Cluster Innovation Centre, University of Delhi, Delhi-110007

Examination : **End Semester Examination –Nov/Dec 2021**
Name of the Course : **B.Tech (Information Technology and Mathematical Innovations)**
Name of the Paper : **Fluidity in Nature: Computational Interpretations**
Paper Code : **911710**
Semester : **7**
Duration : **3 Hours**
Maximum Marks : **75**

Instructions:

This question paper contains six questions, out of which any four are to be attempted. Each question carries equal marks.

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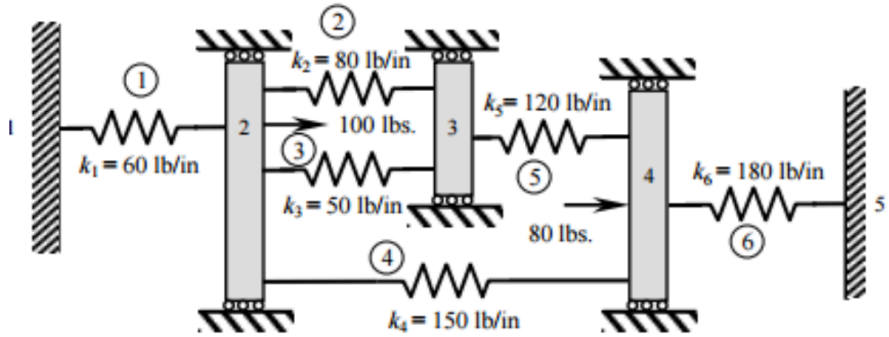
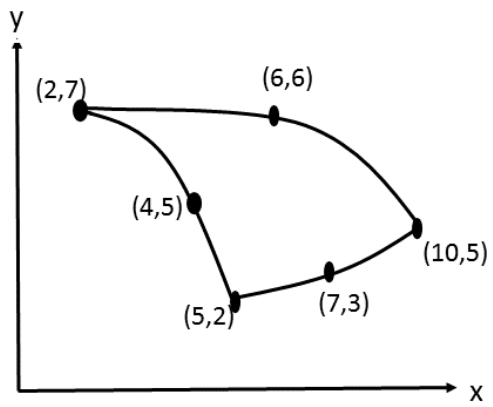
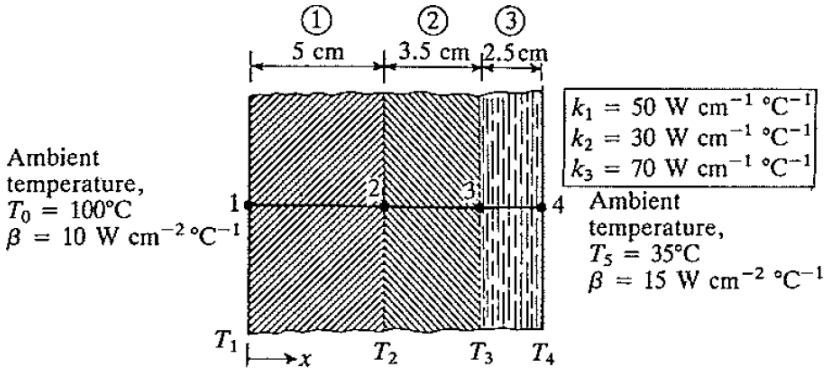
1. Consider the spring assemblage shown in the figure. Determine the displacement of the rigid block and forces in the spring assuming that the rigid block is required to remain vertical (i.e., no tilting from its vertical position). Use boundary conditions to write and solve the condensed equations for the unknown displacement and forces.



2. Derive the expression for shape functions for the quadratic iso-parametric triangular element and hence find the Jacobian matrix for the element shown in the figure.



3. An insulating wall is constructed of three homogeneous layers with conductivities k_1, k_2 and k_3 in intimate contact, as shown in figure given below. Under steady state conditions, the temperatures at the boundaries of the layers are characterised by the external surface temperatures T_1, T_4 and the interface temperatures T_2, T_3. Formulate the problem to determine the temperatures $T_i (i = 1,2,..,4)$ when the ambient temperature T_0 and T_5 and the (surface) film coefficient β_0, β_5 are known. Assume that there is no internal heat generation and that the heat flow is one-dimensional ($\frac{\partial T}{\partial y} = 0$)



4. Discuss the characteristics of Newtonian & Non-newtonian flow and derive momentum equation for a viscous, incompressible laminar flow.

5. Solve the Poisson equation $-\nabla^2 u = 2$ in the square whose vertices are (0,0), (1,0), (1,1) & (0,1). The boundary conditions are $u(0,y) = y^2, u(x,0) = x^2, u(1,y) = 1 - y, and u(x,1) = 1 - x$. Use four linear rectangular elements (a $2X2$ mesh).

6. Determine the interpolation functions for all the nodes of given quartic triangular element shown in the figure.