STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI 600 086
(For candidates admitted during the academic year 2015 – 16& thereafter)

SUBJECT CODE :15MT/PC/CM14

M. Sc. DEGREE EXAMINATION, NOVEMBER 2016
BRANCH I - MATHEMATICS
FIRST SEMESTER

COURSE : CORE
PAPER : CONTINUUM MECHANICS
TIME : 3 HOURS **MAX. MARKS : 100**

SECTION – A **(5 X 2 = 10)**

ANSWER ALL THE QUESTIONS

1. Define body forces and surface forces.
2. What is deformation?
3. Define path lines and stream lines.
4. Write angular momentum principle.
5. Define isotropy and anisotropy for an elastic material.

SECTION – B **(5 X 6 = 30)**

ANSWER ANY FIVE QUESTIONS

6. Explain Cauchy's stress principle.
7. Find the Cauchy stress quadric for the following state of stress.
   (i) $\sigma_{11} = \sigma_{22} = \sigma_{33} = \sigma$ and $\sigma_{12} = \sigma_{13} = \sigma_{23} = 0$.
   (ii) $\sigma_{11} = a$, $\sigma_{22} = b$, $\sigma_{33} = c$ and $\sigma_{12} = \sigma_{13} = \sigma_{23} = 0$, where a, b, c are all of the same sign.
   (iii) $\sigma_{11} = \sigma$ and $\sigma_{22} = \sigma_{33} = \sigma_{12} = \sigma_{13} = \sigma_{23} = 0$.
8. A continuous body undergoes the deformation $x_1 = X_1$, $x_2 = X_1 + AX_3$, $x_3 = X_3 + AX_2$ where A is a constant. Compute the deformation tensor where A is a constant and the Lagrangian finite tensor.
9. A displacement field is given by $u = X_1 X_3^2 \hat{e}_1 + X_1^2 X_2 \hat{e}_2 + X_2^2 X_3 \hat{e}_3$. Determine independently the material deformation gradient F and the material displacement gradient J and verify $J = F - I$.
10. Explain Lagrangian and Eulerian Descriptions.
11. Explain rate of deformation tensor and vorticity.
12. Obtain Hooke's law in terms of elastic constants λ and μ for an isotropic body.

SECTION – C **(3 X 20 = 60)**

ANSWER ANY THREE QUESTIONS

13. The stress tensor at a point P is given with respect to the axes $Ox_1x_2x_3$ by the values $\sigma_{ij} = \begin{pmatrix} 3 & 1 & 1 \\ 1 & 0 & 2 \\ 1 & 2 & 0 \end{pmatrix}$. Determine the principal stress values and the principal stress directions represented by the axes $Ox_1^*x_2^*x_3^*$.
14. A displacement field is given by $x_1 = X_1 + Ax_2$, $x_2 = X_2 + Ax_3$, $x_3 = X_3 + Ax_1$ where A is a constant. Calculate the Lagrangian linear strain tensor L and the Eulerian linear strain tensor E. Compare L and E for the case where A is very small.
15. A velocity field is described by $v_1 = \frac{x_1}{(1+t)}$, $v_2 = \frac{2x_2}{(1+t)}$, $v_3 = \frac{3x_3}{(1+t)}$. Determine the acceleration components for this motion. Also determine the streamlines and pathlines of the flow and show that they coincide.
16. Using linear momentum principle obtain the equations of motion and equilibrium equations.
17. Explain elastic symmetry. Determine the elastic coefficient matrix for a continuum having an axis of elastic symmetry of order $N = 4$. Assume $C_{km} = C_{mk}$.