II B. Tech II Semester Regular/Supplementary Examinations, July- 2023
STRENGTH OF MATERIALS - II
(Civil Engineering)

Time: 3 hours **Max. Marks: 70**

Answer any **FIVE** Questions, each Question from each unit
All Questions carry **Equal** Marks
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UNIT-I

1 a) A material experiences two perpendicular normal stresses accompanied by a state of simple shear. Use Mohr's circle of stresses to determine the principal stresses and the maximum shear stress. [7M]

b) A metal plate with a thickness of 10 mm is subjected to a biaxial stress state. The normal stresses are 100 MPa and 80 MPa, and the shear stress is 60 MPa. Determine the normal and tangential stresses on an inclined plane at an angle of 45 degrees from the horizontal. [7M]

Or

2 a) How do the maximum principal stress theory and the maximum principal strain theory differ in their approach to predicting failure? [7M]

b) A bar is subjected to axial loading at an angle of 30 degrees from the vertical. Determine the normal and tangential stresses on an inclined plane of the bar. [7M]

UNIT-II

3 a) A solid steel shaft of 100 mm diameter and 1.5 m length is subjected to a torque of 1000 Nm. Calculate the angle of twist at the free end of the shaft, given that the modulus of rigidity for steel is 80 GPa. [7M]

b) A shaft made of aluminum has a diameter of 60 mm and is subjected to a torque of 200 Nm. Determine the angle of twist at the free end of the shaft, given that the modulus of rigidity for aluminum is 25 GPa. [7M]

Or

4 a) Two identical open-coiled helical springs are placed in parallel and subjected to an axial load of 800 N. Calculate the deflection of the spring system, given that each spring has a stiffness of 15 N/mm. [7M]

b) An open-coiled helical spring made of 8 mm diameter wire has 12 coils. If the spring is subjected to an axial load of 600 N, calculate the deflection of the spring. [7M]

UNIT-III

5 a) An R.S.Tee-section, 150mm wide X 75mm deep, thickness of flange 9mm, thickness of web 8.4mm, is used as a strut, 3 metre 4 long, ends hinged. Calculate the safe axial load by Rankine’s formula, using a factor of safety of 3. Rankines constants, fc=315 N/mm^2 ; a = 1/ 7500. [9M]

b) What are some of the empirical formulas used to predict column stability? [5M]

Or
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6 a) What is the difference between short, medium and long columns in terms of their behavior under axial compression? [6M]

b) Calculate the critical load of a wooden column with a length of 6 meters, pinned at both ends, using the Rankine-Gordon formula. [7M]

UNIT-IV

7 a) A dam has a trapezoidal cross-section with a height of 20 meters and a base width of 30 meters at the bottom and 10 meters at the top. The dam is subjected to a direct load of 500 kN/m and a bending moment of 100 kN-m/m about the base. Determine the maximum direct stress and maximum bending stress in the dam. [7M]

b) A locomotive coupling rod of length 3m, rectangular section 60mm wide and 120mm deep. It is subjected to an axial thrust of 120kN and a transverse u.d.l of 5kN/m. Assuming the ends to be hinged and taking E = 200GN/m^2, find the max values of deflection, B,M, and stress. [7M]

Or

8 a) A cantilever beam has a circular cross-section with a diameter of 100mm and a length of 2m. The beam is subjected to a concentrated load of 10kN at the free end and a uniformly distributed load of 5kN/m over the entire length. Determine the maximum bending moment and the maximum direct stress developed in the beam. [7M]

b) A chimney with a rectangular cross-section has a height of 30 meters and a base width of 10 meters. The chimney is subjected to a direct load of 200 kN and a bending moment of 50 kN-m about the vertical axis. Determine the maximum direct stress and maximum bending stress in the chimney. [7M]

UNIT-V

9 a) A steel channel section has a depth of 200 mm, flange width of 75 mm, and thickness of 10 mm. If the section is subjected to a bending moment of 50 kN-m about the x-axis and 20 kN-m about the y-axis, calculate the maximum normal stress and the location of the neutral axis. [7M]

b) A steel channel section has a depth of 200 mm, flange width of 75 mm, and thickness of 10 mm. If the section is subjected to a shear force of 30 kN, determine the location of the shear centre. [7M]

