



M.TECH DEGREE EXAMINATIONS: NOV/DEC 2023

(Regulation 2018)

First Semester

DEFENCE TECHNOLOGY

P18DTE0005: Advanced Mechanical Engineering

COURSE OUTCOMES

- CO1:** Understand mechanical analysis software and carry out mathematical modeling for simulation of phenomena behind the structural and fluid dynamics.
- CO2:** Carry out design & finite element analysis of components of systems and subsystems.
- CO3:** Carry out the CFD analysis.

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Examine the two statements carefully and select the answer using the codes given CO3 [K₂]
below:
Assertion (A): Finite difference method is not suitable for structural problems.
Reason (R): In Central Difference approximation scheme, the derivate are replaced by
difference relationship.
- | | |
|---|---|
| a) Both A and R are individually true and R is the correct explanation of A | b) Both A and R are individually true but R is not the correct explanation of A |
| c) A is true but R is false | d) A is false but R is true |
2. On gathering stiffness and loads, the system of equations is given by CO2 [K₂]
_____.
- | | |
|-------------|-------------|
| a) $F = KU$ | b) $K = UF$ |
| c) $U = FK$ | d) $F = UK$ |
3. The art of subdividing the structure into a convenient number of smaller elements is CO1 [K₁]
known as _____.
- | | |
|---------------|-------------------|
| a) assemblage | b) continuum |
| c) traction | d) discretization |

4. Matching type item with multiple choice code

CO1 [K₂]

List I	List II
A. Numerical method	i. Galerkin's Approach
B. Analytical method	ii. Finite Element Method
C. Variational method	iii. Mechanics of solids
D. Weighted residual method	iv. Rayleigh-Ritz method

- | | A | B | C | D |
|----|-----|-----|-----|----|
| a) | ii | iii | iv | i |
| b) | iii | iv | ii | i |
| c) | ii | iv | iii | i |
| d) | iii | i | ii | iv |

5. To find the displacements in non-nodal points of the element, _____ are used.

CO2 [K₂]

- | | |
|---------------------|------------------------|
| a) shape function | b) node function |
| c) element function | d) coordinate function |

6. Consider a freely lying pen on table. Lift the pen and hold it in your hand softly. What do you feel, will there be any stress, strain and tension in the pen?

CO2 [K₂]

- | | |
|--------------|------------|
| a) Stress | b) Strain |
| c) No stress | d) Tension |

7. If any element is specified by the polynomial of the order of two or more, then the element is known as _____.

CO1 [K₂]

- | | |
|-------------------------|--------------------------|
| a) Non-linear element | b) Linear element |
| c) Higher order element | d) Axi-Symmetric element |

8. Stiffness matrix of 1-D element always depends on _____.

CO2 [K₂]

- | | |
|----------------------|---|
| a) Material Property | b) Geometrical Property |
| c) Applied Load | d) Both Material and Geometrical Properties |

9. Example for One-Dimensional element is _____.

CO2 [K₂]

- | | |
|-----------------------|-------------------------|
| a) triangular element | b) truss element |
| c) brick element | d) axisymmetric element |

10. In finite volume method, the conventional nodes are attaining the outcomes through _____ technique.

CO3 [K₂]

- | | |
|----------------------|------------------|
| a) Approximation | b) Interpolation |
| c) Two point average | d) Triangulation |

PART B (10 x 2 = 20 Marks)

- | | | |
|--|-----|-------------------|
| 11. State Hooke's Law and how it is used in FEA based investigations? | CO2 | [K ₂] |
| 12. What did you understand the term approximation in computational analyses? | CO1 | [K ₂] |
| 13. Why discretization is needed in Finite Element Analysis (FEA)? List out the types of discretizations are available to solve structural problems. | CO2 | [K ₂] |
| 14. Differentiate between stiffness and force approaches based analytical procedures involved in direct equilibrium method. | CO2 | [K ₂] |
| 15. What are all the material properties are mandatory to compute structural investigations in ANSYS? | CO2 | [K ₂] |
| 16. List the forces considered in the construction of momentum equation. | CO3 | [K ₂] |
| 17. Does the velocity of the working fluid significantly influence the solver selection process in a CFD tool? | CO3 | [K ₂] |
| 18. List out the initial conditions used in low speed fluid dynamic computations. | CO3 | [K ₂] |
| 19. How different types of walls are represented in CFD tools? | CO3 | [K ₂] |
| 20. Which scheme has low truncation error in FDM approach? | CO3 | [K ₂] |

