Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 60560

M.E./M.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2023.

First Semester

Computer Aided Design

ED 4151 – ADVANCED MECHANICS OF MATERIALS

(Common to Engineering Design)

(Regulations 2021)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write Castigliano's first theorem and its application.
2. How can you find the elastic limit of a material?
3. Define 'Shear Centre'.
4. What is the kern of a rectangular section?
5. Mention the limitations of bending equation.
6. What are the stresses involved in curved beams?
7. How does torsion of a non-circular shaft differ from torsion of a circular shaft?
8. What do you understand by plastic torsion?
9. How are the radial stresses of solid disc and disc with hole different?
10. List any four practical examples of line contact stress.

PART B — (5 × 13 = 65 marks)

11. (a) Consider a thin large rectangular plate, with a small hole at the centre, subjected to uniform tensile stress from its two ends. Find the variations of stress components around the hole by Airy's stress function method.

Or

(b) Obtain the elasticity equation in Cartesian coordinates. Also, share your views on generalized Hooke's law for an isotropic material.

12. (a) Determine the shear centre for the section as shown in the given figure 1.

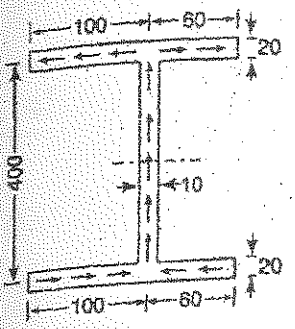

Figure 1

Or

(b) Figure 2 shows an unsymmetrical beam section composed of four stringers A, B, C and D, each of equal area connected by a thin web. It is assumed that the web will not carry any bending stress. The beam section is subjected to the bending moments and the values are : M_y = 500 kgf.cm and M_z = 10,00O kgf.cm. Calculate the stresses in members A and D. The area of each stringer is 0.6 cm².

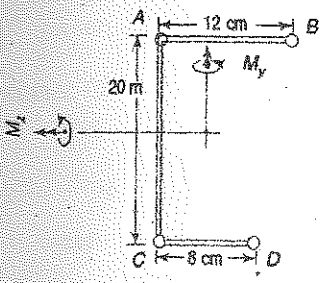

Figure 2

13. (a) A water tank 3.6 m deep and 2.7 m square is to be made of structural steel plate. The sides of the tank are divided into nine panels by two vertical supports and two horizontal supports i.e. each panel is 0.90 m wide and 1.20 m high, and the average head of water on a lower panel is 3 m as shown in Figure 3. Determine the required thickness of the plate for the lower panels, using a working stress limit of 124 MPa. Also, mention the assumptions made if any.

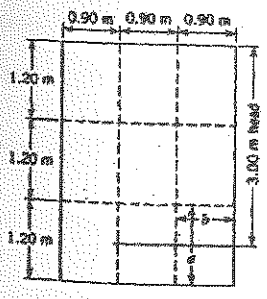

Figure 3

Or

(b) Find the maximum tensile stress in the curved part of the hook as shown in figure 4.

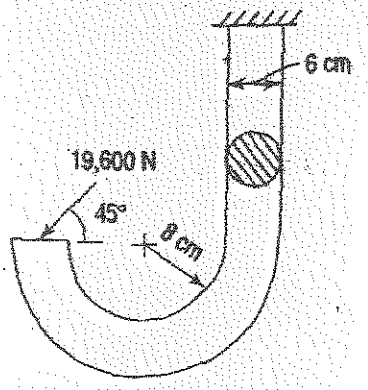

Figure 4

14. (a) Derive the Torsional equation for a non-circular section under twist and state the assumptions made. (13)

Or

(b) A hollow thin-wall torsion member has two compartments with cross-sectional dimensions as indicated in Figure 5. The material is an aluminum alloy for which G = 26 GPa. Determine the torque and unit angle of twist if the maximum shear stress, at locations away from stress concentrations, is 40 MPa.

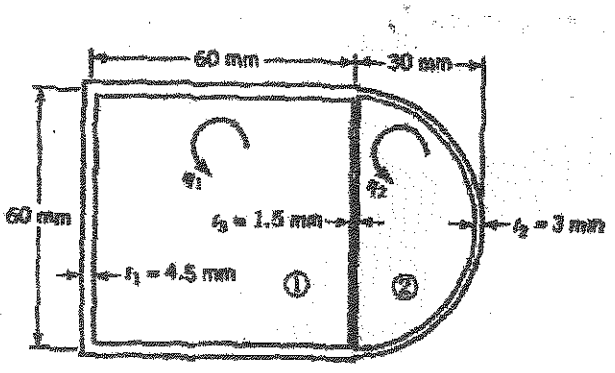

Figure 5

15. (a) Derive the governing equation for the determination of stresses in a rotating disc of uniform thickness. (13)

Or

(b) How do you calculate stress intensity factor in a crack? Discuss with a suitable example. (13)

PART C — (1 × 15 = 15 marks)

16. (a) Prove that the shear centre is at a distance (15)

$$e = R\frac{4(\sin\alpha - \alpha\cos\alpha)}{2\alpha - \sin 2\alpha}$$

from the centre of curvature O of the section as shown in Figure 6.

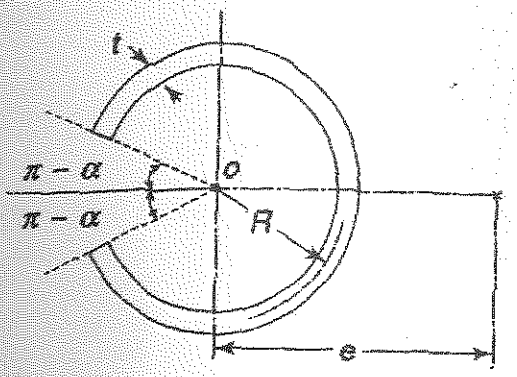

Figure 6

Or

(b) A flat steel disk of 75 cm outside diameter with a 15 cm diameter hole is shrunk around a solid steel shaft. The shrink-fit allowance is 1 part in 1000. Take E = 218×10^6 kgf/cm^2. (15)

(i) Determine the speed at which the shrink-fit will loosen up as a result of rotation.

(ii) What is the circumferential stress in the disk when spinning at the above speed?