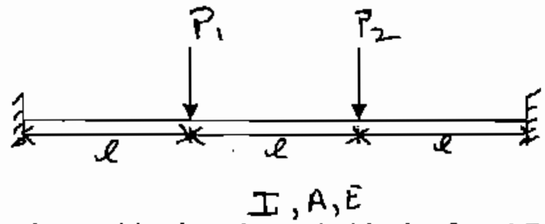
Department of Applied Mechanics
Major Examination
Computational Mechanics AML – 310

01/05/2008

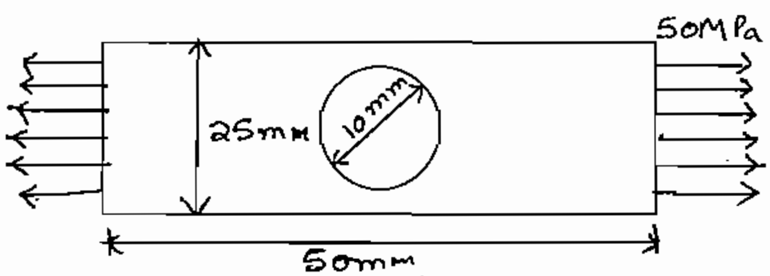
Q-1 Discretize the given fixed ended beam into finite elements



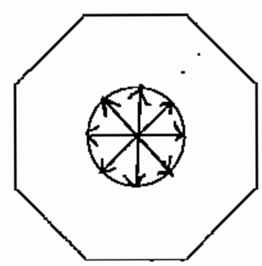
i. Give topology table choosing suitable d.o.f. and BCs
ii. Show elemental stiffness matrix in local co – ordinates.
iii. Show global or overall stiffness matrix.
iv. Banded storage and memory reduction
v. Show governing system of equations.

Q-2 Using the properties of the given system show simplified modeling with proper boundary conditions.

a.



(Rectangular loaded plate with a hole)

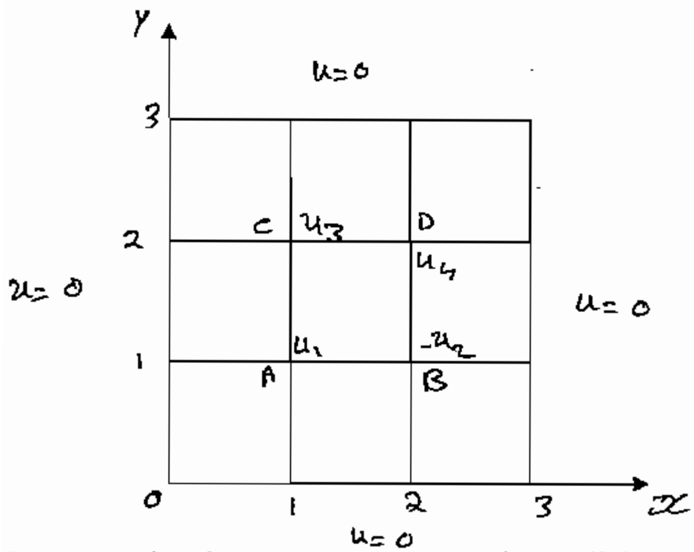


(Octagonal pipe with radial pressure)

b. Plane stress and plane strain models of two common systems with governing equation.

Q-3 Solve the Poisson's equation

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 10(x^2 + y^2 + 10)$$ in the given domain taking h=1, using central difference approach with error estimate of h^4



Q-4 a. For the given speed – up model in parallel proeessing, show the ease of perfect average and maximum degree of parallelism

$$S_p = \frac{T}{(\alpha_1 + \frac{\alpha_2}{K} + \frac{\alpha_3}{p})T + t_d}$$ all symbols stand for their standard meaning.

b. For a eommon parallel programming paradigm. What are different workload alloeation strategies?

Q-5 a. Name five sehemes of weighted residual methods. What is the role of a functional in Rayleigh – Ritz method?

b. Solve the following boundary value problem to first approximation using Rayleigh – Ritz method.

$\frac{d^2y}{dx^2} - x = 0, y(0), \left(\frac{dy}{dx}\right)_1 = \frac{-1}{2}$, the funetional for the problem is

$J(y) = \int_0^1 [(y')^2 + 2yx]dx + y(k)$ using approximate, $y(x) = \alpha_1 x + \alpha_2 x^2$

Q-6 Give the complete loop of computation to solve the following non – linear set of diff. equations

$$2\left(\frac{d^2x}{dt^2}\right)^2 = -15\left(\frac{dx}{dt} + \frac{dy}{dt}\right)\frac{dx}{dt}$$

As per the initial conditions t=0, x=0, y=0

$$5\left(\frac{d^2y}{dt^2}\right)^2 = +12\left(\frac{dx}{dt} + \frac{dy}{dt}\right)\frac{dy}{dt}$$

Applied Mechanics Department

AML 360 Engineering Fluid Flows

Date: 29-4-2008

II Semester, 2007-08. MAJOR TEST Max. Marks: 80.

Time: 10-30-12-30 pm.

