CBCS SC

USN | | | | | | | | | | |

17ME34

# Third Semester B.E. Degree Examination, Dec.2019/Jan.2020
## Mechanics of Materials

Time: 3 hrs. Max. Marks: 100

***Note: Answer any FIVE full questions, choosing ONE full question from each module.***

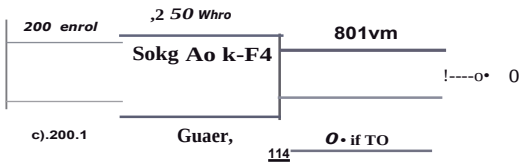
### Module-1

1 a. Explain principle of superposition. **(03 Marks)**

b. Derive an expression for Young's Modulus (E) interms of bulk modulus (K) and Poisson's ratio (n). **(07 Marks)**

c. A stepped bar is subjected to forces as shown in Fig.Q.1(c). Determine the stress induced in different portions and Net deformation in the stepped bar. Take E = 2 x10- $\frac{N}{mm^2}$ **(10 Marks)**

Fig.Q.1(c)




**OR**

2 a. Derive an expression for the total elongation of tapered bar varying diameter from d 1 to d, subjected to axial load 'W. (10 **Marks)**

b. A steel bar is placed between two copper bar, each having same area and length as the steel bar. These are rigidly connected together at a temperature of 25°C. When the temperature is raised to 325°C. The length of the bar is increased by 1.5mm compute the original length and find the stresses in each bar. Take Ested = 210GPa, E. = 100GPa, asteet = 12 x 10 $^{-6}$/°C, oc,„ = 17.5 x 10-6/°C. **Marks)**

### Module_2

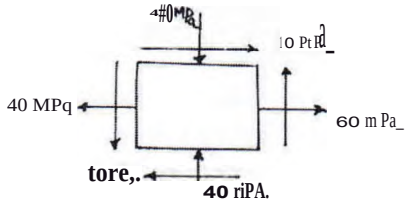
3 a. Derive the expression for normal stress and shear stress on a plane inclined at 'A' angle to the vertical axis in a biaxial stress system with shear stress. **(10 Marks)**

b. Determine the wall thickness necessary for a thick steel cylinder shell having 200mm inner diameter to withstand an internal pressure of 40MPa. Permissible tensile stress in the material is lOOMPa. Also sketch the variation of hoop stress and radial stress across the thickness. **(10 Marks)**

**OR**

4 a. A plane element subjected to stress shown in Fig.Q.4(a). Determine principal stresses, Max shear stress and their plane. Use Mohr's circle method. **(10 Marks)**

Fig.Q.4(a)




b. A cylindrical thin drum 800mm in diameter and 3m long has a shell thickness of 10mm, If the drum is subjected to an internal pressure of 25 bar. Calculate the change in diameter, change in length and change in volume. Take E = 200GPa, n = 0.25. **Marks)**

## Module-3

5 a. Explain different types of beams and loads. **(05 Marks)**

b. Draw SFD and BMD for the beam shown in Fig.Q.5(b).

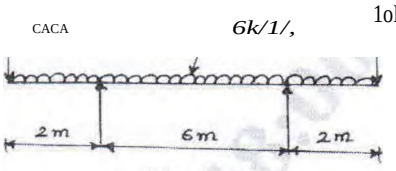



Fig.Q.5(b)

**(15 Marks)**

**OR**

6 a. Prove the relations $\frac{M}{I} = \frac{y}{} = \frac{E}{R}$ with usual notations. **(10 Marks)**

b. A cantilever beam of square section 200mm x 200rnm, 2m long just fails in bending, when a load of 20kN is placed at its free end. A beam of the same material having a rectangular cross-section 150mm x 300mm. Simply supported over a span of 3m is to be used under uniformly distributed load 'W' $\frac{N}{rn}$. What can be maximum value of W? **(10 Marks)**

## Module-4

7 a. List all the assumptions and derive the torsion formula in standard form $\frac{J}{R} = \frac{}{L}$ GO **(10 Marks)**

b. A hollow shaft having diameter ratio of 0.4, transmits 562.5kW power at 100rpm. Determine cross-sectional dimensions of the shaft, if shear stress is not exceed 60MPa and twist in length of 2.5m should not exceed 1.3°. Maximum torque transmitted is 25% higher than average torque G = 90GPa. **(10 Marks)**

**OR**

8 a. Derive an expression for critical load in a column subjected to compressive load, when one end is fixed and the other end free. (10 **Marks)**

b. A 1.5m long column has a circular cross-section of 50mm diameter. One end of the column is fixed and other end is free. Take factor of safety as 3, calculate the safe load using

i) Rankine's formula, take yield stress = 560 N/mm $^2$ and a = $\frac{1}{1600}$

ii) Euler's formula, Young's modulus = 1.2 x 10 $^5$ N/mm$^2$. **(10 Marko**

## Module-5

9 a. Explain Factor of safety. **(04 Marks)**

b. Explain maximum normal stress theory and maximum shear stress theory. **(08 Marks)**

c. A bar of 5m long and 50mm diameter hangs vertically and it has collar attached to it to the lower end rigidly. Determine maximum stresses induced when

i) Weight of 3000N falls through a height of 100mm on the collar.

ii) Weight of 30kN falls through a height of 10mm on the collar. Take = 2 x 10 $^5$ N/mm$^2$. **(08 Marks)**

**OR**

10 a. Derive the expression for strain energy due to shear stress and bending. **(10 Marks)**

b. The stresses induced at a critical point in a machine component made of steel (a, = 380MPa) are as follows: $a_x = 100 \frac{N}{mm^2}$, $a_y = 40 \frac{N}{Mac\ 1}$ $T_{xy} = 80$ N le ate factor of safety by i) Rankine's theory ii) Guest's theory. **(10 Marks)**

* * * * *