Ref No:

SRI KRISHNA INSTITUTE OF TECHNOLOGY



COURSE PLAN

Academic Year 2018-19

Program:	B E – Mechanical Engineering
Semester :	6
Course Code:	17ME61
Course Title:	Finite element Analysis
Credit / L-T-P:	4 / 4-0-0
Total Contact Hours:	50
Course Plan Author:	Sagar H N

Academic Evaluation and Monitoring Cell

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Note : Remove "Table of Content" before including in CP Book Each Course Plan shall be printed and made into a book with cover page

Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

A. COURSE INFORMATION

1. Course Overview

Degree:	BE	Program:	ME
Year / Semester :	3/VI	Academic Year:	2019-20
Course Title:	Finite element Analysis	Course Code:	17ME61
Credit / L-T-P:	04/-0-0	SEE Duration:	180 minutes
Total Contact Hours:	50	SEE Marks:	60 Marks
CIA Marks:	40	Assignment	1 / Module
Course Plan Author:	Sagar H N	Sign	Dt:
Checked By:		Sign	Dt:
CO Targets	CIA Target :%	SEE Target:	%

Note: Define CIA and SEE % targets based on previous performance.

2. Course Content

Content / Syllabus of the course as prescribed by University or designed by institute. Identify 2 concepts per module as in G.

Mod	Content	Teachi	Identified	Blooms
ule		ng	Module	Learning
		Hours	Concepts	Levels
1	Introduction to Finite element Analysis : General description of the Finite element Analysis. Engineering applications of Finite element Analysis. Boundary conditions: homogeneous and non-homogeneous for structural, heat transfer and fluid flow problems. Potential energy method, Rayleigh Ritz method, Galerkin's method, Displacement method of finite element formulation. Convergence criteria, Discretization process, Types of elements: 1D, 2D and 3D, Node numbering, Location of nodes. Strain displacement relations, Stress strain relations, Plain stress and Plain strain conditions, temperature effects. Interpolation models: Simplex, complex and multiplex elements, Linear interpolation polynomials in terms of global coordinates 1D, 2D, 3D Simplex Elements.	10	Elements and nodes	L2 Understand
2	One-Dimensional Elements -Analysis of Bars and Trusses, Linear interpolation polynomials in terms of local coordinate's for1D, 2Delements. Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates, Constant strain triangle, Four-Nodded Tetrahedral Element (TET 4), Eight-Nodded Hexahedral Element (HEXA8), 2D isoparametric element, Lagrange interpolation functions, Numerical integration: Gaussian quadrature one point, two point formulae, 2D integrals. Fore terms: Body force, traction force and point loads, Numerical Problems: Solution for displacement, stress and strain in 1D straight bars, stepped bars and tapered bars using elimination approach and penalty approach, Analysis of trusses.	10	Analysis of bars and trusses	L3 Apply
3	Beams and Shafts: Boundary conditions, Load vector, Hermite shape functions, Beam stiffness matrix based on Euler-Bernoulli beam theory, Examples on cantilever beams, propped cantilever beams, Numerical problems on simply supported, fixed straight and stepped beams	10	Stiffness matrix for beams and shaft	L3 Apply

	using direct stiffness method with concentrated and uniformly distributed load. Torsion of Shafts: Finite element formulation of shafts, determination of stress and twists in circular shafts.			
4	Heat Transfer: Basic equations of heat transfer: Energy balance equation, Rate equation: conduction, convection, radiation, energy generated in solid, energy stored insolid, 1D finite element formulation using vibrational method, Problems with temperature gradient and heat fluxes, heat transfer in composite sections, straight fins. Fluid Flow: Flow through a porous medium, Flow through pipes of uniform and stepped sections, Flow through hydraulic net works.	10	Heat transfer through 1 D	L3 Apply
5	 Axi-symmetric Solid Elements: Derivation of stiffness matrix of axisymmetric bodies with triangular elements, Numerical solution of axisymmetric triangular element(s) subjected to surface forces, point loads, angular velocity, pressure vessels. Dynamic Considerations: Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, axisymmetric triangular element, quadrilateral element, beam element. Lumped mass matrix of bar element, truss element, Evaluation of eigen values and eigen vectors. Applications to bars, stepped bars, and beams. 	10	stiffness matrix solid element	L3 Apply
-	Total	50	-	-

3. Course Material

Books & other material as recommended by university (A, B) and additional resources used by course teacher (C).

1. Understanding: Concept simulation / video ; one per concept ; to understand the concepts ; 15 – 30 minutes

2. Design: Simulation and design tools used – software tools used ; Free / open source

3. Research: Recent developments on the concepts – publications in journals; conferences etc.

5. 1(05)	sarem necent acveropments on the concepts publications in jour	iuis, con	crences etc.
Modul	Details	Chapter	Availability
es		s in	
		book	
Α	Text books (Title, Authors, Edition, Publisher, Year.)	-	-
1, 2,	Logan, D. L., A first course in the Finite element Analysis,6 th	3, 4	In Lib / In
3, 4, 5	Edition, Cengage Learning, 2016.		Dept
	Rao, S. S., Finite element Analysis in engineering, 5 th Edition,		
	Pergaman Int. Library of Science, 2010.		
	3. Chandrupatla T. R., Finite Elements in engineering, 2nd Edition,		
	PHI, 2013		
		2, 4	In Lib/ In dept
В	Reference books (Title, Authors, Edition, Publisher, Year.)	-	-
1, 2	J.N.Reddy, "Finite element Analysis"- McGraw -Hill International	?	In Lib
	Edition.Bathe K. J. Finite Elements Procedures, PHI.		
1, 2	Cook R. D., et al. "Conceptsand Application of Finite Elements	?	Not Available
	Analysis"- 4 th Edition, Wiley & Sons, 2003.		
3, 4, 5	Haleesh "Finite element Analysis"- McGraw -Hill International	?	In lib
	Edition		
С	Concept Videos or Simulation for Understanding	-	-
C1	Numerical method		
	https://www.youtube.com/watch?v=Fvud81pYGOg - 15 Mins		
<u> </u>			

	https://www.youtube.com/watch?v=TsBTI3tO5-8 - 5 Mins		
C2	Formation of stiffness matrices for bars ,beams ,trusses		
	https://www.youtube.com/watch?v=Fvud91pYGOg - 10 Mins		
	https://www.youtube.com/watch?v=TsBTI453tO5-8 - 15 Mins		
C3	Static and Dynamic analysis for bars and beams		
	https://www.youtube.com/watch?v=Fvud8145pYGOg - 5 Mins		
	https://www.youtube.com/watch?v=TsBTI34662tO5-8 - 5 Mins		
	Lab : <u>https://www.youtube.com/watch?v=P9e7hUNPGVs</u> -		
D	Software Tools for Design	-	-
	Klystron Oscillator - Vsim - <u>https://www.txcorp.com/</u> -		
	Stripline - <u>http://www.atlantarf.com/Stripline.php</u>		
E	Recent Developments for Research	-	-
	Improve efficiency -		
	https://ieeexplore.ieee.org/abstract/document/6891996		
F	Others (Web, Video, Simulation, Notes etc.)	-	-
1	How Electron / Vacuum Tubes work ?		
	https://www.youtube.com/watch?v=nA_tglygvNo		
?			

4. Course Prerequisites

Refer to GL01. If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

Students must have learnt the following Courses / Topics with described Content								
	Mod	Course	Course Name	Topic / Description	Sem	Remarks	Blooms	
	ules	Code					Level	
	3	15ME34	Mechanics of		3	-	Understa	
			materials				nd L2	
	3	15ME53	Heat transfer		5	-	Understa	
							nd L2	

5. Content for Placement, Profession, HE and GATE

The content is not included in this course, but required to meet industry & profession requirements and help students for Placement, GATE, Higher Education, Entrepreneurship, etc. Identifying Area / Content requires experts consultation in the area.

Topics included are like, a. Advanced Topics, b. Recent Developments, c. Certificate Courses, d. Course Projects, e. New Software Tools, f. GATE Topics, g. NPTEL Videos, h. Swavam videos etc.

