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

# B.E / B.TECH. DEGREE EXAMINATION, MAY 2023

Third Semester

## AE18402 – STRENGTH OF MATERIALS

*(Automobile Engineering)*

**(Regulation 2018)**

**TIME: 3 HOURS** **MAX. MARKS: 100**

**CO 1** Students will be able to Predict the behavior of the materials for different loading conditions and characteristics of materials.

**CO 2** Students will be able to Select suitable cross-sections for the beams and springs based on theoretical and experimental work.

**CO 3** Students will be able to Estimate the Deflection of beams under different type of loading conditions.

**CO 4** Students will be able to Select the dimensional parameters for the shafts and springs under torsion loads through the different types of testing.

**CO 5** Students will be able to Develop a basic understanding of Biaxial Stresses and impact test on metals.

**PART- A (10 x 2 = 20 Marks)**

(Answer all Questions)

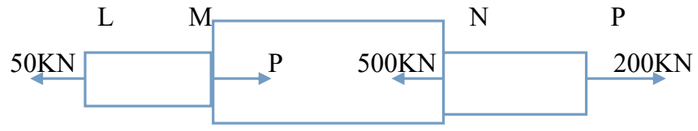
| | | CO | RBT LEVEL |
|---|---|---|---|
| **1.** | State Hooke's Law. | **1** | **1** |
| **2.** | How will you find the stresses and load carried by each member of a composite bar? | **1** | **2** |
| **3.** | Classify the beams according to their support. | **2** | **2** |
| **4.** | What do you mean by section modulus? | **2** | **2** |
| **5.** | Write an expression for finding deflection in a simply supported beam when it is subjected to UDL. | **3** | **1** |
| **6.** | State Mohr's Theorem I & II. | **3** | **1** |
| **7.** | The shearing stress of a solid shaft is not to exceed 40 $N/mm^2$ when the torque transmitted is 20000 N-m. Determine the minimum diameter of the shaft. | **4** | **3** |
| **8.** | Define the stiffness of a spring. | **4** | **1** |
| **9.** | Distinguish between the thin cylinder and thick cylinder. | **5** | **2** |
| **10.** | What are the possibilities of failures in thin cylinders? | **5** | **1** |





**PART- B (5 x 14 = 70 Marks)**

| | | | Marks | CO | RBT LEVEL |
|---|---|---|---|---|---|
| **11. (a)** | A Member LMNP is subjected to point loads as shown in the figure. Calculate (i) Force P necessary for equilibrium (ii) Total elongation of the bar | | **(14)** | **1** | **3** |

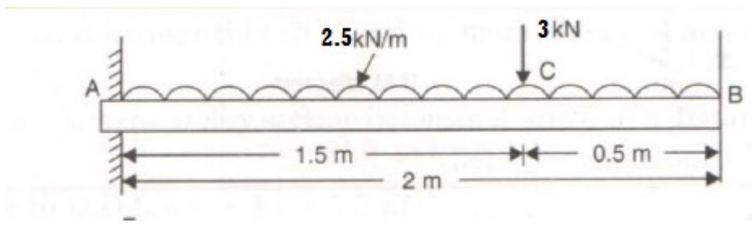



Length LM = 1000 mm, MN = 1000 mm, NP = 600 mm

Area LM = $600mm^2$, MN = $2400mm^2$ NP = $1200mm^2$

**(OR)**

| | | | | | |
|---|---|---|---|---|---|
| **(b)** | **(i)** | A Compound tube consists of a steel tube with 140 mm internal diameter and 160 mm external diameter and an outer brass tube with 160 mm internal diameter and 180 mm external diameter. The two tubes are of the same length. The compound tube carries an axial load of 900 kN. Find the stresses and the load carried by each tube and the amount it shortens. The length of each tube is 140 mm. Take E for steel as 2 x $10^5$ $N/mm^2$ and for brass as 1 x $10^5$ $N/mm^2$. | **(7)** | **1** | **3** |
| | **(ii)** | A Reinforced short column 250 mm x 250 mm in the section is reinforced with 8 steel bars. The total area of steel bars is 1608.50 $mm^2$. The column carries a load of 270 kN. If the modulus of elasticity for steel is 18 times that of concrete, find the stresses in concrete and steel. | **(7)** | **1** | **3** |
| **12. (a)** | | Draw the shear force and bending moment diagram for the beam shown in the figure. | **(14)** | **2** | **3** |



