PSN COLLEGE OF ENGINEERING AND TECHNOLOGY
(Autonomous)
Melathediyoor, Tirunelveli – 627152

Department of Mechanical Engineering

Subject Name & Code	**510023 & FINITE ELEMENT ANALYSIS**
Course Type	Core
Programme	B.E. Mechanical Engineering (UG)
Year/Semester/Section	IV / VII
Nature of Course/Credit	Theory with Problematic / 4
Course Coordinator	Mr. S. MAREESWARAN, AP/Mechanical/PSNCET

INSTITUTION VISION & MISSION

Institution Vision	To provide an academic environment to learn, work and do research enabling the students to face challenges in life with strong ethical values.	
Institution Mission	**IM-1**	To achieve greater heights of excellence in technical knowledge and skill development through innovative teaching and learning practices.
	IM-2	To develop the infrastructure to meet the demands of technological revolution.
	IM-3	To improve and foster research in all dimensions for betterment of society.
	IM-4	To develop individual competencies to enhance employability and entrepreneurship in students.
	IM-5	To instill higher standards of discipline among students, inculcating ethical and moral values for societal harmony and peace.

DEPARTMENT VISION & MISSION

Department Vision	To provide Mechanical Engineering education to meet global standards through enhanced core activities, skill development and research.	
Department Mission	**DM-1**	To educate students to be creative, inquisitive and innovative to become entrepreneurs.
	DM-2	To instill advanced knowledge with research capabilities for global employment.
	DM-3	To uphold moral and ethical standards in life and career

SYLLABUS:

PSN College of Engineering and Technology		**Regulation: 2018**	
Department:	**Mechanical Engineering**	**Branch Code/ Degree/Branch (mention all branches for which the subject is offered)**	**10/ B.E - MECH**

Semester:	VII				
Subject Code:	510023	L	T	P	C
Subject Title:	FINITE ELEMENT ANALYSIS	3	1	0	4

AIM: Expose the students to understand the Simulation & analysis of the given structure or the element by using mathematical models and formulae

Course objective:

- To introduce the concepts of Mathematical Modeling of Engineering Problems.
- To appreciate the use of FEM to a range of Engineering Problems.
- To gain knowledge related to Vibration analysis and heat, Flow transfer analysis

Course outcomes:	
CO1: To formulate finite element equations and solve the engineering problems	K6
CO2: To Solve and analyze the one dimensional structural and heat transfer problems for different applications.	K4
CO3: To Evaluate and analyze the two dimensional structural problems for different applications	K5
CO4: To Impart knowledge on Dynamics problems and free vibration	K4
CO5: To Formulate and analyze heat transfer formulation and fluid flow	K6

UNIT - I INTRODUCTION TO FINITE ELEMENT ANALYSIS	**12**
Engineering design analysis-meaning and purpose, Historical background of FEM Rayleigh Ritz, Weighted residual method, Variational method, basic concepts of FEM, Applicability of FEM to various problems, Advantages and limitations of FEM, Test for convergence, Commercial finite element packages - advantages and limitations	
UNIT – II ANALYSIS USING ONE DIMENSIONAL ELEMENTS	**12**
General procedure of FEM, Skeletal and continuum structures, Discretization of domainbasic types of elements, Formulation of element stiffness matrices and load vector: 1D spar - linear and quadratic elements, plane truss element, beam element, beams on elastic foundation, treatment of boundary condition, problems using one dimensional elements	
UNIT - III ANALYSIS USING TWO DIMENSIONAL ELEMENTS	**12**
Formulation of two dimensional problems, Isoparametric formulation, 2D triangular and quadrilateral elements, Formulation of element stiffness matrices and load vectors for constant strain triangular element, problems using two dimensional elements, higher order elements.	-
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UNIT – IV DYNAMIC ANALYSIS	**12**
Equations of motion for dynamic problems using one dimensional elements, Formulation of element mass matrices, Consistent and lumped mass matrices, Solution of Eigen value problems, Solving Free vibration problems using one dimensional element.	
UNIT- V HEAT TRANSFER AND FLUID FLOW ANALYSIS	**12**
Basic equations of heat transfer and fluid flow, Finite element formulation, One dimensional heat transfer and fluid flow problems, solving steady state heat conduction and convection problems using one dimensional elements.	
Total: 60 Periods	

MCQ QUESTIONS

(150×1 = 150 MARKS)

1. If the structure is divided into discrete areas or volumes then it is called an _____
a) Structure
b) Element
c) Matrix
d) Boundaries

Answer: b

2. In finite element modeling nodal points are connected by unique _____
a) Surface
b) Shape
c) Eigen values
d) Matrix

Answer: a

3. In finite element modeling every element connects to _____
a) 4 nodes
b) 3 nodes
c) 2 nodes
d) Infinite no of nodes

Answer: c

4. In one dimensional problem, each node has_____degrees of freedom.
a) 2 degrees of freedom

b) 3 degrees of freedom
c) No degrees of freedom
d) 1 degree of freedom

Answer: d

5. Which relations are used in one dimensional finite element modeling?
a) Stress-strain relation
b) Strain-displacement relation
c) Total potential energy
d) Total potential energy; Stress-strain relation; Strain-displacement relation.

