Student Exam No._____

Ganpat University
M.Tech SEM II (CAD/CAM) Mechanical Engineering
Regular Examination June 2012
3ME211 Engineering Analysis and Optimization

Time: 3 HOURS **Total Marks: 70**

Instructions:

1) Assume suitable data if necessary.
2) Write your answer to the point.
3) Draw neat and clean sketch/figure.

SECTION I

Q.1 **[12]**

(a) Explain in brief body force vector, traction force vector and point force in FEM with sketch.

(b) A plane truss as shown in the figure 1 composed of members with square cross section of 15 x 15 mm and young modulus is of 69 GPa.

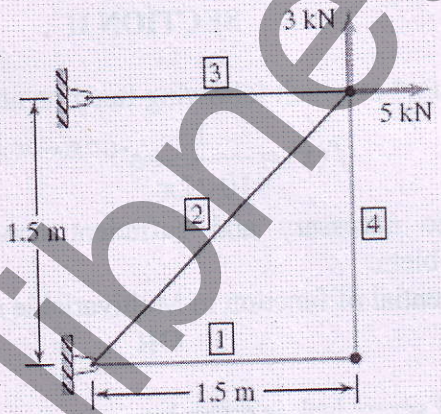


Fig. 1

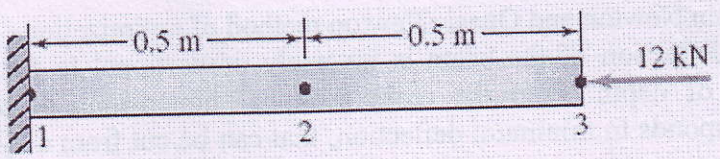
(a) Assemble global stiffness matrices.
(b) Compute nodal displacement.

OR

Q.1 **[12]**

(a) Differentiate between FEM and classical methods for solution of engineering problems.

(b) A steel rod is modeled as two bar elements as shown in Fig. 2. Determine the nodal displacement and axial stress in each of element. What other concern should be examined?



$E = 207$ GPa $A = 500$ mm^2

Fig. 2

Q.2 [11]

(a) How do we calculate stress in truss element? Derive formula for stress in 3D truss element.

(b) Derive the stiffness matrix for bar element using Galerkin's approach in FEM.

OR

Q.2 [11]

(a) Derive the shape function of bar element of length L and two nodes.

(b) What is isoparametric representation? Give correlation between x and y coordinates to ξ and η coordinates in CST element.

Q.3 Attempt **all** questions. [12]

(a) Justify following statement - 'As the number of elements increases in FEM structure more the accurate result we get'

(b) Explain penalty approach for treatment of boundary conditions in FEM.

(c) How local coordinate is transformed into global coordinate system in FEM? Explain using truss element.

SECTION II

Q.4 [12]

(a) Find the value of x* at which following function attains its maximum :

$$f(x) = \frac{1}{10\sqrt{2\pi}} e^{-(1/2)[(x-100)/10]^2}$$

(b) Write down the necessary and sufficient conditions for multivariable optimization problem.

(c) Explain r^{th} differential of function in Multivariable optimization.

OR

Q.4 [12]

(a) The efficiency of screw jack is given by

$$\eta = \frac{\tan\alpha}{\tan(\alpha+\phi)}$$

Where α lead is angle and ϕ is a constant. Prove that the efficiency of the screw jack will be maximum when $\alpha = 45 - \frac{\phi}{2}$ with $\eta_{max} = \frac{(1-\sin\phi)}{(1+\sin\phi)}$

(b) What are differences between constraint surface and composite surfaces?

(c) Determine the maximum value of the function $f(x) = x\cos\pi x^2$ in interval [0, 0.7] up to four iteration using Golden section method.

Q.5 [11]

(a) Explain Newton and Quasi- Newton method of optimization.

(b) The deflection of the beam is inversely proportional to the width and the cube of depth. Find the cross sectional dimensions of a beam, which corresponds to minimum deflection, that can be cut from a cylindrical log of radius r.

OR

Q.5 [11]

(a) Minimize $f(x) = 0.65 - [0.75/(1+x^2)]$ in interval [0, 3] by the Fibonacci method using n = 4.

(b) State various methods available to solve a multivariable optimization problem with equality constraints. Also explain one of the methods in detail.

Q.6 Attempt following questions. [12]

(a) It has been decided to leave a margin of 30 mm at top and 20 mm at other three sides on the printed page of a book. If the area of the page is specified as 5e4 mm^2, determine the dimensions of a page that provide the largest printed area.

(b) Explain Saddle point with one example.