundary condition?	BT 1	Remembering
4.	Write the basic solution of infinite beam under concentrated force P.	BT 1	Remembering
5.	Write the deflection of semi infinite beam under concentrated force.	BT 1	Remembering
6.	Describe elastic foundation	BT 1	Remembering
7.	Write the equations for calculating slope and deflection of a infinite beam subjected to single concentrated load.	BT 2	Understanding
8.	Define semi infinite beam	BT 2	Understanding
9.	State examples for beams on elastic foundation.	BT 2	Understanding
10.	What is Winkler model?	BT 2	Understanding
11.	Define Winkler’s constant.	BT 3	Applying
12.	Compare Kelvin’s and Boussinesq’s equation.	BT 3	Applying
13.	Write short notes on FilonenkoBorodich Soil Model.	BT 3	Applying
14.	What is the basic principle of Rayleigh Ritz method?	BT 3	Applying
15.	Name and state the energy theorems.	BT 3	Applying
16.	Write the differential equation for beam resting on elastic foundation	BT 4	Analyzing
17.	Investigate the deflection, shear force and bending moment equation for an infinite beam loaded with UDL.	BT 4	Analyzing
18.	List the different types of elastic foundation. Give examples.	BT 4	Analyzing
19.	Classify finite beams and infinite beams.	BT 4	Analyzing
20.	Assess the term “end conditioning forces”.	BT 4	Evaluating
21.	Define the characteristic if the system.	BT 5	Evaluating
22.	List the assumptions made in Theory of Simple bending.	BT 5	Evaluating
23.	State the principle of superposition.	BT 6	Creating
24.	What is finite difference method?	BT 6	Creating
25.	What are the assumptions made in Winkler’s Theory?	BT 6	Creating
PART - B			
1.	A very long steel I-Beam 130mm deep rests on a foundation for which $k=1.5N/mm^2/mm$. The beam is subjected to a concentrated load at mid-length. The flange is 75mm wide. E=200GPa and stress is 220MPa. Flange and web thickness is 12mm. What is the maximum load that can be applied without causing the elastic limit exceed?	BT 5	Evaluating

2.	A single train wheel exerts a load of 150kN on a rail which is supported on a elastic foundation. The modulus of the foundation is 18 MPa/mm. Determine the maximum deflection, maximum slope, Maximum shear force, Maximum moment and maximum bending stress. In addition, find their loactions by taking the section modulus as $4x10^5$ mm^3 and EI=10 MNm^2.	BT 5	Evaluating
3.	A semi-infinite steel bar (E = 200GPa) has a square cross section(b =h=80mm) and rests on a Winkler foundation of modulus ko = 0.25 $N/mm^2/mm$. A downward force of 50kN is applied to the end. Find the maximum and minimum deflections and their locations. Also find max. Flexural stress and its location.	BT 5	Evaluating
4.	Find out bending moment and shear force for Semi-infinite beams with concentrated loads.	BT 1	Remembering
5.	Derive the differential equation for the elastic line of beam resting on an elastic foundation.	BT 1	Remembering
6.	Derive the expression for the rotations at A of a simply supported beam AB with udl over the entire span.	BT 1	Remembering
7.	Derive the expression of an infinite beam resting on elastic foundation for bending moment and shear force.	BT 2	Understanding
8.	An infinite beam on a winkler foundation has the following properties: k = 0.3kM/mm/mm, E = 210GPa. A concentrated load of intensity 35kN is applied to the beam. Compute the maximum deflection, shear force, bending moment and slope acting in the beam. The beam cross section is I shaped (flanges : 150x10mmand web 200x8mm)	BT 6	Creating
9.	Explain in detail about beams on elastic foundation.	BT 2	Understanding
10.	Arrive at the expression for an infinite beam resting on elastic foundation for rotation, deflection, shear force and bending moment equation for an infinite beam loaded with UDL.	BT 3	Applying
11.	A semi infinite beam resting on an elastic foundation is hinged at one end and 12kNm moment applied at this end. If the beam is 100mm wide and 50mm thick, determine the maximum deflection stresses in the beam. E = 90GPa, Poisson's ratio = 0.3 and modulus of elastic foundation = 8.4 N/mm^2.	BT 5	Evaluating
12.	An aluminum alloy I-beam of depth 100mm, I_x=$2.45x10^6$ mm^4, E= 72Gpa has a length = 7m, and is supported by 8 springs (k=100N/mm) spaced at a distance l-1m c/c along the beam. A load P=15kN is applied at the centre of the beam over on the springs. Compose the deflection of the beam under the load, the maximum bending moment and maximum bending stress in the beam.	BT 3	Applying

