First Semester M.Tech. Degree Examination, June/July 2015
Applied Mathematics

Time: 3 hrs. Max. Marks:100

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

1 a. Define : i) Significant digit ii) Round off error iii) Truncation error iv) Absolute error v) Accuracy. **(10 Marks)**

b. If $f = \frac{4x^2y^3}{z^4}$ and errors in x, y and z are 0.001. Find the absolute error and relative maximum error in f at x = 1, y = 1, z = 1. **(10 Marks)**

2 a. Briefly explain the Regula – False method. use it to obtain the root of the equation : $x^3 - 2x - 5 = 0$. Perform 3 iterations. **(10 Marks)**

b. Find a real root of the equation x sinx + cosx = 0, correct to 4 decimal places, using Newton – Raphson method. **(10 Marks)**

3 a. Solve the equation : $x^3 - x - 1 = 0$, using Muller's method. Perform two iterations. **(10 Marks)**

b. Find all the roots of the equation : $x^3 - 6x^2 + 11x = 6 = 0$. Using the Graeffe's root squaring method. **(10 Marks)**

4 a. Find y′(1.1) and y″(1.1) from the following table : **(10 Marks)**

x	1.0	1.1	1.2	1.3	1.4	1.5	1.6
y	7.989	8.403	8.781	9.129	9.451	9.750	10.031

b. Evaluate :

$$\int_0^1 \frac{dx}{1+x^2}$$

using Romberg's method correct to four decimal places (take n = 0.5, 0.25, 0.125). **(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. Apply factorization method to solve the equations :

$x + y + z = 1$
$4x + 3y - z = 6$
$3x + 5y + 3z = 4$. **(10 Marks)**

6 a. Using Given's method, reduce the matrix to tridiagonal form :

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 1 & -1 \\ 3 & -1 & 1 \end{bmatrix}.$$

(10 Marks)

b. Find numerically largest eigne value and the corresponding eigen vector of eh matrix :

$$\begin{bmatrix} 4 & 1 & -1 \\ 2 & 3 & -1 \\ -2 & 1 & 5 \end{bmatrix}$$

by power method, taking $[1\ 0,\ 0]^T$ s the initial eigen vector. **(10 Marks)**

7 a. Define :

i) A matrix with linear transformation
ii) Rank of a matrix
iii) Nullity of a matrix. **(10 Marks)**

b. Let $t : R^2 \to R^2$ be a linear transformation defined by t(a, b) = (2a – 3b, a + ab) for all (a, b) $\in R^2$. Find the matrix of 't' relative to this basis B = {(1, 0), (0, 1)}, B′ = {(2, 3), (1, 2)}. **(10 Marks)**

8 a. Define an orthogonal set. Prove that any orthogonal set of nonzero vectors in an inner product space is linearly independent. **(10 Marks)**

b. Find equation y = a + bx of the least square line that best fits the given data :

x	1	2	3	4	5
y	14	27	40	55	68

(10 Marks)

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14MDE12

First Semester M.Tech. Degree Examination, June/July 2015
Finite Element Method

Time: 3 hrs. Max. Marks:100

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

1 a. What is FEM? Briefly explain the steps involved. **(06 Marks)**

b. Describe the convergence criteria used for the displacement functions in FEM. **(06 Marks)**

c. For a fixed beam subjected to uniformly distributed load, derive equation for maximum deflection using Galerkin approach. Assume $y = c\left[1 - \frac{\cos 2\pi x}{L}\right]$. **(08 Marks)**

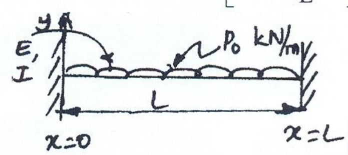

Fig.Q1(c)

2 a. Derive the shape functions for a quadratic element in 1 – dimension and sketch their variation along this element. **(10 Marks)**

b. For the truss element shown in Fig. Q2(b) (x, y) co-ordinates of the element are indicated near nodes 1, 2. The element displacement dof vector is given by $\{u\} = [1.5 \ \ 1.0 \ \ 2.1 \ \ 4.3]^T \times 10^{-2}$ mm. Take $E = 300 \times 10^3$ N/mm². $A = 100$ mm².
Determine the following :
i) Element displacement dof in local co-ordinates
ii) Stress in the element
iii) Stiffness matrix of the element in local co-ordinate system.

