MODEL QUESTION PAPER-1
UNIVERSITY OF KERALA

FIFTH SEMESTER B.TECH DEGREE EXAMINATION NOVEMBER 2015.

Mechanical Engineering

13.504 MECHANICS OF MATERIALS (M)

(2013 Admissions)

Time : Three Hours Maximum : 100 Marks

Part A

Answer all questions

1. State St. Venant's principle for end effects.
2. What is meant by octahedral plane?
3. Write down the Hooke's law in polar co-ordinates
4. What is plane stress?
5. What is interference fit?
6. What is meant by shear centre?
7. What is meant by complementary energy.
8. Give the expressions for strain energy due to torsion
9. What is meant by warping function?
10. Define the term *shear flow*.

(10x2= 20 marks)

Part B

Answer any ONE from each module.

Module I

11. The state of stress at a point is given by σ_x=70 MPa, σ_y=10 MPa, σ_z=-20 MPa, τ_{xy}=-40 MPa, τ_{yz}= τ_{xz}=20MPa. Determine the principal stresses, maximum shear stress and direction of maximum principal stress.

Or

12. At a point in a stressed material the Cartesian stress components are $\sigma_x = -40, \sigma_y = 80, \sigma_z = 120, \tau_{xy} = 72, \tau_{yz} = 46, \tau_{xz} = 32$ Pa. Calculate the normal, shear and resultant stresses on a plane whose normal makes an angle of 48^o with *x*-axis and 61^o with the *y*-axis.

Module II

13. Investigate whether the following polynomial is permissible as an Airy's stress function $\phi = A\left(xy^2 - \frac{3}{4}xyh^3\right)$. If permissible, derive the expressions for stress.

Or

14. a) Derive the equilibrium equations in polar co-ordinates. (10 marks)

b) Determine the tangential stresses in a built up cylinder subjected to an internal pressure of 300MPa if a =10cm, b =15cm and c =20cm with a shrinkage allowance of 0.0012cm. Take E=2.1x10^{5}MPa and $\nu = 0.3$.

(10 marks)

Module III

15. a) Explain the procedure of determination of deflections in structures using Castigliano's theorem. (10marks)

b) Compare the maximum tensile stress in the curved part of a hook having circular cross section with square cross section. (10 marks)

Or

16. a) Determine the shear stress distribution for a circular open section under bending caused by a shear force. Locate the shear centre. (12 marks)

b) Explain the Maxwell reciprocal theorem. (8 marks)

Module IV

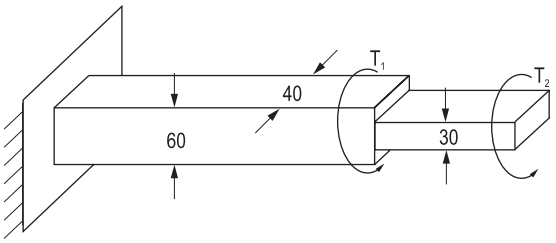
17. (a) What is Prandtl's stress function? Derive the governing differential equation for a prismatic bar subjected to torsion in terms of the Prandtl's stress function. (12 marks)

(b) Compare effects of torsional loading on thin walled open and closed sections (8 marks)

Or

18. (a) Explain membrane analogy (5marks)

(b) A rod with rectangular cross section is used to transmit torque to a machine frame (see figure). It has a width of 40mm. The first 3.0m length of rod has a depth of 60mm and the remaining 1.5 m length has a depth of 30mm. The rod is made of steel having G=77.5 GPa. Given T_1=750Nm and T_2=400Nm, determine the maximum shear stress in the rod. Also determine the angle of twist of the free end.



(15 marks)

(4x20= 80 marks)