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Question Paper Code : 10627

M.E./M.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

First Semester

CAD/CAM

ED 5153 — ADVANCED FINITE ELEMENT ANALYSIS

(Common to M.E. Computer Aided Design/M.E. Engineering Design/
M.E. Product Design and Development)

(Regulation 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Distinguish between plate and Shell elements with respect to Degrees of freedom.

2. With a suitable example write about non-conforming elements.

3. Why do we resort to Iterative Techniques for non-linear problems?

4. Give the strain displacement relations for large displacement formulation.

5. Distinguish between consistent, lumped and HRZ lumped matrices.

6. When do you encounter rigid body modes?

7. Write the governing differential equation for two-dimensional heat transfer problem considering conduction and internal heat generation.

8. Write the Navier-Stokes equations for compressible Newtonian fluids in Cartesian form.

9. Distinguish between h and p refinement.

10. What is meant by error norm?

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PART B — (5 × 13 = 65 marks)

11. (a) (i) Enumerate the assumptions made in the thin plate and thick plate theories. (5)

(ii) Give the strain Displacement relations and constitutive relation for thin plates. Indicate the stresses and lateral loads and associated moments on a neat sketch and give the expressions for Moments and shear forces for the same. (8)

Or

(b) (i) What are the advantages of shell elements? Explain with sketches at least three examples in mechanical engineering where they are used. (6)

(ii) Give the Displacement model for a linear triangular plate element and a rectangular plate bending element. (4)

(iii) What is a degenerated shell element? How is it obtained? (3)

12. (a) (i) Differentiate between Geometric, Material and Contact non-linearities. Give suitable examples when each of these occur. Explain the effect of material and geometric non linearity on the stiffness matrix. (7)

(ii) Explain the Modified Newton Raphson technique for solving nonlinear problems. (6)

Or

(b) (i) With the help of stress strain diagrams describe the following: elastic-perfectly plastic, rigid perfectly plastic, elastic-plastic with linear strain hardening, and elastic-plastic with multi linear strain hardening. Explain the salient features of each type with an example as to when you would resort to such models. (7)

(ii) Distinguish between Isotropic and Kinematic Strain hardening indicating the failure envelope. (6)

13. (a) (i) Determine the first natural frequency of longitudinal vibration of a steel bar fixed at one end and carrying a mass of 1000kg at one end. Plot the mode shapes corresponding to each of these two frequencies. E = 210 GPa and p = 0.78 kg/cc. Assume that area of the bar is $4cm^2$ and length 120cm. (5)

(ii) Differentiate between explicit and implicit techniques. (5)

(iii) Discuss about the choice of critical time step in relation to various solution procedures for dynamic response analysis using FEA. (3)

Or

(b) (i) List the various Direct Integration Methods and explain in detail about the Newmark and Wilson θ method. (7)

(ii) Explain the steps involved in computing the Eigen values using Subspace Iterative technique. (6)

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14. (a) (i) Derive the thermal conduction matrix for two dimensional heat transfer for a linear triangular element. (7)

(ii) Explain the need for the Crank Nicolson scheme for solving partial differential equations in heat transfer. How is it implemented? (6)

Or

(b) (i) Distinguish between Laminar flow and Turbulent flow. (3)

(ii) Derive the partial differential continuity equation for a general 3 dimensional flow. (7)

(iii) Distinguish between Newtonian and non-Newtonian fluids. (3)

15. (a) (i) What are the various mesh quality criteria? Explain how it is evaluated. (7)

(ii) Explain what is meant error estimate. (6)

Or

(b) Write short notes on the following :

(i) Delaunay Triangulation (4)

(ii) Adaptive meshing (5)

(iii) Mesh enrichment. (4)

PART C — (1 × 15 = 15 marks)

16. (a) (i) A javelin is launched by a six feet tall athlete. What mode of vibration would occur first? Discuss why this mode occurs first. If the first natural frequency is to be determined what are the matrices involved and the corresponding boundary conditions? (7)

(ii) A deep drawing process as shown in fig.16(a) for producing cylindrical cups is to be simulated. Explain the modeling procedure for finite element simulation of the above process and discuss the various issues involved. (8)

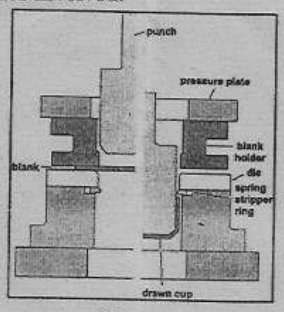

Fig16(a)

Or

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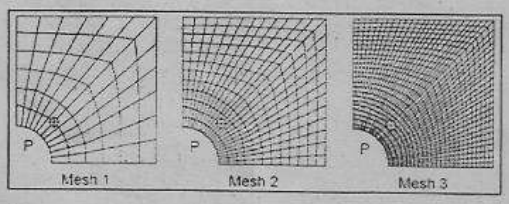
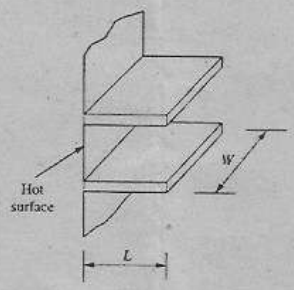
(b) (i) Discuss about the meshes given in fig.16(b)(i) a, b and c. Explain what has been done when going from mesh a to c. Why has such an analysis been done? What kind of mesh is this? Explain the steps needed to create such a mesh. (7)



A b c

fig.16(b)(i)

(ii) Fig.16(b)(ii) shows an array of heat fins attached to the engine of a two wheeler. What kind of loads would act on the same? What are the analyses that can be performed on these fins? Vibration induced in the fins should not cause excessive deflection of the fins. So what is the analysis to be performed? (8)



Array of thin rectangular fins

fig.16(b)(ii)

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