14MDE/MMD/MAR/MAU/IAE/MST/MTH/MTP/MTE/MTR/MEA/MCM/CAE11

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First Semester M.Tech. Degree Examination, Dec.2014/Jan.2015
Applied Mathematics

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. Define : (i) Round off errors (ii) Significant figures
(iii) Truncation errors
Round off the numbers 865250 and 37.46235 to four significant figures and find the relative error in each case. **(10 Marks)**

b. Derive the expression $V(t) = \frac{mg}{C}\left(1 - e^{-\left(\frac{C}{m}\right)t}\right)$ for a parachutist jumps out of a stationary hot air ballon. Compute the velocity prior to opening the chute when the mass is 68.1 kg, the drag coefficient is 12.5 kg/s, gravitational force is 9.8. (Take t = 4 sec as step size) **(10 Marks)**

2 a. Explain False position method to establish the roots of the equation f(x) = 0. Find two approximations when the root lies in (1.4, 1.5) for the equation $x^6 - x^4 - x^3 - 1 = 0$. **(10 Marks)**

b. Discuss Newton-Raphson method to find the root of the equation f(x) = 0. Find the root of the equation $x \log_{10} x - 1.2 = 0$. Take the initial of x as 2. Compute three approximations. **(10 Marks)**

3 a. Apply Bairstow's method to extract the quadratic factor $x^2 + px + q$ when $f(x) = x^3 + x^2 - x + 2 = 0$ with initial values of p and q as -0.9 and 0.9 respectively. **(10 Marks)**

b. Use Graeffe's root squaring method (thrice) to find the roots of the equation, $f(x) = x^3 - 2x^2 - 5x + 6 = 0$ **(10 Marks)**

4 a. Give the equations for $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ using Newton's forward and backward interpolation formulas. Find $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ at x = 1.5 given that, **(10 Marks)**

x	1.5	2.0	2.5	3.0	3.5	4.0
y	3.375	7.0	13.625	24.0	38.875	59.0

b. Use Romberg's method to compute $\int_0^1 \frac{dx}{1+x}$ correct to three decimal places. Use h = 0.5, 0.25, 0.125. Compare with direct integration. **(10 Marks)**

5 a. Apply Gauss-Jordan method to solve the equations $x + y + z = 9$, $2x - 3y + 4z = 13$, $3x + 4y + 5z = 40$. **(10 Marks)**

b. Use triangularisation method to solve the system of equations $3x + 2y + 7z = 4$, $2x + 3y + z = 5$ and $3x + 4y + z = 7$. **(10 Marks)**

6 a. Find the inverse of the matrix $\begin{bmatrix} 1 & 1 & 1 \\ 4 & 3 & -1 \\ 3 & 5 & 3 \end{bmatrix}$ using partition method and solve the equations $x + y + z = 1$, $4x + 3y - z = 6$ and $3x + 5y + 3z = 4$. **(10 Marks)**

b. Apply House-Holder's method to reduce the matrix $A = \begin{bmatrix} 1 & 4 & 3 \\ 4 & 1 & 2 \\ 3 & 2 & 1 \end{bmatrix}$ to the tridiagonal form. **(10 Marks)**

7 a. Give the properties of linear transformation. If $e_1 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$, $e_2 = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ in $I_2 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$, Suppose T is a linear transformation from R^2 to R^3 for $T(e_1) = \begin{bmatrix} 5 \\ -7 \\ 2 \end{bmatrix}$ and $T(e_2) = \begin{bmatrix} -3 \\ 8 \\ 0 \end{bmatrix}$, find the image of an arbitrary x in R^2. **(10 Marks)**

b. For $T(X_1, X_2) = (3X_1 + X_2, 5X_1 + 7X_2, X_1 + 3X_2)$, show that T is one to one linear transformation. Does T map R^2 onto R^3. **(10 Marks)**

8 a. Find the equation $y = \beta_0 + \beta_1 x$ of the least squares line that best fits the data points (2, 1), (5, 2), (7, 3) and (8, 3). **(10 Marks)**

b. Discuss :

i) Gram-Schmidit process.

ii) Least square lines.

iii) The general linear model.

iv) The orthogonal basis $\{V_1 \ V_2\}$ for ω, when $\omega = \text{span}\{x_1 \ x_2\}$ with $x_1 = \begin{bmatrix} 3 \\ 6 \\ 0 \end{bmatrix}$, $x_2 = \begin{bmatrix} 1 \\ 2 \\ 2 \end{bmatrix}$. **(10 Marks)**

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14MDE12

First Semester M.Tech. Degree Examination, Dec.2014/Jan.2015
Finite Element Method

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. What conditions need to be satisfied by the interpolation functions for a finite element solution to converge? What are compatible (conforming) and complete elements? **(05 Marks)**

b. Explain how a specified boundary condition $Q_1 = a_1$ can be handled using penalty approach. **(05 Marks)**

c. Using Galerkin approach determine the displacement of the bar shown in Fig. Q1 (c). Assume $u = c_0 + c_1 x + c_2 x^2$. **(10 Marks)**