$E = 300 \times 10^3$ N/mm²; $A = 100$ mm². $\begin{Bmatrix} u_1 \\ v_1 \\ u_2 \\ v_2 \end{Bmatrix} = \begin{Bmatrix} 1.5 \\ 1.0 \\ 2.1 \\ 4.3 \end{Bmatrix} \times 10^{-2}$ mm. **(10 Marks)**

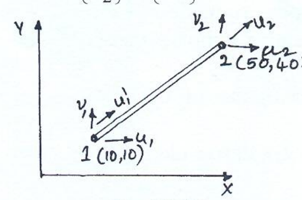

Fig.Q2(b)

3 a. Derive the Hermite shape function of beam element and draw the Hermite shape functions. **(10 Marks)**

b. For the beam and loading shown in Fig. Q3(b), determine i) the slopes at 2 and 3 ii) the vertical deflection at the midpoint of the distributed load.
$E = 200$ GPa ; $I = 4 \times 10^{-6}$ m⁴. **(10 Marks)**

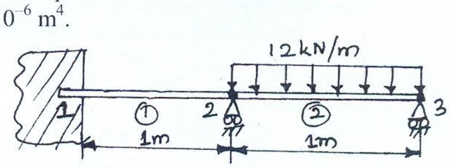

Fig.Q3(b)

4 a. Find J^{-1} matrix for 3D domain using tetrahedral element. **(10 Marks)**

b. A two dimensional plate is shown in Fig. Q4(b). Determine the equivalent point loads at node 7, 8 and 9 for the linearly distributed pressure load acting on the edge 7 – 8 – 9. **(10 Marks)**

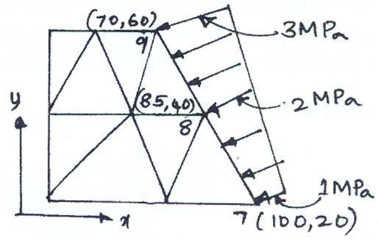

Fig.Q4(b)

5 a. Obtain [B] matrix in case of axisymmetric triangular element. **(10 Marks)**

b. An axisymmetric surface is shown in Fig. Q5(b). Determine the equivalent loads at nodes 6 and 4 the coordinates of nodes are point 6 are (60, 40) mm point 4 are (40, 55)mm and point 2 are (20, 70) mm. **(10 Marks)**

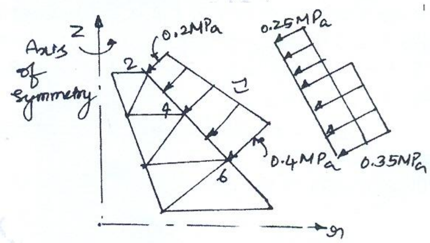

Fig.5Q(b)

6 a. Write short notes on classical plate theory and shear deformation theory. **(15 Marks)**

b. What assumptions are made in Kirchoff's theory of thin shells? Give stress – strain relation for the shells using Kirchoff's theory. **(05 Marks)**

7 a. For a linear triangular or CST element derive element mass matrix or consistent mass matrix. **(10 Marks)**

b. For a truss element derive element mass matrix or consistent mass matrix. **(10 Marks)**

8 For the stepped bar shown in Fig. Q8, determine the eigen values and eigen vectors.
E = 200 GPa ; ρ = 7830 kg/m$^{3+.}$ **(20 Marks)**