**(OR)**

| | | | | | |
|---|---|---|---|---|---|
| **(b)** | A Timber beam of a rectangular section is to support a load of 20 kN uniformly distributed over a span of 3.6 m when the beam is simply supported. If the depth of the section is to be twice the breadth, and the stress in the timber is not to exceed 7 N/mm$^2$, Find the dimensions of the cross-section.<br>How would you modify the cross-section of the beam, if it carries a concentrated load of 20 kN placed at the center with the same ratio of breadth to depth? | **(14)** | **2** | **3** |
| **13. (a)** | A beam of length 6 m is simply supported at its ends and carries two point loads of 48 kN and 40 kN at a distance of 1m and 3m respectively from the left support. Take E = 2 x $10^5$ N/mm$^2$ and I = 85 x $10^6$ mm$^4$. Find the Deflection under each load also find the maximum deflection. | **(14)** | **3** | **3** |

**(OR)**

| | | | | |
|---|---|---|---|---|
| **(b)** | A cantilever of length 3 m carries two point loads 2 kN at free end and 4 kN at a distance of 1 m from the free end. Find the deflection at the free end. Solve by Moment area method. | **(14)** | **3** | **3** |
| **14. (a)** | A hollow shaft of diameter ratio 3/8 is to transmit 375 kW power at 100 rpm. The maximum torque being 20% greater than the mean. The shear stress is not to exceed 60 N/mm$^2$ and a twist in a length of 4 m not to exceed 2 degree. Calculate its external and internal diameters which would satisfy both the above conditions.<br>Assume modulus of rigidity C= 0.85 x $10^5$ N/mm$^2$. | **(14)** | **4** | **3** |

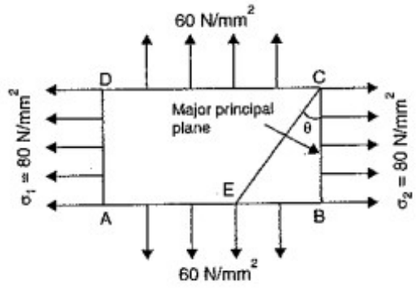
**(OR)**

| | | | | |
|---|---|---|---|---|
| **(b)** | A close coiled helical spring has a stiffness of 10 N/mm its length when fully compressed with adjacent coils touching each other is 400 mm. The modulus of rigidity of the material of the spring is 0.8 x $10^5$ N/mm$^2$.<br>(i) Determine the wire diameter and mean coil diameter if their ratio is 1/10<br>(ii) If the gap between any two adjacent coils is 2 mm, what maximum load can be applied before the spring becomes solid?<br>(iii) What is the corresponding maximum shear stress in the spring? | **(14)** | **4** | **3** |





| | | | | |
|---|---|---|---|---|
| **15. (a)** | At a Point in a strained material the principal tensile stresses across two perpendicular planes are 80 N/mm$^2$ and 40 N/mm$^2$. Determine Normal Stress, Shear stress and the resultant Stress on a plane inclined at 20$^o$ with the major principal plane. Determine also the obliquity. | **(14)** | **5** | **3** |




**(OR)**

| | | | | |
|---|---|---|---|---|
| **(b)** | Calculate the (i) change in diameter, (ii) change in length and change in volume of a thin cylindrical shell 1000 mm diameter, 10 mm thick and 5 m long when subjected to internal pressure of 3 N/mm$^2$. Take the value of E = 2 x $10^5$ N/mm$^2$ and Poisson's ratio = 0.3 | **(14)** | **5** | **3** |

**PART- C (1 x 10 = 10 Marks)**

(Q.No.16 is compulsory)

| | | Marks | CO | RBT LEVEL |
|---|---|---|---|---|
| **16.** | A Water main of 500 mm internal diameter and 20 mm thick is running full. The water main is of cast iron and is supported at two points 10 m apart. Find the maximum stress in the metal. The cast iron and water weigh 7200 N/m$^3$ and 10000 N/m$^3$ respectively. | **(10)** | **2** | **3** |

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