Answer: d

6. One dimensional element is the linear segments which are used to model _____
a) Bars and trusses
b) Plates and beams
c) Structures
d) Solids

Answer: a

7. Modeling is defined as _____
a) Elemental area with uniform cross section
b) Elemental area with non uniform cross section
c) Structural area with uniform cross section
d) Non structural area with non uniform cross section

Answer: a

8. Discretization includes _____ numbering.
a) Element and node
b) Only nodal
c) Only elemental
d) Either nodal or elemental

Answer: a

9. The loading on an element includes _____
a) Body force

b) Traction force
c) Point load
d) Body force, Traction force & Point load

Answer: d

10. Global nodes correspond to _____
a) Entire body
b) On surface
c) On interface
d) On element

Answer: a

11. Local node number corresponds to _____
a) Entire body
b) On element
c) On interface
d) On surface

Answer: b

12. Natural or intrinsic coordinate system is used to define _____
a) Co-ordinates
b) Shape functions
c) Displacement functions
d) Both shape functions and co-ordinate functions

Answer: b

13. In $q=[q_1,q_2]^T$ is defined as _____
a) Element displacement vector
b) Element vector
c) Displacement vector
d) Shape function vector

Answer: a

14. Shape function is just a _____
a) Displacement function
b) Equation
c) Interpolation function
d) Matrix function

Answer: c

15. Isoparametric formula is _____
a) $x=N_1x_1+N_2x_2$
b) $x=N_2x_1+N_1x_2$
c) $x=N_1x_1-N_2x_2$
d) $x=N_2x_1-N_1x_2$

Answer: a

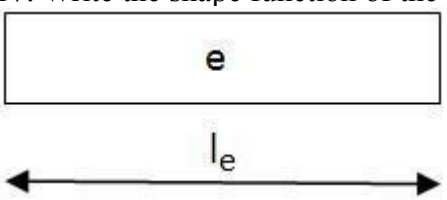
15. $B=\frac{1}{x_2-x_1}[-1\ 1]$ is an _____
a) Strain matrix
b) Element-strain displacement matrix
c) Displacement matrix
d) Elemental matrix

Answer: b

16. Deformation at the end of elements are called _____
a) Load
b) Displacement functions
c) Co-ordinates
d) Nodes

Answer: d

17. Write the shape function of the given element.



$u= N_1u^{(e)}+N_2u_2^{(e)}$. Here N_1 & N_2 are
a) $N_1=1-x/l_e$ & $N_2=x/l_e$
b) $N_1=x/l_e$ & $N_2=1-x/l_e$
c) $N_1=0$ & $N_2=x$

d) $N_1=x$ & $N_2=0$

Answer: a

18. In shape functions, first derivatives must be_____within an element.
a) Infinite
b) Finite
c) Natural
d) Integer

Answer: b

19. In shape functions,_____must be continuous across the element boundary.
a) Derivatives
b) Nodes
c) Displacement
d) Shape function

Answer: c

20. Stresses due to rigid body motion are _____
a) Zero
b) Considered
c) Not considered
d) Infinite

Answer: c

21. The expressions u=Nq; $\varepsilon=Bq;$ $\sigma=EBq$ relate _____
a) Displacement, Strain and Stress
b) Strain and stress
c) Strain and displacement
d) Stress and displacement

Answer: a

22. Dimension of global stiffness matrix is _____
a) $N\,X\,N$, where N is no of nodes
b) $M\,X\,N$, where M is no of rows and N is no of columns

c) Linear
d) Eliminated

Answer: a

23. Each node has only _____
a) Two degrees of freedom
b) One degree of freedom
c) Six degrees of freedom
d) Three degrees of freedom

Answer: b

24. Global stiffness K is a_____matrix.
a) Identity matrix
b) Upper triangular matrix
c) Lower triangular matrix
d) Banded matrix

Answer: d

25. The dimension of K_{banded} is_____(Here NBW is half bandwidth)
a) [N X NBW]
b) [NBW X N]
c) [N X N]
d) [NBW X NBW]

Answer: a

25. In many one-dimensional problems, the banded matrix has only two columns. Here NBW=__
a) 6
b) 3
c) 7
d) 2

Answer: d

26. Stiffness matrix represents a system of _____
a) Programming equations
b) Iterative equations
c) Linear equations
d) Program CG SOLVING equations

Answer: c

27. Stiffness matrix is _____
a) Non symmetric and square
b) Symmetric and square
c) Non symmetric and rectangular
d) Symmetric and rectangular