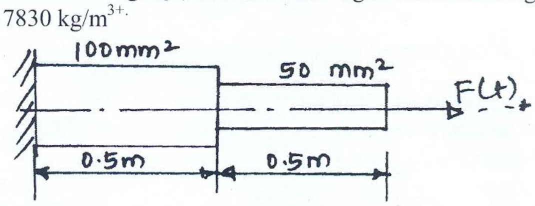

Fig.Q8

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14CAE13

First Semester M.Tech. Degree Examination, June/July 2015
Continuum Mechanics

Time: 3 hrs. Max. Marks:100

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

1 a. Derive equation of equilibrium for 3 – D state of stress and explain their importance. **(10 Marks)**

b. The state of stress at a point in a stressed body is given by:

$$\{\tau_{ij}\} = \begin{bmatrix} 18 & 10 & 25 \\ 10 & 40 & 15 \\ 25 & 15 & 30 \end{bmatrix} \text{MPa}$$

Determine : (i) Invariants of stresses (ii) Principal stresses (iii) Direction of maximum principal stress. **(10 Marks)**

2 a. Explain the importance of compatibility conditions and derive condition of compatibility for 2 – D condition. **(08 Marks)**

b. In a body subjected to a system of loads, the displacement field in micro units is given by $u = (x^2 + y)\ i + (3 + z)\ j + (x^2 + 2y)\ k$

Determine: (i) The strain tensor at P(2, 1, -2) (ii) Principal stains at the above point (iii) Decompose the state of strain at the above point into volumetric and deviatoric components. **(12 Marks)**

3 a. State explain following principles:
(i) principle of super position. (ii) Saint Venant's principle. **(10 Marks)**

b. The strain tensor at a point in a stressed body is given by:

$$\{\epsilon_{ij}\} = \begin{bmatrix} 0.4 & -0.1 & -0.4 \\ -0.1 & 0.2 & 0.3 \\ -0.4 & 0.3 & -0.3 \end{bmatrix} \times 10^{-3}$$

Obtain the stress tensor at the point if the body is made of steel with $\in = 2.1 \times 10^5$ MPa, $\upsilon = 0.3$ **(10 Marks)**

4 a. What is Airy's stress function? Explain. **(03 Marks)**

b. When weight is the only body force, show that the solution of a 2 – D elasticity problem reduces to the solution of the bi – harmonic equation. **(07 Marks)**

$$\left(\frac{\delta^4}{\delta x^4} + 2\frac{\delta^4}{\delta x^2 \delta y^2} + \frac{\delta^4}{\delta x^4}\right)\phi(x, y) = 0$$

c. Investigate what problem of plane stress is solved by $\phi = -\frac{F}{d^3} xy^2 (3d - 2y)$ appled to the region included in y = 0, y = d, x = 0, on the side x positive. **(10 Marks)**

5 Obtain expressions for stresses induced in rotating disk in the following cases:
(i) A solid disk of diameter 'b'
(ii) A disk with a hole of diameter 'a'
Also show that the introduction of the small hole doubles the maximum stress induced. Show the distribution of the stresses in each case. **(20 Marks)**

6 a. Obtain the relationship between natural strain and engineering strain. **(04 Marks)**
b. With reference to bhaviour of material in plastic range, explain different idealized stress-strain diagrams and corresponding mechanical models. **(06 Marks)**
c. Explain the following yield criteria: (i) Tresca (ii) Von Mises. **(10 Marks)**

7 a. Explain viscoelastic behavior of a material and illustrate it by two simple models **(06 Marks)**
b. Explain (i) Law of conservation of mass (ii) Linear momentum principle. **(08 Marks)**
c. Explain (i) Stokesian (ii) Newtonian fluids. **(06 Marks)**

8 Write short notes on Any four
a) Octahedral normal and shear stresses.
b) Mohr's circle diagram for 3 – D state of stress
c) Plane state of stress and plane state of strain
d) Generalized Hooke's law
e) Principle of uniqueness of solution. **(20 Marks)**

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14CAE14

First Semester M.Tech. Degree Examination, June/July 2015
Experimental Mechanics

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions.***
2. Use of statistical tables permitted.
3. Missing data, if any, may be suitably assumed.