			, , , , , , , , , , , , , , , , , , , ,	
Mod	Topic / Description	Area	Remarks	Blooms
ules				Level
1	Numerical methods	Higher Study	Gap A seminar on Finite element Analysis	Understa nd L2

B. OBE PARAMETERS

1. Course Outcomes

Expected learning outcomes of the course, which will be mapped to POs. Identify a max of 2 Concepts per Module. Write 1 CO per Concept.

Mod	Course	Course Outcome					Teach.	Concept	Instr	Assessm	Blooms'
ules	Code.#	At the end of the course,					Hours		Method	ent	Level
		student should be able								Method	
		to									
1	17ME61.1	Understand	d the	cond	cept	of	10	Elements	Lecture	Slip Test	Understan
		elements	and	boundary			and nodes			d L2	
		conditions									
2	17ME61.2	Analysis c	of bars	and	trus	ses	10	Bars and	Lecture	Assignm	L4

	-	Total	50	-	-	-	
				element			
		a xi-symmetric body		solid			
		eigen values and eigen vectors		matrix		ent	d L2
5	17ME61.5	Understand the stiffness matrix,	10	stiffness	Lecture	Assignm	Understan
				wall			
				Composite		Slip Test	
		composite sections		transfer in		ent and	Analyze
4	17ME61.4	Analysis of heat transfer in	10	Heat	Lecture	Assignm	L4
		under different kind of loading.		and Shafts			Analyze
3	17ME61.3	Analysis of beams and Shaft	10	Beams	Lecture	Slip test	L4
		under different kind of loading.		trusses	/ PPT	ent	Analyze

2. Course Applications

Write 1 or 2 applications per CO.

Students should be able to employ / apply the course learnings to . . .

Mod	Application Area	CO	Level
ules	Compiled from Module Applications.		
1	Radial load fatigue analysis and Bending fatigue analysis	CO1	L2
2	Mechanical engineering discipline (such as aeronautical, biomechanical, and	CO1	L2
	automotive industries.		
3	Analysis of temperature gradient in fins ,boilers	CO2	L2
4	Dynamic analysis of bars and beam	CO2	L2
5	Analysis of temperature gradient in fins ,boilers	CO3	L3
6	Heat conduction through composite wall and pipes in industries	CO3	L3
7	Heat conduction through composite wall and pipes in industries	CO4	L2
8	Analysis of temperature gradient in fins ,boilers	CO4	L2
9	Dynamic analysis of bars and beam	CO5	L2
10	Formulation for point mass and distributed masses in different element	CO5	L2

3. Mapping And Justification

CO – PO Mapping with mapping Level along with justification for each CO-PO pair. To attain competency required (as defined in POs) in a specified area and the knowledge & ability required to accomplish it.

Mod	Мар	ping	Mapping	Justification for each CO-PO pair	Lev
ules			Level		el
-	со	РО	-	'Area': 'Competency' and 'Knowledge' for specified 'Accomplishment'	-
	C01	PO1	3	'Engineering Knowledge:' - <u>Acquisition of Engineering Knowledge</u> of <u>element and nodes</u> is essential to accomplish <u>solutions to</u> <u>complex engineering problems</u> in Mechanical Engineering.	L2
1	CO1	PO2	2	'Problem Analysis': <u>Analyzing problems</u> require knowledge / understanding of Numerical methods and element and nodes is essential to accomplish <u>solutions to complex engineering</u> <u>problems</u> in Mechanical engineering.	L3
	CO2	PO1	3	'Engineering Knowledge:' - <u>Acquisition of Engineering Knowledge</u> of <u>cubic and Quad element</u> is essential to accomplish <u>solutions to</u> <u>complex engineering problems</u> in Mechanical Engineering.	
2	CO2	PO2	2	'Problem Analysis': <u>Analyzing problems</u> require knowledge / understanding of bars and Trusses and boundary condition is essential to <u>solutions to complex engineering problems</u> in Mechanical engineering.	
	CO3	PO1	3	'Engineering Knowledge:' - <u>Acquisition of Engineering Knowledge</u> of <u>Beams</u> is essential to accomplish <u>solutions to complex</u> <u>engineering problems</u> in Mechanical Engineering.	
3	CO3	PO2	2	'Problem Analysis': <u>Analyzing problems</u> require knowledge / understanding of Beams ,Shaft and boundary condition is essential to <u>solutions to complex engineering problems</u> in	

				Mechanical engineering.	
	CO4	PO1	3	'Engineering Knowledge:' - <u>Acquisition of Engineering Knowledge</u> of <u>Modes of heat Transfer</u> is essential to accomplish <u>solutions to</u> <u>complex engineering problems</u> in Mechanical Engineering.	
4	CO4	PO2	2	'Problem Analysis': <u>Analyzing problems</u> require knowledge / understanding of conduction and convection and boundary condition is essential to <u>solutions to complex engineering</u> <u>problems</u> in Mechanical engineering.	
	CO5	PO1	3	'Engineering Knowledge:' - <u>Acquisition of Engineering Knowledge</u> of solid element_is essential to accomplish <u>solutions to complex</u> <u>engineering problems</u> in Mechanical Engineering.	
5	CO5	PO2	2	'Problem Analysis': <u>Analyzing problems</u> require knowledge / understanding of formulation of stiffness matrix for solid element is essential to <u>solutions to complex engineering problems</u> in Mechanical engineering.	

4. Articulation Matrix

CO – PO Mapping with mapping level for each CO-PO pair, with course average attainment.

-	-	Course Outcomes	Program Outcomes										-					
Mod	CO.#	At the end of the course	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PS	PS	PS	Lev
ules		student should be able to .	1	2	3	4	5	6	7	8	9	10	11	12	01	02	03	el
1	17ME61.1	Understand the concept of	ſ√	√	-	-	-	-	-	-	-	-	-	-	-	-	-	L2
		elements and boundary	'															
		conditions																
2	17ME61.2	Analysis of bars and trusses	√ √	√	-	-	-	-	-	-	-	-	-	-	-	-	-	L3
		under different kind of	F															
		loading.																
3	17ME61.3	Analysis of beams and Shaft	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-	L3
		under different kind of	F															
		loading.																
4	17ME61.4	Analysis of heat transfer ir	v	√	-	-	-	-	-	-	-	-	-	-	-	-	-	L3
		composite sections																
5	17ME61.5	Understand the stiffness	5 √	√	-	-	-	-	-	-	-	-	-	-	-	-	-	L2
		matrix, eigen values and																
		eigen vectors a xi-symmetric																
		body																
-	CS501PC	Average attainment (1, 2,	'		-	-	-	-	-	-	-	-	-	-	-	-	-	-
		or 3)	<u> </u>	I.,			ļ ,								L ,			
-	PO, PSO	1.Engineering Knowledge; 2	Pro	ble	em	An	aly	'SIS,	: 3	.De	esig	n '	/ [Jev	elo	рт	en	t of
		Solutions; 4.Conduct Investi	gat	ion	5 (ot -	COI	трі	lex	Pr	OD.	len	ıs;	5.	M0(den	n 	1001
		Usage; 6. The Engineer and So	cie	ty;	7.E	nv	iror	ime	ent	and	a S	ust	ain	abi	lity	; 8.	Etr	iics; '
		9.Individual and Teamwork; 10.Communication; 11.Project Management and									and							
		Finance; 12.Life-long Learn	ing	; .	51.	50f	tWa	ire	E	ngi	nee	erin	ıg;	52	2.D	ata	E	ase
		Management; 53.Web Design																

5. Curricular Gap and Content

Topics & contents not covered (from A.4), but essential for the course to address POs and PSOs.

Mod	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
ules					
1	Numerical Methods	Seminar	2 nd week / date	Dr XYZ, Inst	List from B4
					above

6. Content Beyond Syllabus

Topics & contents required (from A.5) not addressed, but help students for Placement, GATE, Higher Education, Entrepreneurship, etc.

COURSE PLAN - CAY 2019-20

Mod	Gap Topic	Area	Actions	Schedule	Resources	PO Mapping
ules			Planned	Planned	Person	
1	ANSYS HFSS - High	Placement	Presentation	3 rd week / date	Dr ABC, Inst.	List from B4
	Frequency	, GATE,	by students &		Self	above
	Software	Higher	Mini Project			
	Simulation Tool	Study,				
		Entrepren				
		eurship.				