Answer: b

28. In stiffness matrix, all the_____elements are positive.
a) Linear
b) Zigzag
c) Diagonal
d) Rectangular

Answer: c

29. The size of global stiffness matrix will be equal to the total_____of the structure.
a) Nodes
b) Degrees of freedom
c) Elements
d) Structure

Answer: b

30. Element stiffness is obtained with respect to its ____
a) Degrees of freedom
b) Nodes
c) Axes
d) Elements

Answer: c

31. Types of Boundary conditions are _____
a) Potential- Energy approach
b) Penalty approach
c) Elimination approach
d) Both penalty approach and elimination approach

Answer: d

32. Potential energy, π = _____
a) $\frac{1}{2}Q^{T}KQ-Q^{T}F$
b) QKQ-QF
c) $\frac{1}{2}KQ-QF$
d) $\frac{1}{2}QF$

Answer: a

33. Equilibrium conditions are obtained by minimizing _____
a) Kinetic energy
b) Force
c) Potential energy
d) Load

Answer: c

34. In elimination approach, which elements are eliminated from a matrix _____
a) Force
b) Load
c) Rows and columns
d) Undefined

Answer: c

35. In elimination approach method, extract the displacement vector q from the Q vector. By using _____
a) Potential energy
b) Load
c) Force

d) Element connectivity

Answer: d

36. Penalty approach method is easy to implement in a _____
a) Stiffness matrix
b) Iterative equations
c) Computer program
d) Cg solving

Answer: c

37. If $Q_i=a_i$ then a_i is _____
a) Displacement
b) Symmetric
c) Non symmetric
d) Specified displacement

Answer: d

38. The first step of penalty approach is, adding a number C to the diagonal elements of the stiffness matrix. Here C is a _____
a) Large number
b) Positive number
c) Real number
d) Zero

Answer: a

39. In penalty approach evaluate_____at each support.
a) Load vector
b) Degrees of freedom
c) Force vector
d) Reaction force

Answer: d

40. For modeling of inclined roller or rigid connections, the method used is ____
a) Elimination approach
b) Multiple constraints

c) Penalty approach
d) Minimum potential energy theorem

Answer: b

41. With temperature effect which will vary linearly?
a) Horizontal stress load
b) Potential energy
c) Vertical stress load
d) Kinematic energy

Answer: c

42. α means _____
a) Co-efficient of thermal expansion
b) Co-efficient of linear expansion
c) Thermal expansion
d) Thermal effect

Answer: a

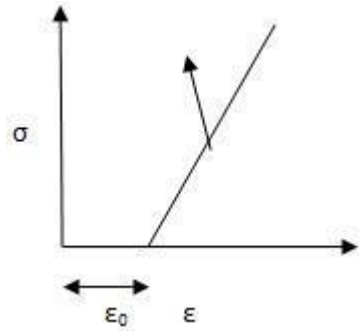
43. In temperature effect, initial strain, ε_0= _____
a) α ΔT
b) α+ΔT
c) α-ΔT
d) Load

Answer: a

44. In a structure, a crack is formed as a result of _____
a) Thermal expansion
b) Thermo couple
c) Thermal strain
d) Thermal stress

Answer: d

45. In the given diagram, the line indicates _____



a) Stress relation
b) Strain relation
c) Stress – strain relation
d) Undefined

Answer: c

46. Stress – strain relation is given as _____
a) $\sigma=E$
b) $\sigma=E\varepsilon$
c) $\sigma=E(\varepsilon-\varepsilon_0)$
d) Undefined

Answer: c

47. Strain energy per unit volume is ____
a) $u_0=E(\varepsilon-\varepsilon_0)$
b) $u_0=\frac{1}{2}E(\varepsilon-\varepsilon_0)$
c) Non symmetric
d) Specified displacement

Answer: b

48. Temperature change is denoted as_____
a) $\Delta T=(T_2-T_1)$
b) θ^e
c) l_e
d) A_e

Answer: b

49. $\theta^e = \frac{E_e A_{ele} \alpha \Delta T}{x_2 - x_1}\{-11\}$ is the temperature effect.

a) True
b) False

Answer: a

50. Stress in each element is _____
a) Eliminated
b) σ=EBq
c) σ=αΔT
d) σ=E(Bq-αΔT)

Answer: d

51. Plane trusses are also known as _____
a) One–dimensional trusses
b) Two-dimensional trusses
c) Three-dimensional trusses
d) Poly dimensional trusses

Answer: b

52. A truss structure consists only____force members.
a) Only one
b) Two
c) Three
d) Poly

Answer: b

53. Plane truss element can be shown in _____
a) Local coordinate system
b) Global coordinate system
c) Local and global coordinate systems
d) Dimensional structure

Answer: c

54. The truss element is a_____when we see it in a local co-ordinate system.
a) Three dimensional
b) One dimensional
c) Two dimensional
d) Thermal component