Or

10 a) A C.I pipe of 200mm internal diameter and thickness of metal 50mm carries water under a pressure of 7 N/mm^2. Find the max and minimum intensities of hoop stress, sketch the Variation of hoop stress and radial pressure across the section. [7M]

b) An aluminum I-beam has a flange width of 150 mm, web depth of 200 mm, and flange thickness of 10 mm. If the beam is subjected to a bending moment of 60kN-m about the x-axis and 30kN-m about the y-axis, determine the principal axes, the moments of inertia about the principal axes, and the maximum normal stress in the section. [7M]

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UNIT-I

1 a) A piece of material is subjected to tensile stresses of 50 MPa in one direction and a compressive stress of 30 MPa at right angles. Draw the Mohr's circle of stress and determine the normal, tangential and resultant stresses on planes making angles of 25^o and 65^o with the plane of 50 MPa stress. [6M]

b) A machine component experiences compound stresses with a maximum shear stress of 120 MPa and normal stresses of 80 MPa and 50 MPa. Determine the principal stresses and strains and use the Maximum Principal stress theory to determine the safety factor of the component. [8M]

Or

2 a) A hollow cylinder with a thickness of 5 mm experiences biaxial stresses due to an internal pressure of 20 MPa and a torque of 100 N-m. Determine the principal stresses and strains, and use the Maximum shear stress theory to determine the maximum allowable internal pressure. [7M]

b) What are the limitations of using the theories of failures based on principal stresses and strains, and how do they compare to other failure theories? [7M]

UNIT-II

3 a) A circular shaft of diameter 50 mm is subjected to a torque of 500 Nm. Calculate the maximum shear stress induced in the shaft, assuming it to be a solid shaft. [7M]

b) Two identical close-coiled helical springs are placed in series and subjected to an axial load of 1000 N. Calculate the deflection of the spring system, given that each spring has a stiffness of 20 N/mm. [7M]

Or

4 a) A solid steel shaft of diameter 60 mm and length 3 meters is subjected to a torque of 4000 Nm. Determine the angle of twist per meter length of the shaft if the shear modulus is 85 GPa. [7M]

b) A hollow steel shaft has an outer diameter of 150 mm and an inner diameter of 100 mm. Determine the minimum wall thickness required for the shaft to withstand a torque of 5000 Nm if the shear modulus is 80 GPa. [7M]

UNIT-III

5 a) What is Euler's theorem for long columns and what assumptions does it make? [5M]

b) A strut, 6 metres long, end free, has to be erected to withstand a load of 400KN. Two sections are available: (i) 300 mm X 150 mm R.S.J., thickness of flanges 18 mm, thickness of web 10 mm. (ii) A.C.I. section, 225 mm external diameter, thickness of metal 25 mm. which is more suitable? Use Rankine's formula with a factor of safety of 3 in both cases; Fc for steel, $315 N/mm^2$ for C.I., $550 N/mm^2$. [9M]

Or
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6 a) How is Euler's critical load formula derived for various end conditions? [5M]

b) A reinforced concrete column with a length of 5 meters and a cross-sectional area of 150 cm^2 is pinned at one end and fixed at the other end. Calculate the equivalent length of the column. [9M]

UNIT-IV

7 a) A retaining wall has a trapezoidal cross-section with a height of 4 meters and a base width of 6 meters at the bottom and 3 meters at the top. The wall is subjected to a direct load of 100 kN/m and a bending moment of 30 kN-m/m about the base. Determine the maximum direct stress and maximum bending stress in the wall. [7M]

b) A horizontal strut 3m long is hinged at both and uniform section 40mm wide and 100mm deep. It carries an axial thrust of 100kN together with a u.d.l of 3N/mm. Calculate the max values of deflection, B.M. and stress. (E = 200 GN/m^2). [7M]

Or

8 a) A beam-column 6m long, hinged at ends is made of ISLB 300. It carries end thrust of 280kN along with a central load of 5kN. Neglecting the self weight and taking E = 200 Gpa, calculate the maximum stress induced. The properties of section are A = 48.08 cm^2, Ixx = 7332.9 cm^4 and Iyy = 376.2 cm^4. [7M]

b) A cast iron column of 200 mm diameter carries a vertical load of 400 kN, at a distance of 40 rnm from the center. Determine the maximum and minimum stress developed in the section, along the diameter passing through the point of loading. [7M]

UNIT-V

9 a) A beam with an unsymmetrical cross-section has a width of 120 mm, a depth of 200 mm, and a thickness of 10 mm on one side and 20 mm on the other side. The centroid of the cross-section is located at a distance of 50 mm from the larger side. The beam is subjected to a bending moment of 50 kN-m about the y-axis. Determine the maximum tensile and compressive stresses developed in the beam. [7M]

b) An I-section beam with a width of 250 mm, a depth of 400 mm, and a web thickness of 12 mm is subjected to a bending moment of 100 kN-m about the y-axis. Determine the location of the neutral axis and the maximum tensile and compressive stresses developed in the beam. The section modulus about the y-axis is 30000 mm^3. [7M]