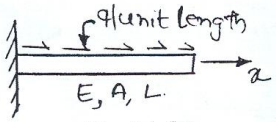

Fig. Q1 (c)

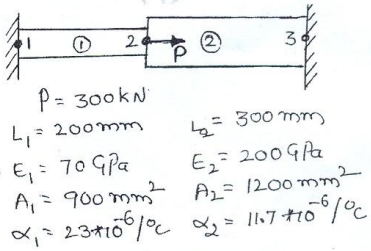

Fig. Q2 (b)

2 a. Derive the stiffness matrix for a truss element. **(10 Marks)**

b. An axial load P = 300 kN is applied at 20°C to the rod shown in Fig. Q2 (b). The temperature is then raised to 60°C. Determine the nodal displacements. Use elimination approach. Also, determine the stresses in the two sections. **(10 Marks)**

3 For the beam shown in Fig. Q3, determine (i) nodal deflections (ii) Support reaction. **(20 Marks)**

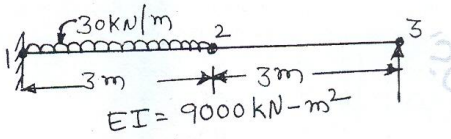

Fig. Q3

4 a. For a hexahedral element (HEXA 8) derive the expression for shape functions. Do not generalize. **(10 Marks)**

b. For a triangular element shown in Fig. Q4 (b) obtain (i) strain-displacement relation matrix B (ii) Strains ϵ_x, ϵ_y, γ_{xy} **(10 Marks)**

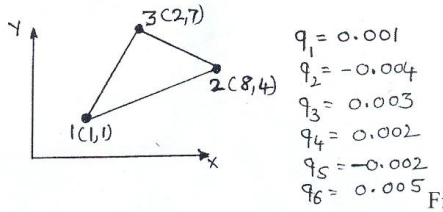

Fig. Q4 (b)

5 For the axisymmetric element assemble the (i) Stiffness matrix (ii) Load vector. **(20 Marks)**

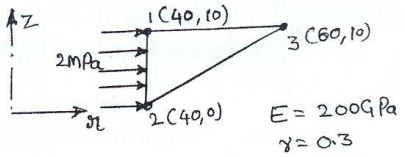

Fig. Q5

6 a. What assumptions are made in Kirchhoff's theory of plate bending? Give stress-strain relation for the plate bending using Kirchoff's theory. **(05 Marks)**

b. The stiffness matrix of C° Midlin plate is $K = \int B_m^T D_m B_m dA$.
Give the coefficients of B_m and D_m matrix. **(05 Marks)**

c. A shell is modeled using a straight element (combination of bar and beam) as shown in Fig. Q6 (c). Write down the coefficients of [K]-stiffness matrix and [d] – displacement vector. **(10 Marks)**

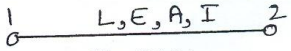

Fig. Q6 (c)

7 a. For the system shown in Fig. Q7 (a), obtain the equation of motion. **(05 Marks)**

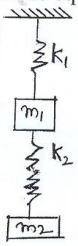

Fig. Q7 (a)

b. For the beam element, write down the lumped mass matrix. **(05 Marks)**

c. For a truss element show that the consistent mass matrix is,

$$m^e = \frac{\rho A_e L_e}{6}\begin{bmatrix} 2 & 0 & 1 & 0 \\ 0 & 2 & 0 & 1 \\ 1 & 0 & 2 & 0 \\ 0 & 1 & 0 & 2 \end{bmatrix}.$$ **(10 Marks)**

8 For the bar shown in Fig. Q8, using consistent mass matrix find, (i) the natural frequencies of longitudinal vibration (ii) find the corresponding mode shapes. **(20 Marks)**

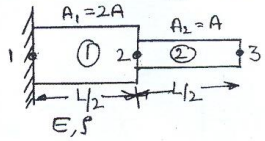

Fig. Q8

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14CAE13

First Semester M.Tech. Degree Examination, Dec.2014/Jan.2015
Continuum Mechanics

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. Define Couchy's stress vector and hence obtain equations of equilibrium using force equilibrium. **(08 Marks)**

b. At a point in a body the stress field is given by

$$\sigma_{ij} = \begin{bmatrix} 1 & -3 & \sqrt{2} \\ -3 & 1 & -\sqrt{2} \\ \sqrt{2} & -\sqrt{2} & 4 \end{bmatrix} \text{MPa}$$

Determine:

i) Principal stresses.
ii) Directions of principal stresses.
iii) Spherical and deviator components.
iv) Principal deviator stress values. **(12 Marks)**

2 a. Give Lagrangian and Eulerian description of property. Obtain the displacement field for the motion equation given in the component form in terms of material and spatial description.