Answer: b

55. Formula for direct cosine l=cosθ= _____

a) x_2-x_1
b) x_2/e
c) x_1/e
d) x_2-x_1/e

Answer: d

56. The direct cosine m is given by formula cosϕ= _____

a) x_2-x_1/e
b) y_2-y_1/e
c) x_1-y_1/e
d) x_2-y_2/e

Answer: b

57. Strain energy (U) in global co-ordinates can be written as _____

a) $q^{'T}k^{'}q^{'}$
b) $q^{'T}k^{'}$
c) $k^{'}q^{'}$
d) $12\,q^{'T}k^{'}q^{'}$

Answer: d

58. The stress σ in a truss element is given by _____

a) σ=E
b) σ=ε
c) σ=E_eε
d) σ=α

Answer: c

59. In 2D elements. Discretization can be done. The points where triangular elements meet are called _____
a) Displacement
b) Nodes
c) Vector displacements
d) Co-ordinates

Answer: b

60. Each triangle formed by three nodes and three sides is called a _____
a) Node
b) Force matrix
c) Displacement vector
d) Element

Answer: d

61. The finite element method is used to solve the problem _____
a) Uniformly
b) Vigorously
c) Approximately
d) Identically

Answer: c

62. In two dimensional modeling each node has_____degrees of freedom.
a) One
b) Infinity
c) Finite
d) Two

Answer: d

63. For a triangular element,element displacement vector can be denoted as ____
a) $q=[q_1,q_2,q_3]^T$
b) $q=[q_1,q_2]^T$
c) $q=[q_1,q_2,\ldots\ldots q_6]^T$

d) Load vector

Answer: c

64. In two dimensional analysis, stresses and strains are related as ____
a) $\sigma=D\varepsilon$
b) $\sigma=\varepsilon$
c) Load values
d) $\varepsilon=D\sigma$

Answer: a

65. In two dimensional modeling, body force is denoted as ____
a) $f=[f_x,f_y]^T$
b) $\sigma=D\varepsilon$
c) $q^{'}=lq$
d) $f=[2|i-j|+1]$

Answer: a

66. The information of array of size and number of elements and nodes per element can be seen in _
a) Column height
b) Element connectivity table
c) Matrix form
d) Undefined

Answer: b

67. In two dimensional modeling, traction force is denoted as _____
a) Row vector
b) $T=[T_x,T_y]^T$
c) $f=[f_x,f_y]^T$
d) $\sigma=D\varepsilon$

Answer: b

68. In two dimensional modeling, elemental volume is given by _____
a) $dV=tdA$

b) dV=dA
c) $f=[f_x,f_y]^T$
d) Trussky program

Answer: a

69. Finite element method is used for computing_____and _____
a) Stress and strain
b) Nodes and displacement
c) Nodes and elements
d) Displacement and strain

Answer: d

70. In deformation of the body, the symmetry of____and symmetry of_____can be used effectively.
a) Stress and strain
b) Nodes and displacement
c) Geometry and strain
d) Geometry and loading

Answer: d

71. For a circular pipe under internal or external pressure, by symmetry all points move _____
a) Radially
b) Linearly
c) Circularly
d) Along the pipe

Answer: a

72. Boundary conditions can be easily considered by using _____
a) Rayleigh method
b) Penalty approach method
c) Galerkin approach
d) Potential energy approach

Answer: b

72. When dividing an area into triangles, avoid large _____
a) Dimensions
b) Loading
c) Aspect ratios
d) Boundary conditions

Answer: c

73. In dividing the elements a good practice may be to choose corner angles in the range of _____
a) 30-120°
b) 90-180°
c) 25-75°
d) 45-180°

Answer: a

74. Stresses can be change widely at _____
a) Large circular sections
b) Notches and fillets
c) Corners
d) Crystals

Answer: b

75. The Constant strain triangle can give_____stresses on elements.
a) Linear
b) Constant
c) Uniform
d) Parallel

Answer: b

76. The_____can be obtained even with coarser meshes by plotting and extrapolating.
a) Minimum stresses
b) Minimum strain
c) Maximum stresses

d) Maximum strain

Answer: c

77. Coarser meshes are recommended for _____
a) Loading
b) Notches and fillets
c) Crystals
d) Initial trails

Answer: d

78. Increasing the number of nodes in coarse mesh regions where stress variations are high, should give better results. This method is called
a) Divergence
b) Convergence
c) Convergent- divergent
d) Un defined

Answer: b

79. In the four-node quadrilateral element, the shape functions contained terms _____
a) ξ
b) σ
c) $\varnothing$
d) Undefined

Answer: a

80. A_____element by using nine-node shape function.
a) Load vector
b) Sub parametric
c) Element displacement vector
d) Constant matrix

Answer: b

81. Eight-Node Quadrilateral. This element belongs to the_____family of elements.
a) Serendipity
b) Constant matrix
c) Load vector
d) Master element

