BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: B. ARCH **SEMESTER : III**
BRANCH: ARCHITECTURE **SESSION : MO/2022**

SUBJECT: AR204 STRUCTURAL MECHANICS

TIME: 3:00 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) Define principal planes and principal stresses for plane stress condition of the body. [CO 1] [BL 1] [2]

Q.1(b) Define the terms: pure shear, uniaxial, and bi-axial state of stress. [CO 1] [BL1] [3]

Q.1(c) At a particular point, the material has biaxial state of stress with σ_x = 14 MPa and σ_y = -56 MPa. [5]
Determine the orientation of an inclined plane through the point such that the normal stress on the plane is zero. [CO 1, 3] [BL 3]

Q.2(a) Define shear stresses in beams. [CO 1, 2,3] [BL 1] [2]

Q.2(b) Outline the assumptions followed to derive the shear stress along the cross-section of the beams. [3]
[CO 1, 2, 3] [BL 4]

Q.2(c) Consider a beam of rectangular cross-section with width *b* and height *h* and it is subjected to shear force *V*. Show that the maximum shear stress of the beam is 1.5 times of the average shear stress. [5]
[CO 1, 2, 3] [BL 1]

Q.3(a) Describe the double integration method used to determine the deflection of beams. [2]
[CO 1, 2, 4] [BL 2]

Q.3(b) Write and explain first and second moment-area theorem. [CO 1, 2, 4] [BL 2] [3]

Q.3(c) Determine the angle of rotation and deflection at the free end of a cantilever beam subjected to a concentrated load *P* at the free end. The beam has length *L* and flexural rigidity *EI*. Use moment-area method. [5]
[CO 1, 2, 3] [BL 3]

Q.4(a) What is Castigliano's first theorem? Explain with an example. [CO 1, 4] [BL 2] [2]

Q.4(b) A cantilever beam is subjected to a couple M_0 as shown in Figure 1. The beam has length *L* and flexural rigidity EI . Derive the expression of angle of rotation at the free end of the beam using Castigliano's theorem. [3]
[CO 1, 2, 3, 4] [BL 6]

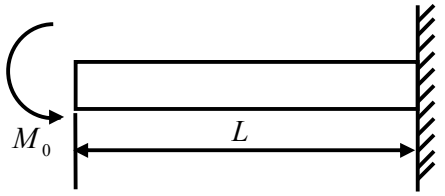

Figure 1

Q.4(c) A simply supported beam AB of length *L* supports uniform load of intensity *q* as shown in Figure 2. Evaluate the strain energy of the beam from the bending moment of the beam. [5]
CO 1, 2, 3, 4] [BL 5]

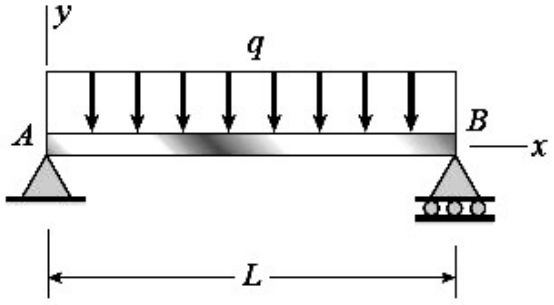

Figure 2

PTO

Q.5(a)	Define the critical load and equivalent length of a column.	[CO 1, 2] [BL 1]	[2]
Q.5(b)	Calculate the ratios of equivalent length and actual length of columns with following end conditions: (i) both ends pinned (ii) fixed at base and free at upper end (iii) both ends fixed.	[CO 1, 2, 3] [BL 3]	[3]
Q.5(c)	Derive the expression for critical load of a column when both the ends of it are pinned. Consider the length and flexural rigidity of the column as *L* and *EI*, respectively.	[CO 1, 2, 3] [BL 6]	[5]

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