C. COURSE ASSESSMENT

1. Course Coverage

Assessment of learning outcomes for Internal and end semester evaluation. Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

Mod	Title	Teach		No. of	quest	ion in	Exam		CO	Levels
ules			CIA-1	CIA-2	CIA-3	Asg	Extra	SEE		
		Hours					Asg			
1	Introduction to Finite Element	10	2	-	-	1	1	2	CO1	L2
2	One-Dimensional Elements-	102	2	-	-	1	1	2	CO2	L3
	analysis of bar and trusses									
3	Beams and Shafts and Torsion	8	-	2	-	1	1	2	CO3	L3
	of Shafts									
4	Heat Transfer and Fluid Flow	10	-	2	-	1	1	2	CO4	L3
5	Axi-symmetric Solid Elements:	12	-	-	4	1	1	2	Co5	L2
	Dynamic Considerations									
-	Total	50	4	4	4	5	5	10	-	-

2. Continuous Internal Assessment (CIA)

Assessment of learning outcomes for Internal exams. Blooms Level in last column shall match with A.2.

Mod	Evaluation	Weightage	CO	Levels
ules		In Marks		
1,2	CIA Exam – 1	30	CO1, CO2	L2,L3
3,4	CIA Exam – 2	30	CO3, CO4	L3,L3
5	CIA Exam – 3	30	Co5	L2
1,2	Assignment - 1	10	CO1, CO2	L2,L3
3,4	Assignment - 2	10	CO3, CO4	L3,L3
5	Assignment - 3	10	Co5	L2
	Seminar - 1	00		
	Seminar - 2	00		
	Seminar - 3	00		
	Other Activities – define – Slip test			
	Final CIA Marks	40	-	-

D1. TEACHING PLAN - 1

Title:	Introduction to Finite Element	Appr	10Hrs
	Course Outcomes	Time.	Blooms
a	Student should able to	-	
1	Inderstand the concent of elements and houndary conditions	- CO1	
_		COI	LZ
h	Course Schedule		
Class No	Module Content Covered	0	
1	General description of the Finite element Analysis Engineering an-	C01	12
-	plications of Finite element Analysis. Boundary conditions: homo-	001	LZ
	geneous and non homogeneous for structural, heat transfer and		
	fluid flow problems.		
2	Potential energy method, Rayleigh Ritz method, Galerkin's	CO1	L2
	method, Displacement method of finite element formulation. Con-		
	vergence criteria, Discretization process		
3	Types of elements: 1D, 2D and 3D, Node numbering, Location of	CO1	L2
	nodes.	<u> </u>	
4	Strain displacement relations, Stress strain relations, Plain stress	COI	LZ
5	Simpley complex and multiplex elements linear interpolation	<u> </u>	1.2
	polynomials in terms of global coordinates 1D, 2D, 3D Simpley Ele-	COZ	LZ
	ments.		
С	Application Areas	СО	Level
1	Radial load fatigue analysis and Bending fatigue analysis	CO1	L2
2	Mechanical engineering discipline (such as aeronautical,	CO1	L2
	biomechanical, and automotive industries.		
d	Review Questions		-
1	Explain plane stress and plain strain problems with suitable	CO1	L2
	examples.		
2	Define FEM, explain basic steps involved in FEM.	C01	L2
3	With an example, Explain node numbering scheme.	CO1	L2
4	Explain principle of minimum potential energy and principle of	CO1	L2
	virtual work.	001	
5	Explain convergence requirement of a polynomial displacement	CO1	L2
	model.	601	
6	Explain simplex, Complex and multiplex elements.	CO1	L2
	what is geometric isotropy? Sketch and explain pascal triangle for	COT	LZ
	2D polynomials.	CO1	1.2
ð	Determine the maximum deflection of the beam as shown in lig	COI	LZ
	1.8 Take $E = 200$ GPa & $T = 2X10^{\circ}$ m ² . Use Rayleign ritz method.	CO1	1.2
9	Determine the displacement of the part as shown in Fig. 1.9. Use P_{res}	COT	LZ
10	Rayleign fitz method for the solution. Take $E = 70$ GPa.	CO1	1.2
11	Lyrian Steps involved in Galerkin's Method.	CO1	1.2
	differential equation	COT	LZ
	$\frac{d^2 u}{d^2 u} = 10 x^2 = 5 0 \le x \le 1 at u = 0 = 0 u(1) = 0$		
	dx^{2}		
е	Experiences		-
1			L2

Title:	One-Dimensional Elements-analysis of bar and trusses	Appr Time:	10 Hrs
а	Course Outcomes	-	Blooms
-	Student should able to	_	Level
1	Analysis of bars and trusses under different kind of loading.	CO2	L3
b	Course Schedule	-	_
Class	Module Content Covered	СО	Level
No			
1	Linear interpolation polynomials in terms of local coordinate's for1D, 2Delements.	CO2	L3
2	Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates.	CO2	L3
3	Constant strain triangle, Four-Nodded Tetrahedral Element (TET 4), Eight-Nodded Hexahedral Element (HEXA28).	CO2	L3
4	2D isoparametric element, Lagrange interpolation functions, Nu- merical integration: Gaussian quadrature one point, two point for- mulae, 2D integrals. Fore terms: Body force, traction force and point loads.	CO2	L3
5	Solution for displacement, stress and strain in 1D straight bars, stepped bars and tapered bars using elimination approach and penalty approach.	CO2	L3
6	Analysis of trusses.	CO2	L3
		CO2	
С	Experiences	СО	Level
1			L3
d	Review Questions	-	-
1	What is an interpolation function?	CO2	L3
2	Derive the shape function of the bar element in local co-ordinate system.	CO2	L3
3	Derive the interpolation function of quadratic bar element in natural co-ordinate system.	CO2	L3
4	Derive the stiffness matrix for CST element.	CO2	L3
5	Explain the concepts of iso, sub and super parametric elements.	CO2	L3
6	Derive the shape function for the nine - noded quadrilateral	CO2	L3
	element.		
7	Using lagrangian method, derive the shape functions of guadrilateral element.	CO2	L3
8	Evaluate the values of $\omega_1, \omega_2, \xi_1, \wedge \xi_2$ used in gauss quadrature two	CO2	L3
9	Describe the general algorithm of Gaussian elimination method for	CO2	L3
10	Explain in brief the penalty method of imposing boundary	CO2	L3
11	For the bar shown in Fig. 2.11 determine (i) nodal displacement &	CO2	L3
	(ii) Stresses in each element Take $E = 200$ GPa & $A = 300$ mm ² .		
12	For a stepped bar loaded as shown in Fig. 2.12 determine (i) Nodal displacements. (ii) elemental stresses (iii) support reactions. Take $E= 200$ GPa.	CO2	L3
13	For a plane truss shown in Fig.2.13 determine the horizontal and vertical displacement, stresses in each element take $E = 20$ GPa and $A = 200$ mm ² .	CO2	L3

14	write down the general guidelines for selecting the interpolation polynomial.	CO2	L3
15	derive stiffness matrix for a 1-D bar element under axial loading.	CO2	L3
16	Derive strain-displacement matrix [B] for a isoparametric linear triangular element.	CO2	L3
е	Experiences	-	-
1			