Answer: a

82. N_I, is of the form _____
a) Co-ordinates
b) $N_I=c(1-\xi)(1-\eta)(1+\xi+\eta)$
c) $N_I=(1-\xi)(1-\eta)$
d) $N_I=(1-\xi)$

Answer: b

83. Six node triangular elements is also known as _____
a) Triangle
b) Quadratic triangle
c) Interpolation
d) Shape function

Answer: b

84. In six node triangular element, the gauss points of a triangular element can be defined by ____
a) Two point rule
b) Three point rule
c) One point rule
d) Undefined

Answer: c

85. The mid node should not be outside of the triangular element this condition should ensures that det J does not attain a value ____
a) Constant
b) Zero
c) Unity
d) Infinite

Answer: b

84. The nodal temperature load can be evaluated by using _____
a) Uniform energy
b) Strain energy
c) Numerical integration
d) Displacement

Answer: c

85. The gauss points for a triangular region differ from the_____region.
a) Rectangular
b) Triangular
c) Square
d) Temperature

Answer: c

86. In a nine node quadrilateral, the shape functions can be defined as _____
a) Shape functions
b) Generic shape functions
c) Elements
d) Planes

Answer: b

87. During finite element formulation of beam each node has_____degrees of freedom.
a) three
b) two
c) one
d) six

Answer: b

88. Beams are horizontal members used for supporting transverse loading.
a) True
b) False

Answer: a

89. The total number of degrees of freedom in a beam with four nodes is _____
a) four
b) eight
c) sixteen
d) thirty two

Answer: b

90. The displacements in beam elements are interpolated using _____
a) shape elements
b) shape functions
c) shape parameters
d) shape factors

Answer: b

91. The shape functions for interpolation on beam elements are defined on the range of _____
a) 0 to +1
b) -1 to 0
c) 0 to +2
d) -1 to +1

Answer: d

92. In beam elements the cross section of the element is assumed.
a) True
b) False

Answer: a

93. Which of the following statements is correct?
a) Stiffness coefficient value for numerical solution is less than the value of exact solution
b) Stiffness coefficient value for numerical solution is greater than the value of exact solution
c) Stiffness coefficient value for numerical solutions is equal to the value of exact solution
d) Stiffness coefficient value for numerical solutions is twice the value of exact solution

Answer: b

94. On a simply supported beam with uniformly distributed load (p) over length (l) the value of reaction force at one support is ___
a) p*l
b) (p*l)/2
c) $(p*l)^2$
d) (p*l)/3

Answer: b

95. In Galerkin method we convert a continuous operator problem into a discrete problem.
a) True
b) False

Answer: a

96. Which of the following is not a one dimensional element?
a) bar
b) brick
c) beam
d) rod

Answer: b

97. Three geometrically identical beams made out of steel, aluminum, and titanium are axially loaded. Which of the following statements is correct?
a) Stress in titanium is the least
b) Stress in cast iron is the highest
c) Stress in steel is the least
d) Stress in all three beams is the same

Answer: d

98. The application of force at which of the following point on a beam will nullify the effect of torsion?
a) Centroid
b) Center of mass

c) Extreme fiber
d) Shear centre

Answer: d

99. For a taper beam element two cross sections are necessary to define the geometry.
a) True
b) False

Answer: a

100. Which of the following statements is correct?
a) Beam elements are recommended for unsymmetrical cross sections
b) Bar elements are recommended for unsymmetrical cross sections
c) Beam and bar elements can both be used for unsymmetrical cross sections
d) Neither beam nor bar elements can be used for unsymmetrical cross sections

Answer: a

101. The equivalent load (f) acting on a simply supported beam element loaded with uniformly distributed load (p) over an element of length (l) is given by which of the following expressions?
a) $f=[pl2, pl^2 12, pl2, -pl^2 12]$

b) $f=[pl2, pl^2 12, pl2, pl^2 12]$

c) $f=[pl2, -pl^2 12, pl2, -pl^2 12]$

d) $f=[pl2, pl^2 12, -pl2, -pl^2 12]$

Answer: a

102. Symmetry in application of boundary conditions should be avoided in which of the following type of analysis?
a) Linear static analysis
b) Modal analysis
c) Thermal analysis
d) Nonlinear static analysis

Answer: b

103. Boundary conditions are applied to simulate the physical constraints on the finite element model.
a) True
b) False

Answer: a

104. Which of the following is the correct equation for stiffness (K) of an element given value of force (F) and displacement (Q)?
a) FQ=K
b) KQ=F
c) KF=Q
d) KFQ=1

Answer: b

105. Which of the following conditions must be fulfilled to apply symmetry in a finite element model?
a) Geometry of the model is symmetric
b) Boundary conditions to be applied are symmetric
c) Geometry model has large number of nodes
d) Geometry of the model is symmetric and boundary conditions to be applied are symmetric

Answer: d

106. Which of the following boundary conditions cannot be directly applied on solid elements?
a) Force
b) Pressure
c) Support
d) Torque

