BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: BE **SEMESTER : VII**
BRANCH: CIVIL **SESSION : MO/19**

SUBJECT: CE7005 FINITE ELEMENT APPLICATIONS IN CIVIL ENGINEERING
TIME: 3:00 HOURS **FULL MARKS: 60**

INSTRUCTIONS:
1. **The question paper contains 7 questions each of 12 marks and total 84 marks.**
2. **Candidates may attempt any 5 questions maximum of 60 marks.**
3. **The missing data, if any, may be assumed suitably.**
4. **Before attempting the question paper, be sure that you have got the correct question paper.**
5. **Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.**

Q.1(a) Explain Geometrical Invariance using the Pascal Triangle in FEM. [2]
Q.1(b) State plane strain and plane stress problem in elasticity with examples. [4]
Q.1(c) What do you mean by convergence in FEM? What are the convergence criteria that to be satisfied in FEM? Explain the modeling error and its remedies in FEM with proper example. [2+2+2]

Q.2(a) What do you mean by shape function in finite element analysis? [2]
Q.2(b) Derive the shape function of a two nodded beam element. [4]
Q.2(c) Derive the stiffness matrix of a truss element in global co-ordinate system. [6]

Q.3(a) What do you mean by natural co-ordinate system? [2]
Q.3(b) Using the Pascal's triangle explain the difference between Lagrangian and Serendipity formulation? [4]
Q.3(c) Show that we will obtain the same shape function from Lagrangian and Serendipity formulation for a 4-nodded rectangular element? [6]

Q.4(a) Write the field variable of the three nodded triangular element as a polynomial form and state why the element is called Constant Strain Triangle (CST). [2]
Q.4(b) Why Isoparametric elements are important? What is the use of Jacobian Matrix in Isoparametric elements? [4]
Q.4(c) Derive the shape function of a three nodded triangular element having coordinates (x_1, y_1), (x_2, y_2) and (x_3, y_3)? [6]

Q.5(a) State the Principle of Minimum Potential Energy. [2]
Q.5(b) Consider the one dimensional bar shown in Fig. 1. The bar is subjected to a concentrated force 'R' at its right end. Write down the Differential and Variational formulation of the bar that gives the governing equations. [4]

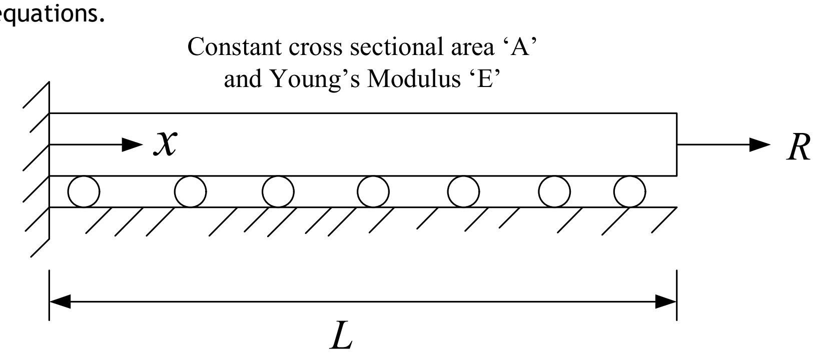

Fig.1. One-dimensional axial bar

Q.5(c)	Find out the stiffness matrix for the three springs in series system shown in Fig. 2, using the principle of minimum potential energy? Also show that you will obtain the same stiffness matrix if the system equilibrium equations are expressed in matrix form?		[6]

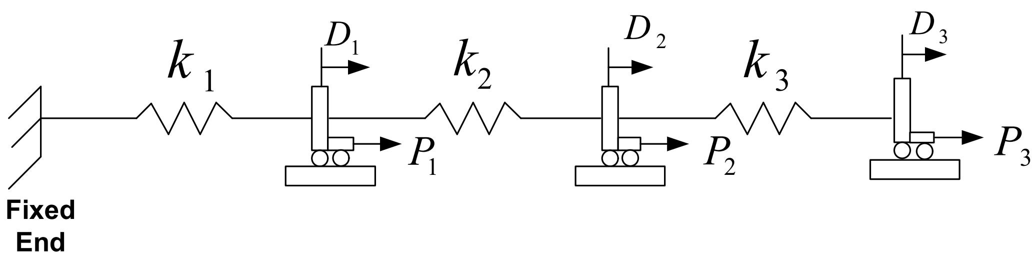

Fig.2. Three Springs in Series System

Q.6(a)	What are the procedures to impose boundary condition in FEM?	[2]
Q.6(b)	A bar is hanging from the ceiling. Using 2-noded bar element, find the elongation of the bar at its centre and the free end due to the self weight of the bar? Assume any suitable data you need?	[4]
Q.6(c)	Analyze the truss shown in Fig. 3. The cross sectional area of the inclined member is twice the area of the horizontal and vertical members. The modulus of elasticity of all the members are constant and assumed to be 'E'?	[6]

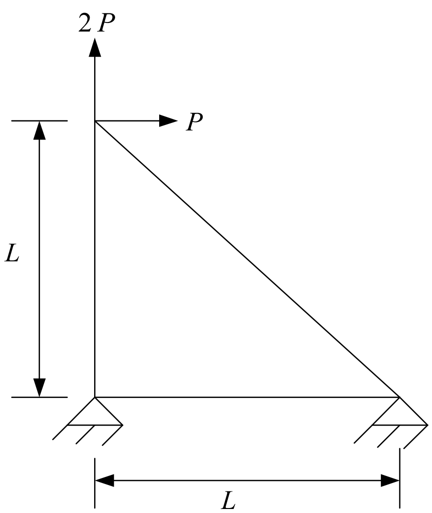

Fig. 3. Truss having three elements

Q.7(a)	Write down the stiffness matrix of a two nodded rigid frame element.	[2]
Q.7(b)	Find out the equivalent nodal loads in a beam from uniformly distributed load (udl) acting on that beam using work equivalence method.	[4]
Q.7(c)	Find out the deflection and the slope of the fixed end beam at a distance '*a*' from the left support where a point load 'P' is applied on the beam as shown in Fig. 4. Also find out the support moments and reactions? Assume any suitable data you need.	[6]

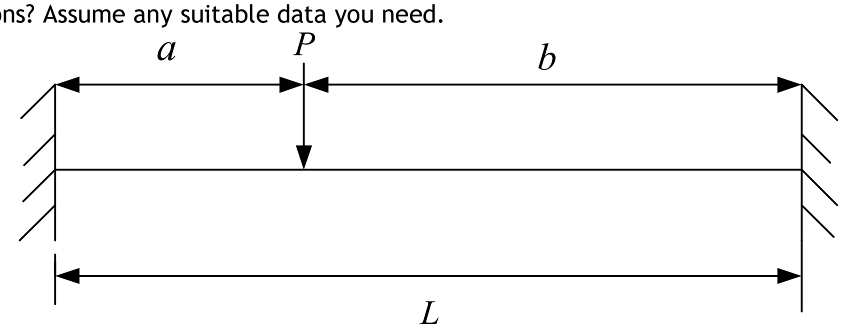

Fig.4. Fixed beam having a point load 'P' at a distance '*a*' from the left support