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# APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
## THIRD SEMESTER M.TECH DEGREE EXAMINATION, FEBRUARY 2021
## MECHANICAL ENGINEERING
## THERMAL ENGINEERING
## 03ME7073 FINITE ELEMENT METHOD FOR THERMAL ENGINEERING

**Max. Marks : 60**                                             **Duration: 3 Hrs**

### Part - A                                                   20 Marks
#### Answer All Questions.(5 Marks Each)

**I**   What is shape function? Explain the properties of shape functions?

**II**  Draw a four noded rectangular element. Write down its shape functions for in natural coordinates?

**III** Explain about numerical oscillations in finite element methods.

**IV**  Explain the determinant method used to obtain the solutions of Eigen value problems in finite element analysis

### Part - B                                                   40 Marks
#### Answer All  Questions (10 Marks Each)

**V**   The following differential equation is available for physical phenomena: $\dfrac{d^2 y}{dx^2} + 50 = 0$

The trial function is *y=ax(10-x)*. The boundary conditions are y(0)=0, y(10)=0. Find the value of the parameter 'a' by (i) Sub-domain collection method and (ii) Least squares method.                                    **(10 marks)**

#### OR

**VI**  Find the temperature distribution and heat transfer through iron fin of thickness 5  mm, height 50 mm and width 1000 mm. The heat transfer coefficient around     the fin is 10 W/m$^2$ °C and ambient temperature is 28°C. The base of the fin is at 108°C and k = 50W/mK. Use two element model.                              **(10 marks)**

**VII** Briefly explain the natural coordinate system. Using the natural coordinate system obtain the shape functions of a linear triangular element.          **(10 marks)**
#### OR

**VIII** The nodal coordinates of the triangular element are i (2, 3), j (7, 4) and, k (4, 6).  At the interior point P, the x –coordinate is 4.5 and $N_i$=0.3. Determine $N_j$, $N_k$ and, y-coordinate of the point P.                                         **(10marks)**

**IX** An insulated rod is initially at 50°C. At time zero, the temperature at each end of the rod is fixed at 10°C. Obtain final system of equations for the four element grid shown and modify them to account for the fact that the temperature at nodes one and five are known, that is, the equations for nodes one and five must be eliminated. Use the consistent formulation and $\theta = 1/2$. Use $\Delta t= 1$ sec. D=2W/cm-°C, $\lambda$=6 J/cm³-°C          **(10marks)**
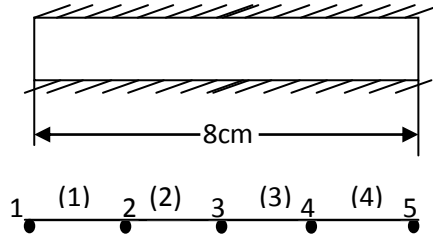


**OR**

**X** Illustrate the formulation of element capacitance matrix in the solution of time dependent field problems.          **(10marks)**

**X1** Determine the Eigen value and natural frequency of a system whose stiffness mass matrices are given below.

$$[k] = \frac{2AE}{L}\begin{bmatrix} 6 & -2 \\ -2 & 2 \end{bmatrix} \quad ; \quad [m] = \frac{\rho AL}{12}\begin{bmatrix} 12 & 2 \\ 2 & 4 \end{bmatrix}$$          **(10marks)**

**OR**

**XII** Consider a uniform cross-section bar of length 2L made up of a material of Young's modulus and density are given by E and $\rho$. Estimate the first two natural frequencies using consistent mass matrix.          **(10marks)**