Reg No.:_____   Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FOURTH SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2018
Course Code: ME202
Course Name: ADVANCED MECHANICS OF SOLIDS (ME)
Max. Marks: 100   Duration: 3 Hours

PART A
Answer any three questions. Each question carries 10 marks.

1. The state of stress at a point is characterised by the components, (10)
$\sigma_x = 12.31, \sigma_y = 8.96, \sigma_z = 4.34, \tau_{xy} = 4.20, \tau_{yz} = 5.27, \tau_{xz} = 0.84$ MPa.
Determine the values of principal stresses and maximum shear stress.

2. a) State St. Venant's principle for end effects. (3)

   b) Write down the generalized Hooke's law for a linear elastic isotropic material (3)

   c) What is meant by octahedral plane? (2)

   d) What is plane stress? (2)

3. a) If the displacement field is given by $U = (x^2 + y)\mathbf{i} + (3 + z)\mathbf{j} + (x^2 + 2 - y)\mathbf{k}$ (5)
   Write down the strain tensor at the point (3,2,-1)

   b) Corresponding to the above, determine the strain in the direction (5)
   $n_x = n_y = n_z = \dfrac{1}{\sqrt{3}}$

4. a) Investigate whether the following polynomial is permissible as an Airy's stress (6)
   function
   $\phi = A\left(xy^2 - \dfrac{3}{4} xyB^3 \right)$. If permissible, derive the expressions for stress.

   b) Write a note on stress transformation. (4)

PART B
Answer any three questions. Each question carries 10 marks

5. a) What is meant by shear centre? (3)

   b) Explain the term "complementary strain energy" (3)

   b) Give the expressions for strain energy due to torsion (4)

6. a) Write down the differential equation of equilibrium in polar co-ordinate (5)
   system in 2-dimensions.

   b) What are the initial assumptions taken while solving problems of rotating (5)
   circular discs

7. A cantilever of rectangular cross section of breadth 4cm and depth 6cm is (10)
   subjected to an inclined load W at free end as shown in figure. The length of
   cantilever is 2.5m and the angle of inclination of the load with vertical is 25°.
   What is the maximum value of W if the maximum stress due to bending is not
   to exceed 200N/mm^2.
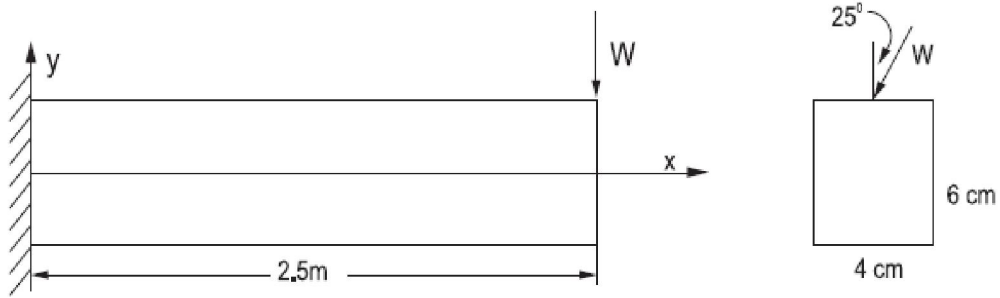
8   a)   A thick walled tube with an internal radius of 12cm is subjected to an internal   (6)
         pressure of 200MPa. ($E=2.1\times10^5$MPa) and $\nu=0.3$). Determine the optimum
         value of the external radius if the maximum shear stress developed is limited to
         350MPa.

   b)   Determine the change in internal radius due to the applied pressure.   (4)

PART C
Answer any four questions. Each question carries 10 marks.

9   a)   Obtain the general expression for strain energy in terms of components of stress.   (5)

    b)   Explain the Maxwell reciprocal theorem.   (5)

10   The cantilever beam supports a uniformly distributed load w and a concentrated   (10)
         load P as shown in figure. Also it is given that $L=2$m, $w=4$kN/m, $P=6$kN and
         $EI=5$MN.m^2. Determine the deflection at the free end using Castigliano's
         theorem.
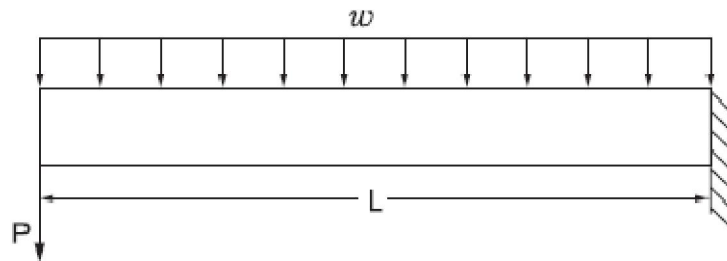
11   A rod with rectangular cross section is used to transmit torque to a machine   (10)
         frame (see figure). It has a width of 40mm. The first 3.0m length of rod has a
         depth of 60mm and the remaining 1.5 m length has a depth of 30mm. The rod is
         made of steel having $G=77.5$ GPa. Given $T_1=750$Nm and $T_2=400$Nm, determine
         the maximum shear stress in the rod. Also determine the angle of twist of the
         free end.
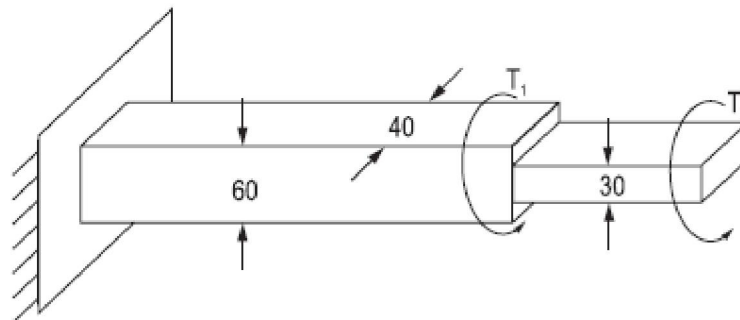
12   a)   A shaft of square section of outer side 55mm and inner side 50mm is subjected   (10)

to a twisting moment such that the maximum shear stress developed is $250N/mm^2$. What is the torque acting on the shaft and what is the angular twist if the shaft is 1.6 m long and $G=70000N/mm^2$

13 a) Explain membrane analogy   (4)

   b) What is meant by warping function?   (3)

   c) Define the term *shear flow*.   (3)

14   A hollow thin wall torsion member has two compartments with cross sectional (10) dimensions as given in figure. The material is an aluminium alloy having $G=26GPa$. Determine the torque if the maximum shear stress is 40MPa.

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