(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 4071 Roll No. | | | | | | | | | | |

# B.Tech.

## (SEM. III ) ODD SEMESTER THEORY EXAMINATION 2010-11

## STRENGTH OF MATERIALS

*Time : 3 Hours* *Total Marks : 100*

**Note :** (1) Attempt **all** questions.

(2) Marks are indicated against each part.

(3) Assume missing data suitably, if any.

1. Attempt any **two** parts :

(a) A vertical rod 2 m long, fixed at the upper end, is 13 $cm^2$ in area for 1 m and 20 $cm^2$ in area for 1 m. A collar is attached to the free end. Through what height can a load of 100 kg fall on to the collar to cause a maximum stress of 50 $N/mm^2$ ?

$E = 2,00,000\ N/mm^2$. 10

(b) (i) What are the five principal theories of failure, name them ? 4

(ii) Construct Mohr's circle for the case of plane stress $\sigma_x = 360\ kg/cm^2$, $\sigma_y = 200\ kg/cm^2$ and $\tau_{xy} = 60\ kg/cm^2$ and determine the magnitudes of the two principal stresses $\sigma_1$ and $\sigma_2$ and the angle $\phi$ between the direction $\sigma_x$ and $\sigma_1$. 6

(c) (i) State and prove Castigliano's Theorem for concentrated loads. 5

(ii) The principal stresses at a point in an elastic material are 60 N/mm$^2$ tensile, 20 N/mm$^2$ tensile, and 50 N/mm$^2$ compressive. Calculate the volumetric strain.

E = 100,000 N/mm$^2$. 5

2. Attempt any **one** of the following :

(a) (i) A flywheel weighing 500 kg is mounted on a shaft 75 mm diameter and midway between bearings 0.6 m apart. If the shaft is transmitting 30 kW at 360 rpm. Calculate the principal stresses and the maximum shear stress at the ends of a vertical and horizontal diameter in a plane close to the flywheel. 12

(ii) Find the maximum deflection in a cantilever of length L due to a load W at its free end. 8

(b) A beam of uniform section 9 m long is carried on three supports at the same level, one at each end and one at 6 m from the left end. A uniformly distributed load of 16 kN/m is carried across the whole span, and a point load of 20 kN at 4.5 m from the end. Draw the S.F and B.M diagrams. 20

3. Attempt any **two** of the following :

(a) Determine the maximum angle of helix for which the error in calculating the extension of a helical spring under axial load by the "close - coiled" formula is less than 1%. 10

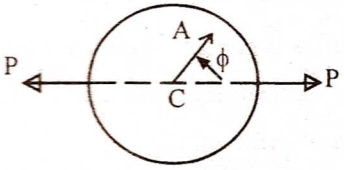
(b) A cantilever leaf spring of length 0.43 m has four leaves of thickness 9 mm. If an end load of 2.5 kN causes a deflection of 36 mm find the width of the leaves.

$E = 200{,}000\ N/mm^2$. 10

(c) A slender column of length $l$ is built-in at its lower end and laterally supported (pin jointed) at its upper end. Find the first critical value of the compression load $\rho$. 10

4. Attempt any two of the following :

(a) A thin spherical shell of mean radius r and wall thickness t is subjected to tensile forces $\rho$ acting along a diameter of the sphere as shown in figure. There is no internal pressure. Find the principal membrane stresses $\sigma_1$ and $\sigma_2$ at the point A on the shell defined by the angle $\phi$ as shown: 10




(b) The cylinder of hydraulic ram is 6 cm internal diameter. Find the thickness required to with stand an internal pressure of 40 $N/mm^2$, if the maximum tensile stress is limited to 60 $N/mm^2$ and maximum shear stress to 50 $N/mm^2$. 10

(c) A compound cylinder is to be made by shrinking one tube on to another so that the radial compression stress at the friction is 28.5 $N/mm^2$. If the outside diameter is 26.5 cm, and the bore 12.5 cm, calculate the allowance for shrinkage at the common diameter, which is 20 cm.

$E = 210{,}000\ N/mm^2$. 10

5. Attempt any **two** of the following :

(a) A curved bar of square section 3 cm sides and mean redius of curvature 4.5 cm is initially unstressed. If a bending moment of 300 N-m is applied to the bar tending to straighten it, find the stresses at the inner and outer faces. 10

(b) A steel tube having outside diameter 5 cm, bore 3 cm is bent into a quadrant of 2 m radius. One end is rigidly attached to a horizontal box plate to which a tangent to that end is a perpendicular, and the free end supports a load if 100 kg. Determine the Horizontal deflection of the free end under this load using Castigliano's Theorem. $E = 208{,}000\ N/mm^2$. 10

(c) (i) Develop a general theory of bending of prismatic beam of arbitrary cross-section. (not having an axial plane of symmetry). 7

(ii) Write brief note of Shear Centre. 3