E1. CIA EXAM - 1

a. Model Question Paper - 1

Crs Code	rs 17ME61 Sem: VI Marks: 30 Time: 75 ode:							75	5 minutes			
Cour	se:	Finite elem	hents analy	/sis			1					
-	-	Note: Ans	swer any 2	2 question	ns, each c	arry eq	ual marks.		Mark	СО	Level	
1	а	Define FEN	1, explain b	pasic steps	involved ir	FEM.			7	CO1	L2	
	b	using Gale	sing Galerkin's method, obtain an approximate solution of								L2	
		differentia	l equation.									
		d^2u	-2^{2}			<u> </u>						
		$\frac{d}{dx^2}$	$10 x^2 = 5,0 \le$	$\leq x \leq 1$, at $u \mid 0$	0 = 0, u(1) =	=0						
		••••			OR							
2	а	Determine	the maxi	mum defle	ction of th	e beam	n as shown ir	n fig	8	CO1	L2	
		1.8 Take E	= 200 GPa	a & I = 2x1	0 ⁻⁹ m ⁴ . Use	Rayleic	gh ritz method	d.				
	b	Explain sin	nplex, Com	plex and n	nultiplex el	ements			7	CO1	L2	
				-								
3	а	Derive the	e interpola	ation funct	tion of qu	adratic	bar elemen	it in	8	CO2	L3	
		natural co-	ordinate s	ystem.								
	b	Derive the	stiffness n	natrix for C	ST elemen	t.			7	CO2	L3	
					OR					CO2		
4	а	For a step	ped bar loa	aded as sho	own in Fig.	2.12 de	etermine (i) N	odal	7	CO2	L3	
		displacem	ents. (ii) el	lemental st	tresses (iii)	suppor	rt reactions. ⁻	Гake				
		E= 200 GP	a.									
	b	For a plan	e truss sh	own in Fig	.2.13 detei	mine th	he horizontal	and	8	CO2	L3	
		vertical di	splacemen	t, stresses	in each el	ement	take E = 20	GPa				
		and $A = 20$	0 mm².									

b. Assignment -1

Note: A distinct assignment to be assigned to each student.

			Model A	Assignment	t Questio	ns				
Crs (Code: 17ME6	1 Sem:	VII	Marks:	5 / 10	Time:	9	0 - 120	minut	tes
Cour	se: Finite e	lement analy	'sis							
Note	: Each stude	nt to answer	2-3 assignr	ments. Eac	h assign:	ment carrie	es eq	ual mai	ſk.	
SNo	USN		Assign	ment Des	scription	l		Mark	СО	Level
			_		-			S		
1	1KT15ME	Explain pl	ane stress	and plai	n strain	problems	with	7	CO1	L2
		suitable exa	mples.							
2	1KT15ME	Define FEM,	explain ba	sic steps i	nvolved i	n FEM.		7	CO1	L2
3	1KT15ME	With an exa	mple, Expl	ain node n	umbering	g scheme.		7	CO1	L2
4	1KT15ME	Explain pri	nciple of	minimum	potentia	al energy	and	7	CO1	L2
		principle of	virtual wor	k.						
5	1KT15ME	Explain c	onvergenc	e require	ment of	a polyno	omial	7	CO1	L2
		displaceme	nt model.							
6	1KT15ME	Explain sim	olex, Comp	lex and m	ultiplex e	lements.		7	CO1	L2
7	1KT15ME	what is geo	metric iso	tropy? Ske	etch and	explain p	ascal	7	CO1	L2