Answer: d

107. Traction is force acting on an area in any direction other than normal.
a) True
b) False

Answer: a

108. Which of the following statements is correct?
a) Reaction force at supports is equal to the sum of the product of stiffness and displacement
b) Reaction force at supports is equal to the product of sum of stiffness and displacement
c) Reaction force at supports is equal to the sum of stiffness's
d) Reaction force at supports is equal to the sum of displacements

Answer: a

109. Which of the following equations give the relation between material properties like modulus of elasticity (E), modulus of rigidity (G), and Poisson's ratio (u)?
a) E = 2*G*(1+u)
b) E = 3*G*(1+u)
c) E = 2*G*(1-u)
d) E = 3*G*(1-u)

Answer: a

110. The simultaneous linear equations used in FEM for solution of static problems are KX=F, the methods available for solving these equations are divided into two types: direct and iterative.
a) True
b) False

Answer: a

111. For the following equations, what is the value of x_2 using Gaussian elimination method? $x_1-x_2+3x_3=10$——— (i)
$5x_2-5x_3=-5$————— (ii)
$-7x_3=-28$ ——————- (iii)
a) 1
b) 2
c) 3
d) 4

Answer: c

112. For the following equations, what is the value of x_1 using Gaussian elimination method? $x_1-x_2+3x_3=10$——— (i)

$5x_2-5x_3=-5$———— (ii)
$-7x_3=-28$————- (iii)
a) 1
b) 2
c) 3
d) 4

Answer: a

113. Which option is not correct about direct methods for solving system of linear equations?
a) In the absence of errors it yields exact solution
b) Errors arising from round off and truncation may give useless results
c) Gaussian elimination method is an example
d) Starts with an initial approximation

Answer: d

114. Which option is not correct about iterative methods for solving system of linear equations?
a) Convergence yields a good approximate solution
b) Insensitive to the growth of round-off errors
c) Gaussian elimination method is an example
d) Starts with an initial approximation

Answer: c

115. In structural mechanics, which option is not correct about linear analysis?
a) Displacements are infinitesimally small
b) Material is linearly elastic
c) Externally applied loads are a function of time
d) Applied loads are not a function of time

Answer: c

116. A generalized Eigen value problem $[K- \omega^2M]X=0$ has a non-zero solution for X. What can be the value of determinant of the matrix $[K- \omega^2M]$?
a) Any integer
b) 0
c) +1

d) Positive integer

Answer: b

117. In FEM, the forced vibrations equation after Finite Element discretization of a structure can be expressed as which option?
a) $M\ddot{x}+K\dot{x}=F$
b) $M\ddot{x}+K\dot{x}=0$
c) $M\ddot{x}+Kx=F$
d) $M\ddot{x}+Kx=0$

Answer: c

118. The free vibrations equation after Finite Element discretization of a structure is expressed as $M\ddot{x}+Kx=0$. Which option is not correct about the free vibration case?
a) Displacements are harmonic
b) $x=Xe^{i\omega t}$ where X is amplitude
c) $[K-\omega^2M]X=0$
d) $KX=M\omega^2$

Answer: d

119. The generalized Eigen value problem $[K-\omega^2M]X=0$ has a non-zero solution for X. What is the value of natural frequency, ω if K=⎛ ⎜ 111111111⎞ ⎟ M=⎛ ⎜ 999999999⎞ ⎟ ?

a) 3
b) 1/9
c) 9
d) 1/3

Answer: d

120. Which option is not correct about free vibration analysis problem $KX=\lambda MX$, where X represents the amplitude of displacement x?
a) The displacements are harmonic
b) X represent mode shapes or Eigen vectors
c) λ represent Eigen value
d) ω represents Eigen value

Answer: d

121. After Finite Element discretization of a structure, which option expresses the free vibrations equation?
a) $M\ddot{x}+K\dot{x}=F$
b) $M\ddot{x}+K\dot{x}=0$
c) $M\ddot{x}+Kx=F$
d) $M\ddot{x}+Kx=0$

Answer: d

122. For the eigenvalue problem of the form A(u) = λB(u), which option is not correct about the parameters used in the equation below?
$-d^2xdx^2=\lambda u$

a) $A=d^2xdx^2$
b) B=1
c) B=0
d) λ is called eigenvalue

Answer: c

123. The generalized Eigen value problem [K- λM]X=0 has a non-zero solution for X. What is the value of λ if K=⎛⎝⎜ 111111111⎞⎠⎟ , M=⎛⎝⎜ 444444444⎞⎠⎟ ?

a) 1
b) 12
c) 4
d) 14

Answer: d

124. For the following eigenvalue equation to represent a heat transfer problem, a=kA and C=ρcA.
$-\frac{d}{dx}\left(a\frac{dU}{dx}\right)=\lambda CU$

a) True
b) False

Answer: a

125. If only the first derivatives of u_x and u_y appear in the weak forms, then their interpolation must be at least bilinear.
a) True
b) False