PART C (10 x 5 = 50 Marks)

- | | | |
|---|-----|-------------------|
| 21. Explain the diagram of interconnected governing equations used for solid mechanics problems. | CO1 | [K ₃] |
| 22. List out all the analytical procedures involved in the Direct Equilibrium Method based finite element approach. | CO2 | [K ₂] |
| 23. How finite element methods based structural engineering approach is differ from finite element analyses? | CO2 | [K ₃] |
| 24. Write down the step-by-step procedures involved in computational structural analysis of cantilever structure using ANSYS Workbench. | CO2 | [K ₂] |
| 25. Differentiate the analytical procedures involved in Finite Difference and Finite Volume Methods. | CO1 | [K ₂] |
| 26. Explain the processes involved in the computational fluid dynamics approach with examples. | CO3 | [K ₂] |
| 27. Explain the approximations of Forward, Backward, and Central schemes involved in Finite Difference Method. | CO1 | [K ₃] |
| 28. Compare and contrast the computational procedures involved in implicit and explicit methods. | CO1 | [K ₂] |
| 29. Write down the step-by-step procedures involved in computational fluid dynamic | CO3 | [K ₃] |

analysis on fixed wing Unmanned Aerial Vehicle (UAV) using ANSYS Workbench. Please use the following boundary and Initial conditions. Velocity of UAV = 27.77778 m/s; Operating Pressure = 101325 Pa; Turbulence Model : SST k-omega;

30. Why pressure correction solvers are needed for incompressible flow based computations? Briefly explain anyone of the pressure correction approach. CO3 [K3]

Answer any TWO Questions
PART D (2 x 10 = 20 Marks)

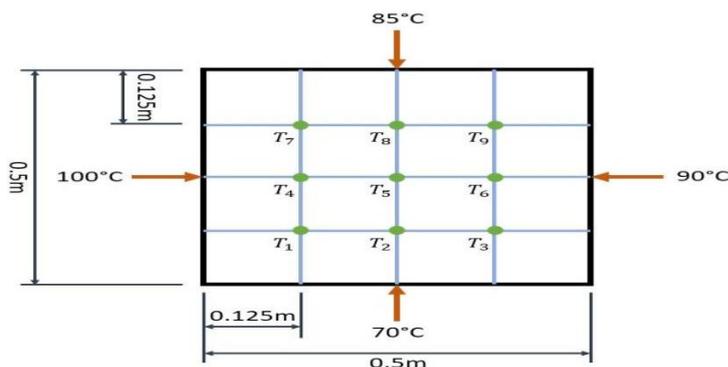
31. The following differential equation is available for a physical phenomenon. 10 CO2 [K4]

$$\frac{d^2y}{dx^2} + 50 = 0, \text{ wherein, } 0 \leq x \leq 10$$

The trial function is, $y = a_1x(10 - x)$; The boundary conditions are: $y(0) = 0$; $y(10) = 0$; Find the value of the parameter “ a_1 ” by the following methods: (i) Least Squares; (ii) Galerkin; (iii) sub-domain collocation; (iv) point collocation;

32. For the below given discretized structure, determine the unknown nodal temperatures through finite difference method. Take, the constant thermal conductivity is 1000 W/mK and uniform imposed heat generation is 1000 KW/m³.

The governing equation is, $\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{q}{k} = 0$.



10 CO1 [K4]

Figure 1. Discretized structure of 2-D test specimen

33. Derive the conservation of mass relationships for infinitesimal small control volume with neat sketch. 10 CO3 [K4]