8 1KT15ME Determine the maximum deflection of the beam as shown in fig 1.8 Take E = 200 GPa & I = 2x10 ⁻⁹ m ⁴ . Use Rayleigh ritz method. 9 1KT15ME Determine the displacement of the bar as shown in Fig. 8 CO1 L2 1.9. use Rayleigh ritz method for the solution. Take E = 70 GPa. 10 1KT15ME Explain steps involved in Galerkin's method. 8 CO1 L2 11 1KT15ME Explain steps involved in Galerkin's method. 8 CO1 L2 11 1KT15ME Using Galerkin's method, obtain an approximate solution 8 CO1 L2 12 1KT15ME Using Galerkin's method, obtain an approximate solution 8 CO1 L2 13 1KT15ME Derive the shape function of the bar element in local co- ordinate system. 14 1KT15ME Derive the interpolation function? 7 CO1 L2 15 1KT15ME Derive the interpolation function of quadratic bar 8 CO1 L2 16 1KT15ME Derive the shape function of the bar element. 8 CO1 L2 16 1KT15ME Derive the shape function for the nine - noded 8 CO1 L2 17 1KT15ME Derive the shape function for the nine - noded 8 CO1 L2 18 1KT15ME Derive the shape function for the nine - noded 8 CO1 L2 19 1KT15ME Derive the shape function for the nine - noded 8 CO1 L2 19 1KT15ME Derive the shape function for the nine - noded 8 CO1 L2 19 1KT15ME Derive the shape function for the nine - noded 8 CO1 L2 19 1KT15ME Derive the shape function for the nine - noded 8 CO1 L2 10 1KT15ME Derive the shape function for the nine - noded 8 CO1 L2 10 1KT15ME Derive the solution of linear algebraic equations. 21 1KT15ME Evaluate the values of $\omega_1, \omega_2, \xi_1, \Lambda \xi_2$ used in gauss 8 CO1 L2 10 1KT15ME Explain in brief the penalty method of imposing 8 CO1 L2 21 1KT15ME Explain in brief the penalty method of imposing 8 CO1 L2 21 1KT15ME For the bar shown in Fig. 2.11 determine (i) nodal 8 21 1KT15ME For the bar shown in Fig. 2.11 determine (i) nodal 8 21 1KT15ME For a stepped bar loaded as shown in Fig. 2.12 7 CO2 L2 determine (i) Nodal displacements. (ii) elemental stresses (ii) support reactions. Take E = 200 GPa. 24 1KT15ME For a plane truss shown in Fig. 2.13 determine the 7 CO2 L
shown in fig 1.8 Take E = 200 GPa & I = 2x10° m². Use Rayleigh ritz method.91KT15MEDetermine the displacement of the bar as shown in Fig. 1.9. use Rayleigh ritz method for the solution. Take E = 70 GPa.CO1L210IKT15MEExplain steps involved in Galerkin's method.8CO1L2111KT15MEusing Galerkin's method, obtain an approximate solution8CO1L2111KT15MEusing Galerkin's method, obtain an approximate solution8CO1L2121KT15MEWhat is an interpolation function?7CO1L2131KT15MEDerive the shape function of the bar element in local co- ordinate system.7CO1L2141KT15MEDerive the interpolation function of quadratic bar8CO1L2151KT15MEDerive the shape function for CST element.8CO1L2161KT15MEExplain the concepts of iso, sub and super parametric8CO1L2171KT15MEDerive the shape function for the nine - noded8CO1L2181KT15MEEvaluate the values of $\omega_1, \omega_2, \xi_1, \wedge \xi_3$ used in gauss8CO1L2191KT15MEExplain in brief the penalty method of imposing duadrilateral element.8CO1L2191KT15MEEvaluate the values of $\omega_1, \omega_2, \xi_1, \wedge \xi_3$ used in gauss8CO1L2141KT15MEExplain in brief the penalty method of imposing duadrilateral element.8CO1L2
Rayleigh ritz method.91KT15MEDetermine the displacement of the bar as shown in Fig. 1.9. use Rayleigh ritz method for the solution. Take E = 70 GPa.CO1L2101KT15MEExplain steps involved in Galerkin's method.8CO1L2111KT15MEExplain steps involved in Galerkin's method.8CO1L2111KT15MEExplain steps involved in Galerkin's method.8CO1L2111KT15MEinterpolation function an approximate solution of the differential equation.7CO1L2121KT15MEWhat is an interpolation function?7CO1L2131KT15MEDerive the shape function of the bar element in local co- ordinate system.7CO1L2141KT15MEDerive the siftness matrix for CST element.8CO1L2161KT15MEDerive the shape function for the nine - noded quadrilateral element.8CO1L2171KT15MEDerive the shape function for the nine - noded quadrilateral element.8CO1L2191KT15MEEvaluate the values of $\omega_1, \omega_2, \xi_1, \wedge \xi_2$ used in gauss quadrature two point method.8CO1L2201KT15MEExplain in brief the penalty method of imposing boundary conditions.8CO1L2211KT15MEExplain in brief the penalty method of imposing boundary conditions.8CO1L2211KT15MEFor the bar shown in Fig. 2.11determine the applacement & (i
91KT15MEDetermine the displacement of the bar as shown in Fig. 1.9. use Rayleigh ritz method for the solution. Take E = 70 GPa.CO1L2101KT15MEExplain steps involved in Galerkin's method.8CO1L2111KT15MEusing Galerkin's method, obtain an approximate solution of the differential equation.8CO1L2121KT15MEWhat is an interpolation function?7CO1L2131KT15MEWhat is an interpolation function of the bar element in local co- ordinate system.7CO1L2141KT15MEDerive the shape function of the bar element.8CO1L2161KT15MEDerive the stiffness matrix for CST element.8CO1L2161KT15MEExplain the concepts of iso, sub and super parametric elements.8CO1L2171KT15MEUsing lagrangian method, derive the shape functions of quadrilateral element.8CO1L2191KT15MEDerive the general algorithm of Gaussian elimination method for the solution of linear algebraic equations.8CO1L2201KT15MEExplain in brief the penalty method of imposing boundary conditions.8CO1L2211KT15MEFor the bar shown in Fig. 2.11 determine (i) nodal displacement & (ii) Stresses in each element Take E = 200GPa & A = 300 mm².7CO2L2231KT15MEFor a stepped bar loaded as shown in Fig. 2.12 determine (i) Nodal displacements. (ii) elemental stresses (iii) support reactions. Take
1.9. use Rayleigh ritz method for the solution. Take E = 70 GPa.10101KT15MEExplain steps involved in Galerkin's method.8CO1L2111KT15MEusing Galerkin's method, obtain an approximate solution of the differential equation. $\frac{d^2 u}{dx^2} - 10 x^2 = 5, 0 \le x \le 1, atu(0) = 0, u(1) = 0$ 8CO1L2121KT15MEWhat is an interpolation function?7CO1L2131KT15MEDerive the shape function of the bar element in local co-
To GPa.10IKT15MEExplain steps involved in Galerkin's method.8CO1L211IKT15MEExplain steps involved in Galerkin's method.8CO1L211IKT15MEUsing Galerkin's method, obtain an approximate solution8CO1L211IKT15MEof the differential equation. $\frac{d^2u}{dx^2} - 10x^2 = 5, 0 \le x \le 1, atu 0 = 0, u(1) = 0$ 7CO1L212IKT15MEWhat is an interpolation function?7CO1L213IKT15MEDerive the shape function of the bar element in local co- ordinate system.7CO1L214IKT15MEDerive the interpolation function of quadratic bar element in natural co-ordinate system.8CO1L215IKT15MEDerive the shape function for the nine - noded quadrilateral element.8CO1L216IKT15MEDerive the shape function for the nine - noded quadrilateral element.8CO1L218IKT15MEUsing lagrangian method, derive the shape functions of quadrilateral element.8CO1L219IKT15MEDescribe the general algorithm of Gaussian elimination guadrature two point method.8CO1L220IKT15MEFor the bar shown in Fig. 2.11 determine (i) nodal boundary conditions.8CO1L221IKT15MEFor a stepped bar loaded as shown in Fig. 2.12 determine (i)7CO2L223IKT15MEFor a stepped bar loaded as shown in Fig. 2.13
10IKT15MEExplain steps involved in Galerkin's method.8CO1L2111KT15MEusing Galerkin's method, obtain an approximate solution of the differential equation.8CO1L2111KT15MEusing Galerkin's method, obtain an approximate solution of the differential equation.8CO1L2121KT15MEWhat is an interpolation function?7CO1L2131KT15MEDerive the shape function of the bar element in local co- ordinate system.7CO1L2141KT15MEDerive the interpolation function of quadratic bar element in natural co-ordinate system.8CO1L2151KT15MEDerive the stiffness matrix for CST element.8CO1L2161KT15MEDerive the shape function for the nine - noded quadrilateral element.8CO1L2171KT15MEDerive the shape function for the nine - noded quadrilateral element.8CO1L2191KT15MEDescribe the general algorithm of Gaussian elimination method for the solution of linear algebraic equations.8CO1L2201KT15MEExplain in brief the penalty method of imposing boundary conditions.8CO1L2L2211KT15MEFor a stepped bar loaded as shown in Fig. 2.127CO2L2231KT15MEFor a stepped bar loaded as shown in Fig. 2.137CO2L2241KT15MEFor a plane truss shown in Fig.2.13 determine the horizontal and vertical displ
101011
11INTISMEUsing layerInterface, order that approximate solution0ColL211INTISMEof the differential equation. $\frac{d^2u}{dx^2} - 10 x^2 = 5, 0 \le x \le 1, atu(0) = 0, u(1) = 0$ 121KT15MEWhat is an interpolation function?7COlL213IXT15MEDerive the shape function of the bar element in local coordinate system.7COlL214IKT15MEDerive the interpolation function of quadratic bar element in natural co-ordinate system.8COlL216IKT15MEDerive the stiffness matrix for CST element.8COlL216IKT15MEDerive the shape function for the nine - noded elements.8COlL217IKT15MEDerive the shape function for the nine - noded element.8COlL218IKT15MEUsing lagrangian method, derive the shape functions of equadrilateral element.8COlL219IKT15MEEvaluate the values of $\omega_1, \omega_2, \xi_1, \wedge \xi_2$ used in gauss equadrilateral element.8COlL220IKT15MEExplain in brief the penalty method of imposing equadrature two point method.8COlL221IKT15MEFor a stepped bar loaded as shown in Fig. 2.127CO2L223IKT15MEFor a plane truss shown in Fig. 2.13 determine the resees (ii) support reactions. Take E = 20 GPa.7CO2L224IKT15MEFor a plane truss shown in Fig.2.13 determine the element take E = 20 GPa and A = 200 GPa.7CO2L2<
$\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 5, 0 \le x \le 1, at u(0) = 0, u(1) = 0$ $\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 5, 0 \le x \le 1, at u(0) = 0, u(1) = 0$ $\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 5, 0 \le x \le 1, at u(0) = 0, u(1) = 0$ $\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 5, 0 \le x \le 1, at u(0) = 0, u(1) = 0$ $\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 5, 0 \le x \le 1, at u(0) = 0, u(1) = 0$ $\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 5, 0 \le x \le 1, at u(0) = 0, u(1) = 0$ $\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 5, 0 \le x \le 1, at u(0) = 0, u(1) = 0$ $\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 5, 0 \le x \le 1, at u(0) = 0, u(1) = 0$ $\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 5, 0 \le x \le 1, at u(0) = 0, u(1) = 0$ $\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 5, 0 \le x \le 1, at u(0) = 0, u(1) = 0$ $\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 5, 0 \le x \le 1, at u(0) = 0, u(1) = 0$ $\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 5, 0 \le x \le 1, at u(0) = 0, u(1) = 0$ $\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 5, 0 \le x \le 1, at u(0) = 0, u(1) = 0$ $\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 5, 0 \le x \le 1, at u(0) = 0, u(1) = 0$ $\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 5, 0 \le x \le 1, at u(0) = 0, u(1) = 0$ $\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 5, 0 \le 1, at u(0) = 0, u(1) = 0$ $\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 5, 0 \le 1, at u(0) = 0, u(1) = 0$ $\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 5, 0 \le 1, at u(0) = 0, u(1) = 0$ $\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 1, at u(1) = 1, $
