APPLIED MECHANICS DEPARTMENT

AML705 FINITE ELEMENT METHODS

Time : 2 hrs) **Major Test – 4/5/2007** **(Max. marks: 40**

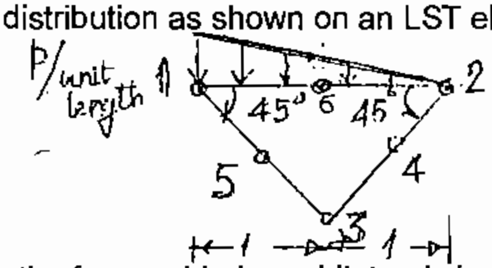
1. Consider a one dimensional ordinary differential equation

$$-\frac{d}{dx}\left(x^2\frac{d\varphi}{dx}\right)=\alpha x^2$$

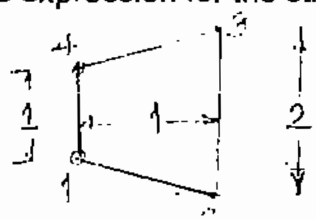
with the boundary condition φ(a)=A , φ(b)= B, where α,A and B are constants. Use Galerkin method with $W_i = N_i$ to formulate general equations for the element matrices $\mathbf{K}^e$ and $\mathbf{F}^e$ for an element with 2 nodes and 'm' nodes.

2. i) Use quadratic shape functions $N_1 = \frac{\xi(\xi-1)}{2}$; $N_2 = (1-\xi^2)$; $N_3 = \frac{\xi(\xi+1)}{2}$ and derive a) the stiffness and b) the mass matrices for a bar element
   ii) Derive the reduced stiffness matrix for a two node bar element by eliminating the d.o.f corresponding to the middle node.

3. i) Write down the shape functions for the CST and LST in terms of area coordinates and derive the expression for stiffness matrix and equivalent nodal load vector for a CST element.
   ii) Compute the equivalent load vector corresponding to the pressure distribution as shown on an LST element.



4. For the four nodded quadrilateral shown below derive the expression for the Jacobean and the B matrix. Use a 1 point Gaussian integration and write down the expression for the stiffness matrix.



5. Use the beam element to solve the following structural problem. Obtain the stresses in the beam element at the ends.