Or

10 a) A T-section beam is subjected to a shear force of 10 kN at a distance of 300 mm from the left end. The section has a width of 200 mm, a depth of 300 mm, and a flange thickness of 20 mm. The centroid of the cross-section is located at a distance of 75 mm from the top flange. Determine the position of the shear center and the shear stress developed in the beam at a point 150 mm from the left end. [7M]

b) Explain the term moment of inertia of an area about X and Y axes and product of inertia. Write the values of the same for a rectangle section $(b \times d)$ about a set of rectangular axes X and Y passing through any two adjacent sides. [7M]

Code No: R2022012 **R20** **SET - 3**

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UNIT-I

1	a)	A steel bar with a rectangular cross-section is subjected to an axial load of 10 kN. If the width of the cross-section is 50 mm and the height is 100 mm, calculate the normal and tangential stresses on a plane inclined at 30 degrees to the horizontal.	[7M]
	b)	Compare and contrast the advantages and disadvantages of analytical and graphical methods for determining principal stresses and strains, and discuss the situations where each method may be preferred.	[7M]

Or

2	a)	Discuss the principles behind principal stresses and strains, and explain how they can be used to determine the maximum stress a material can withstand before failure occurs.	[7M]
	b)	A circular rod made of aluminum is subjected to biaxial stresses of 50 MPa and 20 MPa on two perpendicular planes. Using Mohr's circle, determine the maximum and minimum normal stresses and the corresponding planes of failure.	[7M]

UNIT-II

3	a)	A weight of 2500 N is dropped on to a closely coiled compression spring with 15 coils. Calculate the height of drop before striking so that the spring is compressed by 20 cm. The diameter of rod is 25mm and mean diameter of coil is 200mm. Take $N = 9 \times 10^4$ N/mm^2	[7M]
	b)	Derive expression for bending stress, change in the number of turns and strain – energy stored in a closely coiled helical spring subjected to an axial twist.	[7M]

Or

4	a)	A closely coiled helical spring of 10mm dia. steel rod having 12 coils and mean dia. 100mm is subjected to an axial twist of 900 N-cm. Calculate the increase in the number of turns, the bending stress induced in the section and the total angle of bend. Take $E = 200$ GN/m^2 and $N = 80$ GN/m^2.	[7M]
	b)	A close coiled helical spring is made of 10mm diameter wire coiled to a mean dia. of 120mm the number of turns being 10. It is fixed at one end and a twist of 15 N-m is applied at the other end. Taking $E = 200$ GN/m^2, evaluate i) the max. bending stress induced ii) angle of twist of spring and iii) number of turns after application of torque.	[7M]
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UNIT-III

5 a) What is the Rankine-Gordon formula, and how does it differ from Euler's formula? [7M]

b) A Strut is built-up of two 150 mm X 75 mm X 10mm Tee-Sections riveted back to back on the 150mm sides so as to form the section of a cross. Use Gordon's formula to determine the safe load for the strut, length 4 metres, ends fixed. The constants may be taken as 315 N/mm^2 and 1 / 250 for hinged ends. Use a factor of safety of 3. [7M]

Or

6 a) What is Prof. Perry's formula and how is it used in column stability analysis? [6M]

b) Derive the Euler's critical load formula for a long column with both ends fixed. [8M]