13.	Determine the deflection at various points of the built in beam of length 6m resting on an elastic foundation and loaded as shown below using finite difference method. Take E= 210Gpa, Moment of Inertia, I = $6x10^8$mm4 and k = 3MPa/mm. Compare the results using node intervals of h = 3m and h = 1.5m. 	BT 5	Evaluating
14.	Discuss about wrinkle model for elastic foundation.	BT 1	Remembering

PART-C			
1	Explain the two approaches generally adopted to solve problems of beams of finite length resting on elastic foundation. Out of these two approaches which one is generally preferred and why?	BT 2	Understanding
2	An infinite beam on a wrinkle foundation has the following properties: EI= 500 x 10^9Nmm^2, k = 0.25N/mm^2/mm. two loads 30kN each and 2.6m apart are applied to the beam. Compute the maximum deflection and maximum bending moment. 	BT 5	Evaluating
3	Elaborate the different types of elastic foundation. Give examples.	BT 6	Creating
4	Show that a longitudinal element of a thin cylindrical shell subjected to radial forces uniformly distributed along the circumference can be considered as a beam resisting on an elastic foundation.	BT 4	Analyzing

UNIT-V **PLASTICITY**			
Physical Assumptions – Yield criteria – Failure theories – Applications of thick cylinder – Plastic stress strain relationship. Elasto-plastic problems in bending and torsion and thick cylinder.			
PART-A			
1.	Define hardening rule.	BT 1	Remembering
2.	What are the factors which are affecting the plastic deformation?	BT 1	Remembering
3.	List out the various failure theories of plasticity?	BT 1	Remembering
4.	What is strain energy theory?	BT 1	Remembering
5.	What is plasticity?	BT 1	Remembering
6.	Define shape factor	BT 1	Remembering
7.	What is plastic hinge?	BT 2	Understanding
8.	Define isotropic hardening.	BT 2	Understanding
9.	What do you mean by plasticity?	BT 2	Understanding
10.	State the assumptions made in yield line theory.	BT 2	Understanding
11.	Describe the Von-Mises yield criteria.	BT 3	Applying
12.	Write the final equation for plastic stress strain relationship.	BT 3	Applying
13.	What is Bauschinger's effect?	BT 3	Applying
14.	Show the stress strain behaviour of a material which is rigid with strain hardening properties.	BT 3	Applying
15.	Give the advantages of true stress-strain diagram.	BT 3	Applying
16.	What is meant by yield line?		
17.	List out the yield conditions in plasticity.	BT 4	Analyzing
18.	Outline St.Venant"s theory for torsion.	BT 4	Analyzing
19.	Justify the important factors affecting plastic deformation?	BT 4	Analyzing
20.	Discuss the Tresca's yield criteria.	BT 5	Evaluating
21.	Assess the failure criterion equation for any 3 theory of failures.	BT 5	Evaluating
22.	Identify the applications of thick cylinders.	BT 5	Evaluating
23.	Explain the elastic plastic behaviour in bending.	BT 6	Creating
24.	Invent strain hardening.	BT 6	Creating
25.	Invent the stress-strain curve for a plastic and elastic material.	BT 6	Creating
PART-B			
1.	A simply supported rectangular beam of length 4m and dimensions of 200mm wide and 350mm depth is subjected to a central point load. Taking yield stress as 250MPa, find the load at the 1. Incipient yielding stage 2. Elasto plastic stage when the outer 75mm depth of beam yields plastically. 3. Plastic stage	BT 1	Remembering
2.	The state of stress at a point is given by σ_x = 70MPa, σ_y = 120MPa, and τ_{xy}= 35 MPa, if the yield strength for the material is 125 MPa, check whether yielding will occur according to Tresca's and Von Mises condition.	BT 1	Remembering