$\frac{d^{2}u}{dx^{2}} - 10 x^{2} = 5, 0 \le x \le 1, at u 0 = 0, u (1) = 0$ 12 IKT15ME What is an interpolation function? 7 CO1 L2 13 IKT15ME Derive the shape function of the bar element in local co- ordinate system. 14 IKT15ME Derive the interpolation function of quadratic bar all controls and the element in natural co-ordinate system. 15 IKT15ME Derive the stiffness matrix for CST element. 16 IKT15ME Derive the shape function for the nine - noded a CO1 L2 16 IKT15ME Derive the shape function for the nine - noded a CO1 L2 16 IKT15ME Derive the shape function for the nine - noded a CO1 L2 18 IKT15ME Using lagrangian method, derive the shape functions of a quadrilateral element. 18 IKT15ME Using lagrangian method, derive the shape functions of a quadrilateral element. 19 IKT15ME Describe the general algorithm of Gaussian elimination a CO1 L2 20 IKT15ME Explain in brief the penalty method of imposing boundary conditions. 21 IKT15ME For the bar shown in Fig. 2.11 determine (i) nodal a CO2 L2 determine (i) Nodal displacements. (ii) elementa set the values of ω_{1} , ω_{2} , β_{1} , β_{2} , β_{2
dx^2 Dr. (a) (b) (c) (c) (c)121KT15MEWhat is an interpolation function?7C01L2131KT15MEDerive the shape function of the bar element in local coordinate system.7C01L2141KT15MEDerive the interpolation function of quadratic bar element in natural co-ordinate system.8C01L2151KT15MEDerive the stiffness matrix for CST element.8C01L2161KT15MEExplain the concepts of iso, sub and super parametric elements.8C01L2171KT15MEDerive the shape function for the nine - noded quadrilateral element.8C01L2181KT15MEUsing lagrangian method, derive the shape functions of quadrature two point method.8C01L2201KT15MEDescribe the general algorithm of Gaussian elimination method for the solution of linear algebraic equations.8C01L2211KT15MEExplain in brief the penalty method of imposing a conditions.8C01L2221KT15MEFor the bar shown in Fig. 2.11 determine (i) nodal displacement & (ii) Stresses in each element Take E = 200GPa & A = 300 mm².C02L2231KT15MEFor a plane truss shown in Fig.2.13 determine the for a stepped bar loaded as shown in Fig. 2.127C02L2241KT15MEFor a plane truss shown in Fig.2.13 determine the horizontal and vertical displacement, stresses in each element take E = 20 GPa and A = 200 mm².C02L2251KT15MEFor a plane truss shown in Fig.2.13 det
12 1KT15ME What is an interpolation function? 7 C01 L2 13 1KT15ME Derive the shape function of the bar element in local coordinate system. 7 C01 L2 14 1KT15ME Derive the interpolation function of quadratic bar element in natural coordinate system. 8 C01 L2 15 1KT15ME Derive the stiffness matrix for CST element. 8 C01 L2 16 1KT15ME Derive the shape function for the nine - noded guadrilateral elements. 8 C01 L2 17 1KT15ME Derive the shape function for the nine - noded guadrilateral element. 8 C01 L2 18 1KT15ME Derive the shape function for the nine - noded guadrilateral element. 8 C01 L2 19 1KT15ME Using lagrangian method, derive the shape functions of guadrature two point method. 8 C01 L2 20 1KT15ME Describe the general algorithm of Gaussian elimination guadrature two point method. 8 C01 L2 21 1KT15ME Explain in brief the penalty method of imposing guadrature two point method. 8 C01 L2 22 1KT15ME<
131KT15MEDerive the shape function of the bar element in local co- ordinate system.7C01L2141KT15MEDerive the interpolation function of quadratic bar element in natural co-ordinate system.8C01L2151KT15MEDerive the stiffness matrix for CST element.8C01L2161KT15MEExplain the concepts of iso, sub and super parametric elements.8C01L2171KT15MEDerive the shape function for the nine - noded quadrilateral element.8C01L2181KT15MEUsing lagrangian method, derive the shape functions of quadrature alement.8C01L2191KT15MEEvaluate the values of ω_1 , $\omega_{22}\xi_{13}\wedge\xi_2$ used in gauss quadrature two point method.8C01L2201KT15MEDescribe the general algorithm of Gaussian elimination method for the solution of linear algebraic equations.8C01L2211KT15MEExplain in brief the penalty method of imposing displacement & (ii) Stresses in each element Take E = 200GPa & A = 300 mm².8C02L2231KT15MEFor a plane truss shown in Fig. 2.13 determine the horizontal and vertical displacement, stresses in each element and vertical displacement, stresses in each element ake E = 20 GPa and A = 200 mm².C02L2251KT15MEWrite down the general guidelines for selecting the interpolation polynomial.8C02L2
ordinate system.141KT15MEDerive the interpolation function of quadratic bar element in natural co-ordinate system.8CO1L2151KT15MEDerive the stiffness matrix for CST element.8CO1L2161KT15MEExplain the concepts of iso, sub and super parametric elements.8CO1L2171KT15MEDerive the shape function for the nine - noded quadrilateral element.8CO1L2181KT15MEUsing lagrangian method, derive the shape functions of quadrilateral element.8CO1L2191KT15MEEvaluate the values of $\omega_1, \omega_{22}\xi_1, \wedge \xi_2$ used in gauss quadrature two point method.8CO1L2201KT15MEExplain in brief the penalty method of imposing boundary conditions.8CO1L2211KT15MEFor the bar shown in Fig. 2.11 determine (i) nodal displacement & (ii) Stresses in each element Take E = 200GPa & A = 300 mm ² .8CO2L2231KT15MEFor a plane truss shown in Fig.2.13 determine for horizontal and vertical displacement, stresses in each element take E = 20 GPa and A = 200 mm ² .7CO2L2251KT15MEwrite down the general guidelines for selecting the and vertical displacement for selecting the and vertical
14 IKT15ME Derive the interpolation function of quadratic bar element in natural co-ordinate system. 8 CO1 L2 15 IKT15ME Derive the stiffness matrix for CST element. 8 CO1 L2 16 IKT15ME Derive the stiffness matrix for CST element. 8 CO1 L2 16 IKT15ME Derive the shape function for the nine - noded quadrilateral element. 8 CO1 L2 17 IKT15ME Derive the shape function for the nine - noded quadrilateral element. 8 CO1 L2 18 IKT15ME Using lagrangian method, derive the shape functions of quadrature two point method. 8 CO1 L2 20 IKT15ME Evaluate the values of ω ₁ , ω ₂ , ξ ₁ , ∧ ξ ₂ used in gauss 8 CO1 L2 21 IKT15ME Describe the general algorithm of Gaussian elimination method for the solution of linear algebraic equations. 8 CO1 L2 21 IKT15ME Explain in brief the penalty method of imposing boundary conditions. 8 CO1 L2 21 IKT15ME For the bar shown in Fig. 2.11 determine (i) nodal displacement & (ii) splacement & (ii) stresses in each element Take E = 200GPa. 7 CO2<
element in natural co-ordinate system. 8 CO1 L2 15 1KT15ME Derive the stiffness matrix for CST element. 8 CO1 L2 16 1KT15ME Explain the concepts of iso, sub and super parametric elements. 8 CO1 L2 17 1KT15ME Derive the shape function for the nine - noded a guadrilateral element. 8 CO1 L2 18 1KT15ME Using lagrangian method, derive the shape functions of quadrilateral element. 8 CO1 L2 19 1KT15ME Evaluate the values of ω ₁ , ω ₂ , ξ ₁ , ∧ ξ ₂ used in gauss a quadrature two point method. 8 CO1 L2 20 1KT15ME Describe the general algorithm of Gaussian elimination method for the solution of linear algebraic equations. 8 CO1 L2 21 1KT15ME Explain in brief the penalty method of imposing boundary conditions. 8 CO2 L2 22 1KT15ME For the bar shown in Fig. 2.11 determine (i) nodal a splacement & (ii) Stresses in each element Take E = 200GPa & A = 300 mm². 7 CO2 L2 23 1KT15ME For a stepped bar loaded as shown in Fig. 2.12 7 CO2 L2 24 1KT
151KT15MEDerive the stiffness matrix for CST element.8CO1L2161KT15MEExplain the concepts of iso, sub and super parametric elements.8CO1L2171KT15MEDerive the shape function for the nine - noded quadrilateral element.8CO1L2181KT15MEUsing lagrangian method, derive the shape functions of quadrilateral element.8CO1L2191KT15MEEvaluate the values of ω₁, ω₂,ξ₁,∧ξ₂used in gauss quadrature two point method.8CO1L2201KT15MEDescribe the general algorithm of Gaussian elimination method for the solution of linear algebraic equations.8CO1L2211KT15MEExplain in brief the penalty method of imposing boundary conditions.8CO2L2211KT15MEFor the bar shown in Fig. 2.11 determine (i) nodal displacement & (ii) Stresses in each element Take E = 200GPa & A = 300 mm².8CO2L2231KT15MEFor a stepped bar loaded as shown in Fig. 2.12 determine (i) Nodal displacements. (ii) elemental stresses (iii) support reactions. Take E= 200 GPa.7CO2L2241KT15MEFor a plane truss shown in Fig.2.13determine the horizontal and vertical displacement, stresses in each element take E = 20 GPa and A= 200 mm².2L2251KT15MEwrite down the general guidelines for selecting the interpolation polynomial.8CO2L2
16 1KT15ME Explain the concepts of iso, sub and super parametric elements. 8 CO1 L2 17 1KT15ME Derive the shape function for the nine - noded quadrilateral element. 8 CO1 L2 18 1KT15ME Using lagrangian method, derive the shape functions of quadrilateral element. 8 CO1 L2 19 1KT15ME Evaluate the values of ω ₁ , ω ₂ , ξ ₁ , ∧ ξ ₂ used in gauss 8 CO1 L2 quadrature two point method. 20 1KT15ME Evaluate the solution of linear algebraic equations. 8 CO1 L2 20 1KT15ME Explain in brief the penalty method of imposing boundary conditions. 8 CO1 L2 21 1KT15ME For the bar shown in Fig. 2.11 determine (i) nodal displacement & (ii) Stresses in each element Take E = 200GPa & A = 300 mm². 8 CO2 L2 23 1KT15ME For a stepped bar loaded as shown in Fig. 2.12 7 CO2 L2 determine (i) Nodal displacements. (ii) elemental stresses (iii) support reactions. Take E = 200 GPa. 7 CO2 L2 24 1KT15ME For a plane truss shown in Fig.2.13 determine the horizontal and vertical displacement, stresses in each element take E = 20 GPa and A =