UNIT-IV

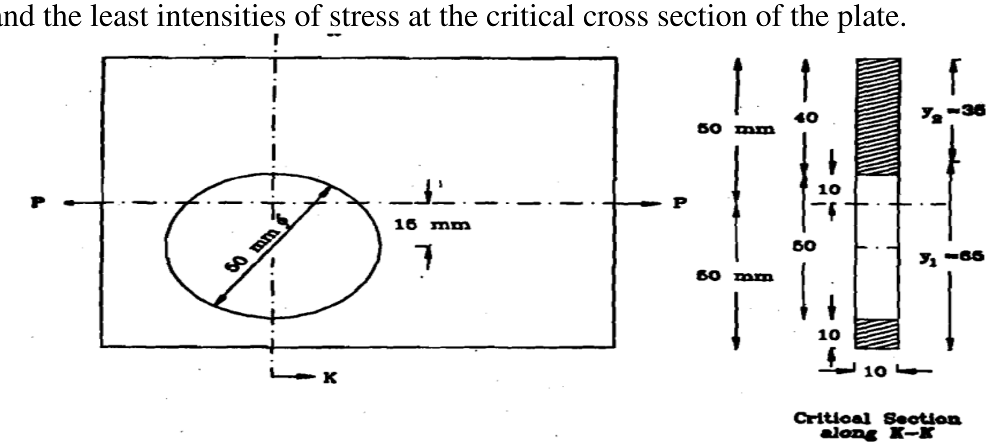
7 a) A tapering chimney of hollow circular section is 45 m high. Its external diameter at the base is 3.6m and at the top it is 2.4 m. It is subjected to a wind pressure of 22 kN/m of the projected area. Calculate the overturning moment at the base. If the weight of the chimney is 6000 kN and the internal diameter at the base is 1.2m, determine the maximum and minimum stress intensities at the base [7M]

b) A beam-column 6m long, hinged at ends is made of ISLB 300. It carries an end thrust of 280kN along with a central load of 5kN. Neglecting the self weight and taking E = 200 Gpa, calculate the maximum stress induced. The properties of section are A = 48.08 cm^2. Ixx = 7332.9 cm4 and Iyy = 376.2 cm^4. [7M]

Or

8 a) A short hollow cylindrical column carries a compressive force of 400 KN. The external diameter of the column is 200 mm and the internal diameter is 120 mm. Find the maximum permissible eccentricity of the load, if the allowable stresses are 60 N/mm^2 in compression and 25 N/mm^2 in tension. [7M]

b) A rectangular plate 10 mm thick with a hole of 50 mm diameter drilled on it is as shown in Figure. It is subjected to an axial pull of 45 kN. Determine the greatest and the least intensities of stress at the critical cross section of the plate. [7M]



UNIT-V

9 a) An L-section beam with a width of 250 mm, a depth of 400 mm, and a leg thickness of 20 mm is subjected to a shear force of 20 kN at a distance of 100 mm from the top flange. The centroid of the cross-section is located at a distance of 100 mm from the top flange. Determine the position of the shear center and the shear stress developed in the beam at a point 150 mm from the left end. [7M]

b) Find the increase in internal dia of tube 100 mm in internal dia. Subjected to an internal pressure of $90 N/mm^2$. Neglect longitudinal strain and take E = $200 GN/m^2$ and = 0.3. [7M]

Or

10 a) A channel section beam with a width of 150 mm, a depth of 300 mm, and a flange thickness of 20 mm is subjected to a shear force of 30 kN at a distance of 100 mm from the top flange. The centroid of the cross-section is located at a distance of 50 mm from the top flange. Determine the position of the shear center and the shear stress developed in the beam at a point 200 mm from the left end. [7M]

b) What do you understand by centroidal principal axes and principal moments of inertia. Determine the principal moments pf inertia for an unequal angle section $80 \times 60 \times 10 mm$. [7M]

Code No: R2022012 **R20** **SET - 4**

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(Civil Engineering)

Time: 3 hours **Max. Marks: 70**

Answer any **FIVE** Questions, each Question from each unit
All Questions carry **Equal** Marks
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UNIT-I

1 a) Explain the principles behind Mohr's circle of stresses and how it can be used to determine the principal stresses and strains of a material, as well as the advantages and disadvantages of this method. [7M]

b) A rectangular bar is subjected to an axial load of 50 kN. If the bar has a length of 2 m, a width of 0.5 m, and a thickness of 0.25 m, calculate the normal and tangential stresses on an inclined section of the bar at an angle of 30 degrees to the vertical. [7M]

Or

2 a) A cylindrical pressure vessel is subjected to a compound stress state due to both axial and tangential loads. Determine the normal and tangential stresses on an inclined plane at an angle of 45 degrees to the longitudinal axis of the vessel, and recommend the appropriate material and thickness for the vessel to prevent failure. [7M]

b) A structural engineer is designing a building with a large number of inclined beams. Using the principles of stresses on an inclined plane and compound stresses, recommend the appropriate materials and cross-sectional shapes for the beams to ensure they can withstand the expected loading. [7M]

UNIT-II

3 a) A circular shaft of diameter 40 mm and length 2.5 meters is subjected to a torque of 3000 Nm. Calculate the power transmitted by the shaft if the shaft rotates at a speed of 2000 rpm. [7M]

b) Three close-coiled helical springs are connected in series to support a load of 800 N. If each spring has a stiffness of 10 N/mm, determine the total deflection of the combination. [7M]