3.	Derive the expression for stresses in idealized stress-strain curve (linear).	BT 1	Remembering
4.	Discuss the following a) Recovery b) Recrystallization c) Grain growth	BT 1	Remembering
5.	A rectangular beam of width 4cm and depth 6cm is 3m long and carries a concentrated load 2kN at mid span. If the stress-strain curve for the beam material is given by $\sigma=700\varepsilon^{0.25}$, determine the maximum stress induced in the beam.	BT 2	Understanding
6.	Explain the various failure theories adopted in elastic plastic analysis with necessary sketches.	BT 2	Understanding
7.	The stress tensor at a point is given by 50 50 150 50 100 100 150 100 150 Calculate for the plane having direction cosines of $(1/\sqrt{6}, 1/\sqrt{3}, 1/\sqrt{2})$ (a) Total stresses (b) Normal stress (c) Shear stress and its direction	BT 2	Understanding
8.	A hollow circular shaft of inner radius 2cm and outer radius 5cm is subjected to a twisting moment so that the outer 1cm deep shall yields plastically. The yield stress in shear for the shaft material is 175 MPa and it is made of a non- linear material whose shear stress- shear strain curve is given by $\tau=280\gamma^{0.25}$.If this twisting moment is now released, make up the residual stress distribution in the shaft and the associated residual angle of twist, $G=0.84\times10^5$ N/mm^2.	BT 3	Applying
9.	Briefly explain about the stress strain relationships with the various categories of material.	BT 3	Applying
10.	A cantilever beam 10cm wide, 12cm deep is 4m long and is subjected to an end load of 5kN. If the σε curve for the material is given by $\sigma=700\varepsilon^{0.}$ Determine the maximum stress method and the radius of curvature.	BT 3	Applying
11.	A steel anchor steel bolt is subjected to a bending moment of 400Nm and a torque of 200Nm. If the yield stress in tension of the bolt material is 280MPa. Determine the diameter of the bolt according to 1. Trescas criteria 2. Von Mises yield criteria.	BT 4	Analyzing
12.	Discuss about a) Soap film analogy b) Sand Heap analogy	BT 2	Understanding
13.	Discuss about the mechanism of plastic deformation.	BT 2	Understanding

14.	A circular shaft of inner radius 60 mm and outer radius 120mm is made from a material having yield stress in shear of 150 MPa. Find the twisting couple applied to the shaft at 1. Incipient yielding stage 2. Elasto plastic stage when the outer 30mm depth of beam yields plastically. 3. Full yielding	BT 6	Creating

PART-C			
1	A solid circular shaft of radius 12cm is subjected to transmit 600 kW at 540rpm.The maximum torque is 30 percent greater than the mean torque. If the shear stress strain curve for the shaft materials is given by $\tau=280\gamma^{0.25}$, assess the maximum stress induced in the shaft and the corresponding angle of twist, prioritize these values if the shear stress-strain curve is a linear one? $G=0.84 \times 10^5$ N/mm².	BT 2	Understanding
2	Arrive at the plastic torque equation sand hill/heap analogy for circular, rectangular and equilateral triangle.	BT 4	Analyzing
3	With the help of case study justify any two theories of failure.	BT 5	Evaluating
4	A rectangular beam having linear stress-strain behavior is 6cm wide and 8cm deep. It is 3m long, simply supported at the ends and carries a uniformly distributed load over the whole span. The load is increased so that the outer 2cm depth of the beam yields plastically. If the yield stress for the beam material is 240MPa. Illustrate the residual stress distribution in the beam.	BT 1	Remembering

Prepared by
Mr. SATTAINATHAN SHARMA A/ Assistant Professor- Civil Department