$x_1 = X_1 e^t + X_3(e^t - 1)$
$x_2 = X_2 + X_3(e^t - e^{-t})$
$x_3 = X_3$. **(10 Marks)**

b. Shear deformation is given by

$x_1 = X_1$
$x_2 = X_2 + AX_3$
$x_3 = X_3 + AX_2$

where A is a constant. Determine Green's deformation tensor and hence obtain Lagrangian finite strain tensor. **(06 Marks)**

c. Write the strain compatibility equations. **(04 Marks)**

3 a. The state of strain at a point is given by $\epsilon_x = 0.001$, $\epsilon_y = -0.003$, $\epsilon_z = \gamma_{xy} = 0$ $\gamma_{xz} = -0.004$, $\gamma_{yz} = 0.001$. Determine the stress tensor at this point. Also calculate Lame's constant λ. Take $E = 2.1 \times 10^5$ MPa γ (Poisson's ratio) = 0.28. **(12 Marks)**

b. State and prove uniqueness theorem. **(08 Marks)**

4 a. Investigate the problem of plane stress solved by the stress function

$$\phi = \frac{3F}{4h}\left[xy - \frac{xy^3}{3h^2}\right] + \frac{P}{2}y^2$$ applied to the region included in $y = \pm h$ and $x = 0$ to positive x. **(12 Marks)**

b. Explain:

i) Plane stress condition
ii) Plane strain condition with examples. **(08 Marks)**

5 a. Obtain expressions for radial and tangential stresses in a rotating hollow disc of inner radius 'a' and outer radius 'b' using stress function approach. **(16 Marks)**

b. Show that in a hollow disc of inner radius 'a' and outer radius 'b', rotating at 'ω' radians/sec, the maximum radial stress σ_r occurs at the geometric mean of inner and outer radii. **(04 Marks)**

6 a. State Von Mises and Tresca yield criteria. Obtain expressions for Von Mises criteria in terms of principal stresses and octahedral shearing stress. **(10 Marks)**

b. The state of stress at a point is given by σ_x = 70MPa, σ_y = 120MPa, τ_{xy} = 35 MPa. If the yield strength of the material is 125MPa determine whether Yielding occurs or not according to Tresca and Von Mises condition. **(10 Marks)**

7 a. Explain the two visco-elastic models used for modeling and hence write generalized Kelvin and Maxwell models. **(10 Marks)**

b. Discuss creep and relaxation models used for modeling visco-elastic behavior. **(10 Marks)**

8 Write notes on the following:

a. Stokesian and Newtonian fluids.

b. Specialized fluids.

c. Steady, irrotational and potential flows.

d. Conservation of mass, continuity equations. **(20 Marks)**

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14CAE14

First Semester M.Tech. Degree Examination, Dec.2014/Jan.2015
Experimental Mechanics

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. Explain with block diagram, generalized measurement system, give an example. **(08 Marks)**

b. The following readings are taken from a certain physical length. Compute the mean reading, standard deviation variance and average of the absolute value of the deviation, using the "baised" basis also determine based on the standard deviation "sample" or unbiased basis. **(12 Marks)**

Reading	1	2	3	4	5	6	7	8	9	10
X cm	5.30	5.73	6.77	5.26	4.33	5.45	6.09	5.64	5.81	5.75

2 a. Explain the following : i) Probability distributions ii) Standard deviation of the mean. **(10 Marks)**

b. With the help of a block diagram, explain the major elements of a data acquisition and processing system. **(10 Marks)**

3 a. Define gauge factor for an electrical resistance strain gauge. Drive an expression for the same. **(10 Marks)**

b. A rectangular strain rosette is bonded at a critical point onto the surface of a structural member. When the structural member is loaded, the strain gauge shows the following readings, $\epsilon_0 = +850\mu m/m$, $\epsilon_{45} = -50\mu m/m$, $\epsilon_{90} = -850\mu m/m$

The gauge factor and the cross sensitivity of the gauges are 2.80 and 0.06 respectively. Find
i) Actual strains.
ii) Magnitude and directions of corrected principal strains.
Take Poisson's ratio of the material of the strain gauge as 0.285. **(10 Marks)**

4 a. With neat sketches, explain the construction of foil type of metal resistance strain gauges and list the desirable features of backing and adhesive material. **(10 Marks)**

b. Establish the stress optic relation for a two dimensional photo elasticity. **(10 Marks)**

5 a. Explain calibration of photoelastic model material using a circular disc under diameteral compression. **(10 Marks)**

b. Derive an expression for light transmitted through a two dimensional photo elastic model under condition of plane stress placed in a plane polariscope and discuss the formation of isochromatics and isoclinics. **(10 Marks)**

6 a. Explain the stress freezing techniques for three dimensional photoelasticity. **(10 Marks)**

b. Explain with the neat sketch the phenomenon of scattered light photoelasticity by using polariscope. **(10 Marks)**

7 a. Explain with the neat sketch the phenomenon of scattered light as an interior polarizer and analyzer. **(10 Marks)**

b. Explain the following:
i) Types of brittle coatings. ii) Advantage and applications of brittle coating. **(10 Marks)**

8 a. Draw schematic representation of holographic set up and explain recording and reconstruction process of images in holography. **(10 Marks)**

b. Explain with neat sketch the phenomenon of out of plane displacement measurement by using shadow Moire method. **(10 Marks)**

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