NOTE: ANSWER ALL QUESTIONS

(1) Water ($\rho = 10^3\ kg/m^3$, $\mu = 1\,cP$) is being pumped through a circular pipe of 200 mm diameter. The velocity profile across the cross section of the pipe was measured as

$$u(r) = 5\left[1 - r/R\right]^{0.15}\ m/s.$$

where r = radial distance from the pipe axis, R = pipe radius. Calculate average velocity (U_{av}) through the pipe and hence the value of Reynolds Number (Re). The pressure drop in 100 m length of horizontal pipe section was measured as 7.5 m of water column. Calculate the value of friction factor. If the average roughness height of the pipe surface is 0.2 mm, how would you characterise the pipe in terms of its roughness? (12)

(2) The velocity profile and skin friction coefficient in the turbulent B.L over a flat plate is given by,

$$u/U_\infty = (y/\delta)^{1/8}, \quad 0 \le y/\delta \le 1, \quad u/U_\infty = 1 \text{ for } y \ge \delta$$

$$C_f = \tau_w / \tfrac{1}{2}\rho U_\infty^2 = 0.020/Re_\delta^{1/5}, \quad Re_\delta = (U_\infty \delta/\nu)$$

Starting from Momentum Integral Equation, derive the expression for $\delta(x)$ and C_D in terms of appropriate Reynolds Numbers. Assume that B.L is turbulent from the leading edge.

The wing of an aircraft has a chord of 2 m and length of 10 m. It is flying at a velocity of 100 m/s in an otherwise still air ($\rho = 1.2\ kg/m^3$, $\mu = 0.02\,cP$). Using the above results, calculate displacement thickness (δ^*) at the trailing edge. Also calculate the power required to overcome the skin friction drag in KW. (14).

(3) Define Eddy Kinematic Viscosity (ε_t) of a fluid and explain its relation to the Prandtl's mixing length. Explain the variation ε_t in the following cases

(a) fully turbulent wall layer

(b) [illegible] turbulent flows. (8)

4) (a) Explain the Variation of C_D with Reynolds Number for a bluff body and a streamlined body. Give reasons for the difference in the Variation.

(b) Define "maximum allowable roughness". Explain how does roughness affect the drag on a bluff body and a streamlined body. (8)

5) Consider a two dimensional fully turbulent Jet flow. Using proper turbulence model, derive the expressions for the functional dependence of width of the Jet $[b(x)]$ and max Velocity $[U_{max}(x)]$. x is the distance along the axis of the Jet. (8)

6) Briefly Explain the following.

(a) Laminar B.L flow in an adverse pressure gradient.

(b). Principle of Superposition in inviscid Potential flows.

(c). Reynolds Analogy for heat transfer on a flat plate B.L flow. (12)

7) The Velocity Potential in an inviscid flow is given by,

$$\phi = (3x+2y+z)e^{-2t}.$$

Is the fluid incompressible? Assuming body force is due to gravity only ($-z$ direction) and $\rho = 800\ kg/m^3$, derive the expression for the Variation of pressure distribution in the flow field. (10)

8)

(a) Explain the significance of Orr-Sommerfield Equation and state how it can be used to predict the transition to turbulent flows,

(b). Describe the Variation of pressure on a Sphere in a creeping fluid flow. How does it differ from that in an inviscid fluid flow?

(8)

Department of Applied Mechanics (Semester II, 2007-2008)

AML - 700 Experimental Methods in Fluids & Solids

MAJOR EXAM

Time 8-10 Am

Max Marks - 80

Date 2/5/08

Note: Attempt all Questions

Q1 Plot the normalised histogram and evaluate the mean & Standard error for the following set of readings

3.3, 3.5, 3.2, 3.7, 3.0, 3.6, 3.5, 3.6, 3.4, 3.6, 3.8, 3.6, 3.6, 3.7, 3.5, 3.6, 3.5, 3.5, 3.6, 3.5 (8)

Q2 a. What do you understand by significant digits and is it decided (3)

Q 2b. The standard error of the mean for 25 measurements of a part is found to be 2.4 cm. Find the standard deviation. What must be the total number of measurements if the standard error is to be reduced to 1.2 cm (4)

Q3. Calculate the values of X and Y which satisfy the following equations with best Accuracy using the method of least squares

$$X^2 + Y^3 = 16 \quad \pm 0.2$$

$$X^2 Y + Y^2 = 23 \quad \pm 0.4$$

$$XY = 6 \quad \pm 0.1$$

(First approximation: Assume X = 3 and Y = 2) (9)

Q4. A velocity transducer generates 5 mv/cm/s. The output of the transducer is fed to an RC circuit with R = 1 MΩ and C = 0.1 μF. Find the amplitude and phase of voltage across 'R' relative to the input motion to the transducer, the amplitude of motion being 0.5 and frequency 10 Hz (6)

Q.5. A plastic company produces two types of styrofoam cups (A and B) which can experience eight types of defects. One hundred defective samples of each cup are collected and the number of each type of defect is determined. The following table results

Defect	Cup A	Cup B
1	1	5
2	2	3
3	3	3
4	25	23
5	10	12
6	15	16
7	38	30
8	6	8
Total	100	100

Based on the data, show that the cups have the same pattern of defects. (7)

Q6. Write short Notes on

(a) Failure theory in Brittle Coating (3)

(b) Procedure for estimating compressive stresses (3)

(c) Refrigeration technique in Brittle coating (3)

Q.7. Briefly explain the following (Any three)

(a) Concept of Polarised light and then describe circularly Polarised light. (4)

(b) Arrangement of optical elements for circular polariscope. (4)

(c) Effect of stressed model in circular Polariscope (4)

(d) Compensation Technique (4)

Q8. Write short Notes

(a) Strain Rosettes (3)

(b) Calibration of Wheat stone Bridge for strain Measurement (3)

(c) Arrangement for Measurement of bending strains in two mutually perpendicular directions (4)

Q9. Briefly explain the procedures for the following (Any three)

(a) Measurement of Reynolds stresses using Hot wire Anemometer (4)

(b) Dual Beam set up for Laser Doppler Anemometer (4)

(c) Vortex flow Meter (4)

(d) Coriolis Mass flow meter (4)