Answer: a

126. In FEM, if two independent variables are components of the same vector, then they can be approximated by two different types of interpolations.
a) True
b) False

Answer: b

127. What can one conclude about the displacement components u_x and u_y in the finite element model of the plane elasticity equations?
a) They are primary variables and must be carried as primary nodal degrees of freedom
b) They are secondary variables and must be carried as primary nodal degrees of freedom
c) They are primary variables and must be carried as secondary nodal degrees of freedom
d) They are secondary variables and must be carried as secondary nodal degrees of freedom

Answer: b

128. Which interpolation functions must be used for the primary variables in weak forms of plane elasticity equations?
a) Hermite family interpolation function
b) Lagrange family interpolation function
c) Hierarchical interpolation function
d) Quadratic interpolation function

Answer: b

129. What are the simplest elements that fit for the finite element model of the plane elasticity equations?
a) Linear triangular and quadratic quadrilateral elements
b) Quadratic triangular and linear quadrilateral elements
c) Linear triangular and linear quadrilateral elements

d) Quadratic triangular and quadratic quadrilateral elements

Answer: c

130. What is the correct statement regarding the shape function S of a linear triangular element?
a) The first derivatives of S and hence, all the strains are element-wise constant
b) The first derivatives of S are linear, but the strains are element-wise constant
c) The first derivatives of S and hence the strains are linear functions
d) The first derivatives of S are element-wise constant, but the strains are linear

Answer: a

131. What is the other name of a linear triangular element for plane elasticity problems?
a) Constant-strain triangle
b) Linear-strain triangle
c) Quadratic-strain triangle
d) Variable-strain triangle

Answer: a

132. What is the function on ∂s∂nif S (n, e) denotes the shape function of a linear quadrilateral element?
a) Linear in e and constant in n
b) Constant in e and Linear in n
c) Linear in both e and n
d) Constant in both e and n

Answer: a

133. For a linear triangular element, what is the order of matrix B in the strain-displacement relation ε=BD, where D denotes the displacement matrix?
a) 6×3
b) 3×6
c) 3×8
d) 8×3

Answer: b

134. 10. For a linear quadrilateral element, what is the order of matrix B in the strain- displacement relation ε=BD, where D denotes the displacement matrix?
a) 6×3
b) 3×6
c) 3×8
d) 8×3

Answer: c

135. Which option is not correct with respect to the orders of the matrices in the following finite element model of plane elastic equations?
$M^e\ddot{\Delta}_e+K^e\Delta^e=F^e+Q^e$

a) Mass matrix M has order 2n x 2n
b) Stiffness matrix K has order 2n x n
c) The element load vector F has order 2n x 1
d) The vector of internal forces Q has order 2n x 1

Answer: b

136. 12. Which form of a periodic solution is sought for the natural vibration study of plane elastic bodies?
a) $\{\Delta\}=\{\Delta_0\}e^{i\omega t}$
b) $\{\Delta\}=\{\Delta_0\}e^{-i\omega}$
c) $\{\Delta\}=\{\Delta_0\}e^{-i\omega t}$
d) $\{\Delta\}=\{\Delta_0\}e^{-i\omega/t}$

Answer: c

137. Which option is correct for the first derivative of the shape function S in the study of plane elasticity problems?
a) It is element-wise constant for triangular element whereas not a constant for quadrilateral element
b) It is element-wise constant for both the triangular element as well as a quadrilateral element
c) It is not a constant for triangular element whereas element-wise constant for quadrilateral element
d) It is a combination of a linear function and constant for both the triangular element and a quadrilateral element

Answer: a

138. 1. For fluid flows, which expression does not characterize the slow flow of a viscous and incompressible fluid in a closed domain?
a) $v.\nabla v=0$
b) $\mu\neq 0$
c) =0
d) =0

Answer: d

139. In mathematical modeling, for which option, a fluid flow can be approximated by a two- dimensional model?
a) One of the dimensions is very small, and there is some flow along with it
b) One of the dimensions is very long, and there is no flow along with it
c) One of the dimensions is very long, and there is some flow along with it
d) The velocity components in two directions vary along the third direction

Answer: b

140. For fluid flows obeying conservation of mass, what is the value of k if v=4x+ky denotes the velocity at any point in the flow?
a) -4
b) 4
c) -2
d) 2

Answer: a

141. The following equation represents the momentum equation for a fluid flow that is approximated by a two-dimensional model. What does k stand for?
$\rho\partial v_x\partial t-\partial\partial x(2k\partial v_x\partial x)-\partial\partial y[k(\partial v_x\partial y+\partial v_y\partial x)]+\partial P\partial x-f_x=0$
a) Thermal conductivity
b) Fluid viscosity
c) Density
d) Pressure

Answer: b

142. If a finite element model involves the natural and direct formulation of momentum and continuity equations, then it is known as the velocity-pressure formulation or mixed formulation.

