AML 706 MAJOR 2007

#1 The frame shown consists of 3 members. Given $E = 200 \times 10^9\,Pa$, $A = 2450\ mm^2$, $I = 27 \times 10^6\ mm^4$ for all members.

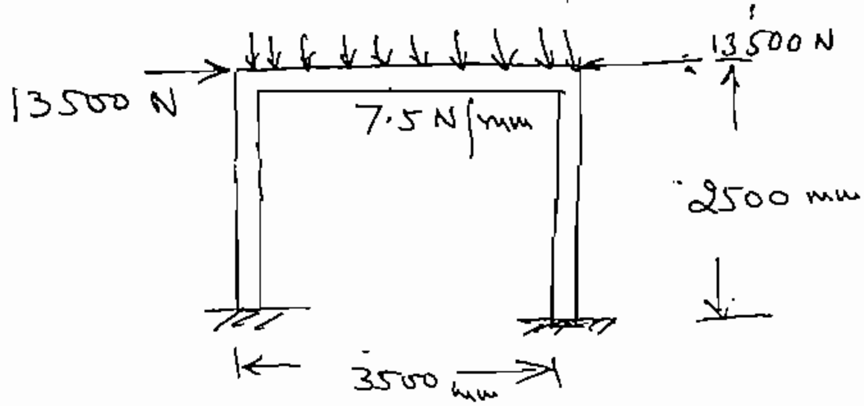
a) Determine the cross-section of dimensions (i.e thickness and width) of beam. Assume rectangular x-section

b) <u>Using symmetry</u> write the Boundary Conditions (BCs)

c) Set up the stiffness matrix (for symmetric case)

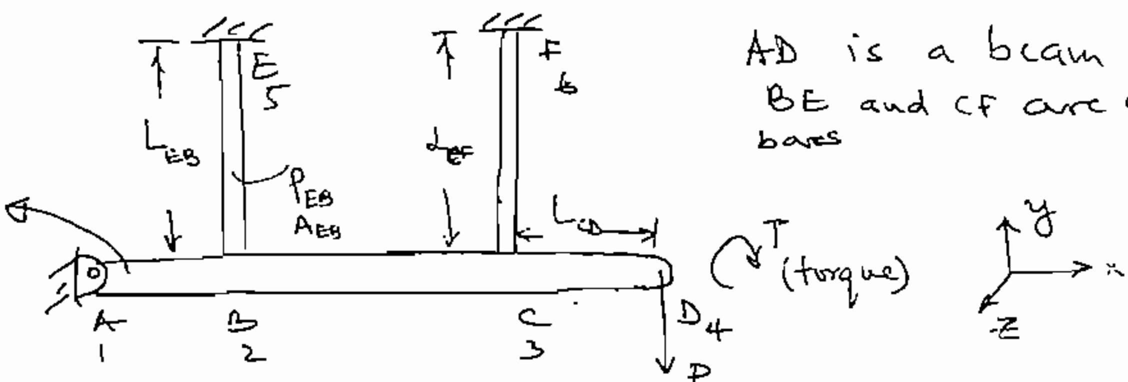
d) Set up the load matrix (")

e) Impose BCs and write the final stiffness and load matrix after elimination



#2

E,
ρ,
A



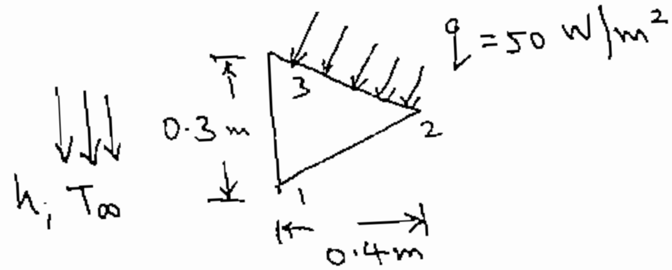
AD is a beam
BE and CF are axial bars

a) Write the stiffness matrix for element BE

b) If the X-section of beam AD is circular what is the relation between Polar M.I (J) of the X-section and Area M.I. $I_{yy} = I_{zz}$

) Write the load vector for element CD
) If the rod AD is very stiff how will you solve the problem (Brief Answer).