1 a. Define accuracy and precision with example. **(04 Marks)**

b. List out different types of errors in measurement system. **(04 Marks)**

c. The specimens of mild steel are chemically analysed for carbon content in two different laboratories. The percentage of carbon content contained are as follows :

$$\text{LabA}:\begin{cases}0.23 & 0.23 & 0.21 & 0.25 & 0.28\\ 0.24 & 0.20 & 0.18 & 0.23 & 0.24\end{cases}$$

$$\text{LabB}:\begin{cases}0.21 & 0.19 & 0.24 & 0.20 & 0.22\\ 0.18 & 0.20 & 0.22 & 0.25 & 0.17\end{cases}$$

Test the hypothesis that there is no significant difference in two laboratories in their determination of percentage of carbon. **(12 Marks)**

2 a. A set of machine bearings of a particular make are tested for wear at different operating temperatures controlled by an oil bath. The following test results are obtained :

Operating temperature x(in C)°	100	150	200	250	300	350	400
Amount of wear (y) in mg/100h of operation	3.2	5.2	5.8	7.9	9.6	11.7	13.2

i) Find the linear least square curve regression y on x (i.e. Assuming temperature values given in the data are without error)

ii) Estimate the amount of wear at 325°C and 0°C and comment

iii) Determine also the internal estimate of uncertainties in the values of slope and intercept of the regression fit–line. **(14 Marks)**

b. Explain basic components of data acquisition system. **(06 Marks)**

3 a. Derive the expression for the gauge factor of an electrical resistance gauge.

$$F=\frac{dS/S}{\in}+(1+2\gamma)$$

Where F = Gauge factor, S = resistivity, γ = Poisson's ratio, $\in$ = Normal stain. **(10 Marks)**

b. A rectangular strain gauge rosette is bonded at a critical point on to the surface of a structural member. When the structural member is loaded, the strain gauges show the following readings : $\in_0 = 850\ \mu$ m/m ; $\in_{45} = -50\ \mu$ m/m ; $\in_{90} = -850\ \mu$ m/m.
The gauge factor and the cross sensitivity of the gauges are 2.80 and 0.06. Find actual strains, magnitude and directions of corrected principal stains. Given that, E = 200 GPa, γ_0 = Poisson's ratio of the material of the strain gauge = 0.285. **(10 Marks)**

4 a. Derive the expression for fringe order using stress–optic law in case of two dimensional photo-elasticity and define material and model fringe values. **(10 Marks)**

b. The material fringe constant in tension for a given photo-elastic model is 18 kN/m when calibrated with sodium (λ = 589.3 nm). The model has a thickness of 6 mm. If the model is observed with mercury light (λ = 548.1 nm) and the stress ($\sigma_1 - \sigma_2$) at a point is 18 KPa, what is the fringe order? Assume C (stress optic coefficient) is independent of λ. **(04 Marks)**

c. Explain wave-plate, half wave-plate, quarter wave-plate. **(06 Marks)**

5 a. In 2D photo-elasticity, explain the shear difference method of separating stresses. **(10 Marks)**
b. What are the properties of an ideal photo – elastic materials? **(05 Marks)**
c. Explain the experimental procedure to calibrate a circular disc. **(05 Marks)**

6 a. What is meant by stress-freezing technique? Explain. **(10 Marks)**
b. Derive the following relation for bi-refringent coatings

$$\left(\sigma_{1c} - \sigma_{2c}\right) = \frac{E_c(1+\gamma_p)}{Ep(1+\gamma_c)}\left(\sigma_{1p} - \sigma_{2p}\right)$$

where σ_{1p}, σ_{2p}, E_p are the principal stresses and modulus of elasticity on the surface of the machine part and σ_{1p}, σ_{2p}, E_c are the correspond values of coating. **(10 Marks)**

7 a. What are the advantages of brittle coating method? **(05 Marks)**
b. Explain with neat sketch of schematic representation of holographic –setup. **(07 Marks)**
c. Describe the method of calculating the fringe spacing in Moire Fringe method. **(08 Marks)**

8 Write short notes on the following (any Four) :
a. Normal distribution
b. Theory of wheat stone's bridge
c. Difference between ISO – chromatic and ISO – clinics
d. Holography and its importance
e Brittle crating technique. **(20 Marks)**

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