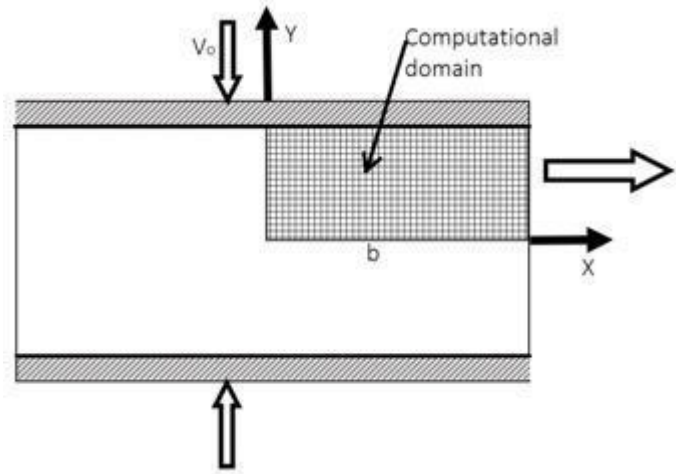
a) True
b) False

Answer: a

143. In the formulation of the finite element model for fluids flows, which option is not correct about the penalty formulation?
a) The continuity equation is an additional relation among the velocity components
b) The constraint is satisfied in an approximate sense
c) Uses the penalty function method
d) Involves natural and direct formulation of momentum and continuity equations

Answer: d

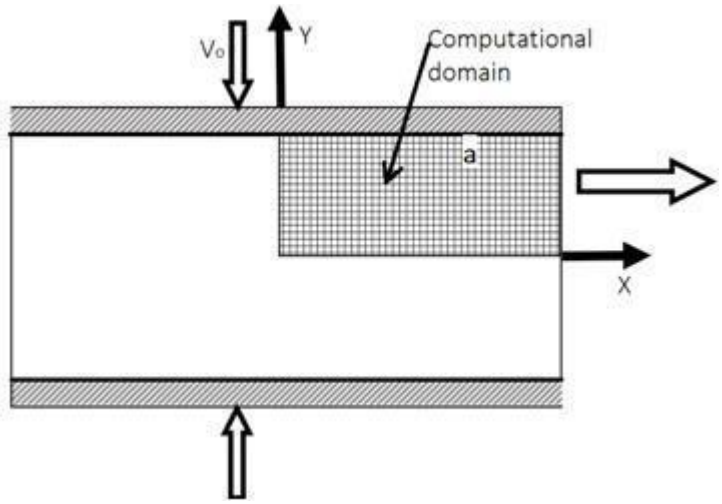
144. Consider the unsteady flow of a viscous fluid squeezed between two horizontal parallel plates, as shown in the following figure. The flow is induced by the uniform motion of the plates toward each other. What are the boundary conditions at the boundary ‘b’ of the domain if v_x, $v_y$are the velocity components?



a) $v_y \neq 0$ and $v_x \neq 0$
b) $v_y = 0$ and $v_x \neq 0$
c) $v_y \neq 0$ and $v_x = 0$
d) $v_y = 0$ and $v_x = 0$

Answer: b

145. Consider the unsteady flow of a viscous fluid squeezed between two horizontal parallel plates, as shown in the following figure. The flow is induced by the uniform motion of the plates toward each other. What are the boundary conditions at the boundary ‘a’ of the domain if v_x, $v_y$are the velocity components?



a) v_y=-V_0 and v_x=0
b) v_y=-V_0 and v_x≠0
c) v_y=V_0 and v_x=0
d) v_y=V_0 and v_x≠0

Answer: a

146. Which statement is not true regarding the variables present in the viscous flow problems?
a) Velocity components are zero on fixed walls
b) Shear stress is zero along the line of symmetry
c) Vertical velocity component v_y and horizontal stress t_x must be zero along the horizontal line of symmetry
d) Shear stress is non zero along the line of symmetry

Answer: d

147. Considering the problem of (linear) bending of beams according to the Euler-Bernoulli beam theory, if the beam is in equilibrium, then solving the equations governing the equilibrium of the Euler-Bernoulli beam is equivalent to minimizing the total potential energy.
a) True
b) False

Answer: a

148. Which option is not correct about free vibration analysis problem KX= λMX, where X represents the amplitude of displacement x?
a) The displacements are harmonic
b) X represent mode shapes or Eigen vectors
c) λ represent Eigen value
d) ω represents Eigen value

Answer: d

149. After Finite Element discretization of a structure, which option expresses the free vibrations equation?
a) $M\ddot{x}+K\dot{x}=F$
b) $M\ddot{x}+K\dot{x}=0$
c) $M\ddot{x}+Kx=F$
d) $M\ddot{x}+Kx=0$

Answer: d

150. In beam elements the cross section of the element is assumed.
a) True
b) False

Answer: a