| U.S.N. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|

# B.M.S. College of Engineering, Bengaluru-560019

**Autonomous Institute Affiliated to VTU**

## January / February 2025 Semester End Main Examinations

**Programme: B.E.** **Semester: III**

**Branch: Mechanical Engineering** **Duration: 3 hrs.**

**Course Code: 23ME3PCSOM / 22ME3PCSOM** **Max Marks: 100**

**Course: Strength of Materials**

**Instructions**: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

**Important Note:** Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

| | | | UNIT - I | *CO* | *PO* | Marks |
|---|---|---|---|---|---|---|
| 1 | a) | | A compound bar is made of a bronze bar of 300 $mm^2$ cross sectional area and a steel bar of 200 $mm^2$ cross sectional area connected in series. The lengths of bronze and steel portions are 300 mm & 200 mm respectively. Determine the maximum axial force P that can be applied on the compound bar, taking allowable stresses for bronze and steel as 130 MPa and 90 MPa. Also determine the net deformation in the compound bar. Take, $E_b$=85 GPa, $E_s$=200 GPa. | *CO1* | *PO1* *PO2* | **10** |
| | b) | | A weight of 300 kN is supported by a short concrete column of 250 mm square section. The column is reinforced with 4 steel bars of total cross-sectional area 5500 $mm^2$. Find the stresses in steel and the concrete if the modular ratio = 15 ($E_s$ = 15 $E_c$) and the stress in the concrete must not exceed 4.5 $MN/m^2$. What area of steel is required in order that the column may support a load of 500 kN. | *CO1* | *PO1* *PO2* | **10** |
| | | | **OR** | | | |
| 2 | a) | | Derive the expression for the extension of a tapered circular bar subjected to an axial pull, P. | *CO1* | *PO1* *PO2* | **10** |
| | b) | | A stressed element in a beam is subjected to 100 $N/mm^2$ tensile and 120 $N/mm^2$ compressive loads along the mutually perpendicular directions. Determine graphically the normal and tangential stresses on a plane inclined at $40^o$ to the vertical. | *CO1* | *PO1* *PO2* *PO4* | **10** |
| | | | **UNIT – II** | | | |
| 3 | a) | | A simply supported beam of 6 m length is subjected to transverse point loads of 15 kN, 20 kN and P kN at 1.5 m, 2.5 m and 4 m respectively, from left end. Draw the shear force and bending moment diagrams. Determine the magnitude of load, P when the maximum bending moment is limited to 100 kN/m. | *CO2* | *PO1* *PO2* *PO4* | **10** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | b) | A cantilever beam of 4 m length is subjected to a UDL of 12 kN/m for the entire length. Draw its shear force and bending moment diagrams. | *CO2* | *PO1*<br>*PO2*<br>*PO4* | **10** |
| | | | **OR** | | | |
| | 4 | a) | Derive the relationship between the load intensity, shear force and the bending moment, when a beam is subjected to transverse loads. | *CO2* | *PO1*<br>*PO2*<br>*PO4* | **05** |
| | | b) | An overhanging beam of 8 m length with 1 m overhang on either sides is subjected to transverse point loads of 15 kN, 20 kN and 25 kN at 1.5 m, 2.5 m and 4 m respectively, from left support. It is made up of steel having density 7840 kg/m$^3$ and cross-section 100 mm$^2$. Draw the shear force and bending moment diagrams. | *CO2* | *PO1*<br>*PO2*<br>*PO4* | **15** |
| | | | **UNIT – III** | | | |
| | 5 | a) | A simply supported beam of 5 m length is subjected to a clockwise bending moment of 120 kN/m at the midspan. Determine, in terms of EI, the magnitude of bending and shear stresses at the support and midspan. | *CO3* | *PO1*<br>*PO2*<br>*PO4* | **10** |
| | | b) | Prove that the maximum shear stress developed in a circular cross-section is 1.3 times the average shear stress. | *CO3* | *PO1*<br>*PO2*<br>*PO4* | **10** |
| | | | **OR** | | | |
| | 6 | a) | A simply supported beam of 2 m span carries a UDL of 140 N/m over the whole span. The cross-section of the beam is a I-section with a flange width of 120 mm, stem and flange thickness of 20 mm and overall depth 160 mm. Determine the maximum shear stress in the beam and draw the shear stress distribution for the section. | *CO3* | *PO1*<br>*PO2*<br>*PO4* | **10** |
| | | b) | A simply supported beam of 4 m span carries a central point load of 40 kN. The cross-section of the beam has a sectional area moment of inertia, I and Young's Modulus, E. Determine the maximum lateral displacement in the beam and its location. Also find the slope at the mid-span. | *CO3* | *PO1*<br>*PO2*<br>*PO4* | **10** |
| | | | **UNIT - IV** | | | |
| | 7 | a) | Write the assumptions and derive the torsional equation when a circular shaft is subjected to a torsional load. | *CO4* | *PO1*<br>*PO2* | **10** |
| | | b) | A shaft is transmitting 440 kW of power at 200 rpm. The maximum shear stress allowed is 75 N/mm$^2$. Determine the diameter of the shaft. Also evaluate the internal and external diameters of a hollow shaft, limited to thickness of 20 mm, for the same usage. | *CO4* | *PO1*<br>*PO2* | **10** |
| | | | **OR** | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 8 | a) | Prove that a hollow shaft is stiffer and stronger than a solid circular shaft, for the same material, length and weight. | *CO4* | *PO1*<br>*PO2* | **14** |
| | | b) | A shaft is transmitting 250 kW of power at 100 rpm. The maximum shear stress allowed is 75 $N/mm^2$. Determine the diameter of the shaft? | *CO4* | *PO1*<br>*PO2*<br>*PO4* | **06** |
| | | | **UNIT – V** | | | |
| | 9 | a) | Derive the expression for the change in the volume of a thin cylinder when subjected to an internal gas pressure of 20 $N/mm^2$. | *CO5* | *PO1*<br>*PO2* | **10** |
| | | b) | Determine the buckling load for a strut of T-section, the flange width being 100 mm, overall depth 80 mm and both flange and stem 12 mm thick. The strut is 4 m long and is hinged at both ends. Take E = 200 GPa. | *CO5* | *PO1*<br>*PO2* | **10** |
| | | | **OR** | | | |
| | 10 | a) | Why does the Euler's buckling theory fail for some columns. Elaborate your answer. | *CO5* | *PO1*<br>*PO2* | **10** |
| | | b) | A 1.5 m long circular column of 50 mm diameter is fixed at one end and the other end is free. Taking the factor of safety as 3 and E = 1.2 x $10^5$ $N/mm^2$, determine the safe load using<br>i) Rankine' formula with yield stress as 560 $N/mm^2$ and $\alpha = 1/1600$.<br>ii) Euler's formula. | *CO5* | *PO1*<br>*PO2* | **10** |

**********