elements. 17 1KT15ME Derive the shape function for the nine - noded quadrilateral element. 8 CO1 L2 18 1KT15ME Using lagrangian method, derive the shape functions of quadrilateral element. 8 CO1 L2 19 1KT15ME Evaluate the values of ω1, ω2, ξ1, ∧ ξ2used in gauss quadrature two point method. 8 CO1 L2 20 1KT15ME Describe the general algorithm of Gaussian elimination method for the solution of linear algebraic equations. 8 CO1 L2 21 1KT15ME Explain in brief the penalty method of imposing boundary conditions. 8 CO1 L2 22 1KT15ME For the bar shown in Fig. 2.11 determine (i) nodal displacement & (ii) Stresses in each element Take E = 200GPa & A = 300 mm². 8 CO2 L2 23 1KT15ME For a stepped bar loaded as shown in Fig. 2.12 7 CO2 L2 24 1KT15ME For a plane truss shown in Fig.2.13 determine the horizontal and vertical displacement, stresses in each element take E = 20 GPa and A= 200 mm². 7 CO2 L2 25 1KT15ME write down the general guidelines for selecting the horizontal and vertical displacement, stresses in each element take E = 20 GPa and A= 200 mm². 8 CO2 L2
171KT15MEDerive the shape function for the nine - noded quadrilateral element.8CO1L2181KT15MEUsing lagrangian method, derive the shape functions of quadrilateral element.8CO1L2191KT15MEEvaluate the values of $\omega_1, \omega_2, \xi_1, \land \xi_2$ used in gauss quadrature two point method.8CO1L2201KT15MEDescribe the general algorithm of Gaussian elimination method for the solution of linear algebraic equations.8CO1L2211KT15MEExplain in brief the penalty method of imposing boundary conditions.8CO1L2221KT15MEFor the bar shown in Fig. 2.11 determine (i) nodal displacement & (ii) Stresses in each element Take E = 200GPa & A = 300 mm².8CO2L2231KT15MEFor a stepped bar loaded as shown in Fig. 2.127CO2L2241KT15MEFor a plane truss shown in Fig.2.13 determine the horizontal and vertical displacement, stresses in each element take E = 20 GPa and A= 200 mm².7CO2L2251KT15MEwrite down the general guidelines for selecting the interpolation polynomial.8CO2L2
quadrilateral element.18 1KT15MEUsing lagrangian method, derive the shape functions of quadrilateral element.819 1KT15MEEvaluate the values of $ω_1, ω_2, \xi_1, \land \xi_2$ used in gauss quadrature two point method.8CO1L220 1KT15MEDescribe the general algorithm of Gaussian elimination method for the solution of linear algebraic equations.8CO1L221 1KT15MEExplain in brief the penalty method of imposing boundary conditions.8CO1L222 1KT15MEFor the bar shown in Fig. 2.11 determine (i) nodal displacement & (ii) Stresses in each element Take E = 200GPa & A = 300 mm².8CO2L223 1KT15MEFor a stepped bar loaded as shown in Fig. 2.12 determine (i) Nodal displacements. (ii) elemental stresses (iii) support reactions. Take E= 200 GPa.7CO2L224 1KT15MEFor a plane truss shown in Fig.2.13 determine the element take E = 20 GPa and A= 200 mm².7CO2L225 1KT15MEwrite down the general guidelines for selecting the interpolation polynomial.8CO2L2
18 1KT15ME Using lagrangian method, derive the shape functions of quadrilateral element. 8 19 1KT15ME Evaluate the values of ω ₁ , ω ₂ , ξ ₁ , ∧ ξ ₂ used in gauss quadrature two point method. 8 CO1 L2 20 1KT15ME Describe the general algorithm of Gaussian elimination method for the solution of linear algebraic equations. 8 CO1 L2 21 1KT15ME Explain in brief the penalty method of imposing boundary conditions. 8 CO1 L2 22 1KT15ME For the bar shown in Fig. 2.11 determine (i) nodal displacement & (ii) Stresses in each element Take E = 200GPa & A = 300 mm². 8 CO2 L2 23 1KT15ME For a stepped bar loaded as shown in Fig. 2.12 7 CO2 L2 24 1KT15ME For a plane truss shown in Fig.2.13 determine the horizontal and vertical displacement, stresses in each element take E = 20 GPa and A= 200 mm². 7 CO2 L2 25 1KT15ME write down the general guidelines for selecting the interpolation polynomial. 8 CO2 L2
quadrilateral element.19 1KT15MEEvaluate the values of ω₁, ω₂, ξ₁, ∧ ξ₂used in gauss quadrature two point method.8CO1L220 1KT15MEDescribe the general algorithm of Gaussian elimination method for the solution of linear algebraic equations.8CO1L221 1KT15MEExplain in brief the penalty method of imposing boundary conditions.8CO1L222 1KT15MEFor the bar shown in Fig. 2.11 determine (i) nodal displacement & (ii) Stresses in each element Take E = 200GPa & A = 300 mm².8CO2L223 1KT15MEFor a stepped bar loaded as shown in Fig. 2.12 determine (i) Nodal displacements. (ii) elemental stresses (iii) support reactions. Take E= 200 GPa.7CO2L224 1KT15MEFor a plane truss shown in Fig.2.13 determine the horizontal and vertical displacement, stresses in each element take E = 20 GPa and A= 200 mm².7CO2L225 1KT15MEwrite down the general guidelines for selecting the interpolation polynomial.8CO2L2
19 1KT15ME Evaluate the values of ω ₁ , ω ₂ , ξ ₁ , ∧ξ ₂ used in gauss 8 CO1 L2 quadrature two point method. 20 1KT15ME Describe the general algorithm of Gaussian elimination 8 CO1 L2 20 1KT15ME Describe the general algorithm of Gaussian elimination 8 CO1 L2 21 1KT15ME Explain in brief the penalty method of imposing boundary conditions. 8 CO1 L2 22 1KT15ME For the bar shown in Fig. 2.11 determine (i) nodal displacement & (ii) Stresses in each element Take E = 200GPa & A = 300 mm². 8 CO2 L2 23 1KT15ME For a stepped bar loaded as shown in Fig. 2.12 7 CO2 L2 determine (i) Nodal displacements. (ii) elemental stresses (iii) support reactions. Take E= 200 GPa. 7 CO2 L2 24 1KT15ME For a plane truss shown in Fig.2.13 determine the horizontal and vertical displacement, stresses in each element take E = 20 GPa and A= 200 mm². 7 CO2 L2 25 1KT15ME write down the general guidelines for selecting the interpolation polynomial. 8 CO2 L2
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 20 1KT15ME Describe the general algorithm of Gaussian elimination 8 CO1 L2 method for the solution of linear algebraic equations. 21 1KT15ME Explain in brief the penalty method of imposing 8 CO1 L2 boundary conditions. 22 1KT15ME For the bar shown in Fig. 2.11 determine (i) nodal 8 CO2 L2 displacement & (ii) Stresses in each element Take E = 200GPa & A = 300 mm². 23 1KT15ME For a stepped bar loaded as shown in Fig. 2.12 7 CO2 L2 determine (i) Nodal displacements. (ii) elemental stresses (iii) support reactions. Take E= 200 GPa. 24 1KT15ME For a plane truss shown in Fig.2.13 determine the 7 CO2 L2 horizontal and vertical displacement, stresses in each element take E = 20 GPa and A= 200 mm². 25 1KT15ME write down the general guidelines for selecting the 8 CO2 L2
 20 TKT15ME Describe the general algorithm of Gadassian elimination of Coll L2 method for the solution of linear algebraic equations. 21 1KT15ME Explain in brief the penalty method of imposing 8 CO1 L2 boundary conditions. 22 1KT15ME For the bar shown in Fig. 2.11 determine (i) nodal 8 CO2 L2 displacement & (ii) Stresses in each element Take E = 200GPa & A = 300 mm². 23 1KT15ME For a stepped bar loaded as shown in Fig. 2.12 7 CO2 L2 determine (i) Nodal displacements. (ii) elemental stresses (iii) support reactions. Take E= 200 GPa. 24 1KT15ME For a plane truss shown in Fig.2.13 determine the 7 CO2 L2 horizontal and vertical displacement, stresses in each element take E = 20 GPa and A= 200 mm². 25 1KT15ME write down the general guidelines for selecting the 8 CO2 L2 interpolation polynomial.
21 1KT15ME Explain in brief the penalty method of imposing boundary conditions. 8 CO1 L2 22 1KT15ME For the bar shown in Fig. 2.11 determine (i) nodal displacement & (ii) Stresses in each element Take E = 200GPa & A = 300 mm². 8 CO2 L2 23 1KT15ME For a stepped bar loaded as shown in Fig. 2.12 7 CO2 L2 determine (i) Nodal displacements. (ii) elemental stresses (iii) support reactions. Take E= 200 GPa. 7 CO2 L2 24 1KT15ME For a plane truss shown in Fig.2.13 determine the 7 CO2 L2 horizontal and vertical displacement, stresses in each element take E = 20 GPa and A= 200 mm². 2 L2 25 1KT15ME write down the general guidelines for selecting the 8 CO2 L2
 21 IKTISME Explain in bitch the penalty method of imposing 6 CO1 E2 boundary conditions. 22 IKTISME For the bar shown in Fig. 2.11 determine (i) nodal 8 CO2 L2 displacement & (ii) Stresses in each element Take E = 200GPa & A = 300 mm². 23 IKTISME For a stepped bar loaded as shown in Fig. 2.12 7 CO2 L2 determine (i) Nodal displacements. (ii) elemental stresses (iii) support reactions. Take E= 200 GPa. 24 IKTISME For a plane truss shown in Fig.2.13 determine the 7 CO2 L2 horizontal and vertical displacement, stresses in each element take E = 20 GPa and A= 200 mm². 25 IKTISME write down the general guidelines for selecting the 8 CO2 L2 interpolation polynomial.
22 1KT15MEFor the bar shown in Fig. 2.11 determine (i) nodal8CO2L2displacement & (ii) Stresses in each element Take E = 200GPa & A = 300 mm².200GPa & A = 300 mm².7CO2L223 1KT15MEFor a stepped bar loaded as shown in Fig. 2.127CO2L2determine (i) Nodal displacements. (ii) elemental stresses (iii) support reactions. Take E= 200 GPa.7CO2L224 1KT15MEFor a plane truss shown in Fig.2.13 determine the horizontal and vertical displacement, stresses in each element take E = 20 GPa and A= 200 mm².7CO2L225 1KT15MEwrite down the general guidelines for selecting the interpolation polynomial.8CO2L2
 22 IKTISME For a stepped bar loaded as shown in Fig. 2.12 determine (i) hodding of CO2 E2 E2 determine (i) Nodal displacements. (ii) elemental stresses (iii) support reactions. Take E= 200 GPa. 24 1KT15ME For a plane truss shown in Fig.2.13 determine the 7 CO2 L2 horizontal and vertical displacement, stresses in each element take E = 20 GPa and A= 200 mm². 25 1KT15ME write down the general guidelines for selecting the 8 CO2 L2 interpolation polynomial.
23 1KT15ME For a stepped bar loaded as shown in Fig. 2.12 7 CO2 L2 determine (i) Nodal displacements. (ii) elemental 5 CO2 L2 24 1KT15ME For a plane truss shown in Fig.2.13 determine the 7 CO2 L2 24 1KT15ME For a plane truss shown in Fig.2.13 determine the 7 CO2 L2 25 1KT15ME write down the general guidelines for selecting the 8 CO2 L2
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25 1KT15ME write down the general guidelines for selecting the 8 CO2 L2 interpolation polynomial.
interpolation polynomial.
26 1KT15ME dorive stiffness matrix for a 1 D har element under axial 8 CO1 12
loading
27 1KT15ME Derive strain-displacement matrix [B] for a isoparametric 8 CO1 12
linear triangular element.
28 1KT15ME Explain principle of minimum potential energy and 8 CO2 12
principle of virtual work.
29 1KT15ME Explain convergence requirement of a polynomial 8 CO2 12
displacement model.
30 1KT15ME Explain simplex. Complex and multiplex elements. 8 CO2 L2
31 1KT15ME what is geometric isotropy? Sketch and explain pascal 8 CO2 L2
triangle for 2D polynomials
32 1KT15ME Determine the maximum deflection of the beam as 8 CO2 L2
32 1KT15ME Determine the maximum deflection of the beam as 8 CO2 L2 shown in fig 1.8 Take E = 200 GPa & I = 2×10^{-9} m ⁴ . Use