Or

4 a) A solid shaft of diameter 80 mm and length 4 meters is subjected to a combined loading of bending moment and torsional moment. If the bending moment is 5000 Nm and the torsional moment is 2000 Nm, determine the maximum shear stress induced in the shaft if the shear modulus is 90 GPa. [7M]

b) Two close-coiled helical springs are connected in parallel to support a load of 1200 N. If one spring has a stiffness of 20 N/mm and the other has a stiffness of 30 N/mm, determine the total deflection of the combination. [7M]

UNIT-III

5 a) How is Euler's critical load formula derived for various end conditions, and what is its significance? [7M]
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b) A Stanchion, 6 meters long, ends free, is built-up of two 400 mm X 100 mm standard channels placed 15 cm back to back, with one 400 mm X 12 mm plate riveted to each flange. It carries a load of 1300 KN, which is off the axis YY, in the vertical plane through the axis XX. Calculate the permissible eccentricity if the maximum permissible compressive stress is $105 N/mm^2$. For each channel, area of section = $6293 mm^2$, distance of c.g.from base = 24.2 mm; Ixx = $15082.6X10^4 mm^4$; Iyy = $504.8X10^4 mm^4$; E = $2X10^5 N/mm^2$. [7M]

Or

6 a) What are some empirical formulas used to predict the behavior of columns, and how are they derived? [7M]

b) A steel column with a length of 2 meters and a cross-sectional area of 100 cm^2 is subjected to an axial compressive load of 500 kN. Is this column classified as a short, medium, or long column? Why? [7M]

UNIT-IV

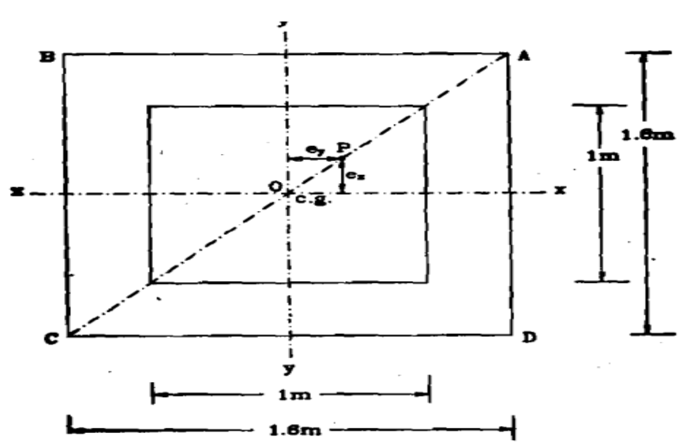
7 a) A short hollow cylindrical column carries a compressive force of 400 kN. The external diameter of the column is 200 mm and the internal diameter is 120 mm. Find the maximum permissible eccentricity of the load if the allowable stresses are 60 MPa in compression and 25 MPa in tension. [7M]

b) A locomotive coupling rod of length 3m, rectangular section 60mm wide and 120mm deep. It is subjected to an axial thrust of 120kN and a transverse u.d.l of 5kN/m. Assuming the ends to be hinged and taking E = $200 GN/m^2$, find the max values of deflection, BM, and stress. [7M]

Or

8 a) A horizontal strut of length L, having hinged ends, carries an axial compressive load P, and central vertical load W. Derive expression for max values of deflection, B.M and stress. [7M]

b) A short hollow pier 1.6 m x 1.6 m outsides and 1.0 m x 1.0 m inner sides supports a vertical load of 2000 kN at a point located on a diagonal 0.5 m from the vertical axis of the pier. Calculate the normal stresses at the 4 comers of the section of the pier, neglecting its self-weight. [7M]



UNIT-V

9 a) What is meant by the centroidal principal axis of a section? Explain its significance in the analysis of structures. [7M]

b) Determine the principal moments of inertia for an unequal L - angle section 80 mm x 60 mm x 8 mm. [7M]

Or

10 a) An unsymmetrical I-section beam with a width of 200 mm, a depth of 400 mm, a web thickness of 12 mm on one side, and 24 mm on the other side is subjected to a shear force of 15 kN at a distance of 150 mm from the left end. The centroid of the cross-section is located at a distance of 80 mm from the larger side. Determine the position of the shear center and the shear stress developed in the beam at a point 100 mm from the left end. [7M]

b) What do you understand by circle of inertia? Using the same obtain graphically the principal moments of inertia for an unequal angle section $60\times40\times6mm$. [7M]