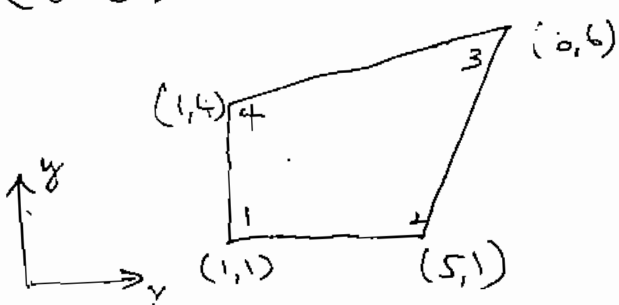
3) For the element shown
a) determine the stiffness (conductivity) matrix
b) " the heat load vector



$h = 50\ W/m^2\,C$
$T_\infty = 25\ C$
$k_x = 1.5\ W/m\,C$
$k_y = 1.0\ W/m\,C$

(For (a) do not perform matrix multiplications)

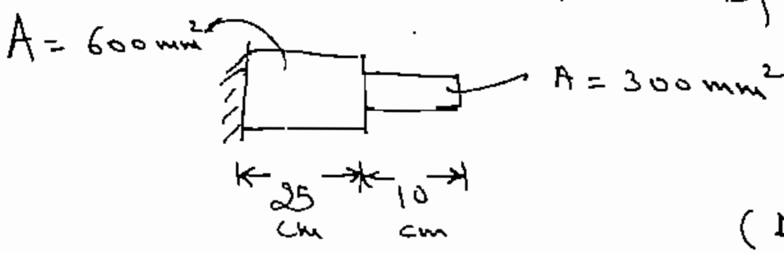
4). Follow the steps given below to numerically integrate
$\iint (xy + y^2)\, dx\, dy$ over the domain of fig.



a) Write x and y in terms of ξ and η
b) What are the values of ξ and η for one point formula
c) Determine the values of x and y at the Gauss point using ξ and η determined in (b)
d) Determine the Jacobian using the equation

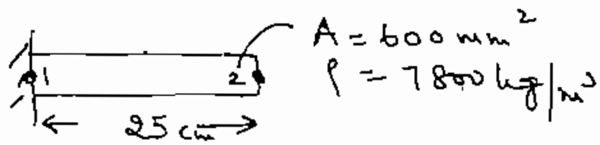
e) Evaluate the integral

#5 For the axial bar shown determine the natural frequencies and the corresponding mode shapes. Draw the shapes on $x-u$ graph (x - coord of node and u axial displacement)



$E = 200 \times 10^{9}$ N/m²
$\rho = 7800$ kg/m³
(Do calculations using 'm')

#6 A



The initial velocity of node 2 is 2 m/s. Node 1 is fixed and initial displacement of nodes 2 ~~and 3~~ is zero. A linearly varying force $F = 10^{5} t$ is applied at node 2. Using $\Delta t = 10^{-5}$ sec

(a) Determine displacement of node 2 at $t = 10^{-5}$ sec

(b) " " " " " at $t = 2 \times 10^{-5}$ sec

(c) Velocity of node 2 at $t = 10^{-5}$ s

B) Using Central Difference scheme show that for no damping case

$$\{u\}_{j+1} = \left(\frac{M}{\Delta t^2}\right)^{-1}\left(\left\{\frac{2M}{(\Delta t)^2} - K\right\}\{u\}_j - \frac{[M]}{(\Delta t)^2}\{u\}_{j-1}\right)$$

(C) For a triangular plane stress element write the expression for K.E. The element has 6 degrees of freedom. The expression should contain these dofs and shape fns

$$K \cdot E = \frac{1}{2}[\quad]\int[\quad]\, t\, dA \,\{\quad\}$$