33 1KT15ME	Determine the displacement of the bar as shown in Fig.	8	CO2	L2
	1.9. use Rayleigh ritz method for the solution. Take $E =$			
	70 GPa.			
34 1KT15ME	Explain steps involved in Galerkin's method.	8	CO2	L2
35 1KT15ME	using Galerkin's method, obtain an approximate solution	8	CO2	L2
	of the differential equation.			
	$d^2 u = 10 v^2 - 5 0 \le v \le 1$ sty $(0) = 0 v(1) = 0$			
	$\frac{1}{dx^2} = 10x = 5, 0 \le x \le 1, at u(0) = 0, u(1) = 0$			
36 1KT15ME	What is an interpolation function?		CO2	L2
37 1KT15ME	Derive the shape function of the bar element in local co-	8	CO2	L2
	ordinate system.			
38 1KT15ME	Derive the interpolation function of quadratic bar	8	CO2	L2
	element in natural co-ordinate system.			
39 1KT15ME	Derive the stiffness matrix for CST element.	8	CO2	L2
40 1KT15ME	Explain the concepts of iso, sub and super parametric		CO2	L2
	elements.			
41 1KT15ME	Derive the shape function for the nine – noded	8	CO2	L2
40 1KT1EME	quadrilateral element.		602	
42 IKI15ME	Using lagrangian method, derive the shape functions of	8	C02	L2
	quadrilateral element.	0	<u> </u>	1.2
45 INIISME	Evaluate the values of ω_1 , ω_2 , ξ_1 , $\wedge \xi_2$ used in gauss	0	COZ	LZ
	quadrature two point method.			
44 1KT15ME	Describe the general algorithm of Gaussian elimination	8	CO2	L2
	method for the solution of linear algebraic equations.		602	
45 IKIISME	Explain in priet the penalty method of imposing		COZ	LZ
46 1KT15ME	For the bar shown in Fig. 2.11 determine (i) nodal	8	CO2	12
40 INTISME	displacement δ_{i} (ii) Stresses in each element Take E –	0	002	LZ
	200 GPa & $\Delta = 300$ mm ²			
47 1KT15ME	For a stepped bar loaded as shown in Fig. 2.12	8	CO2	L2
	determine (i) Nodal displacements. (ii) elemental	-		
	stresses (iii) support reactions. Take $E= 200$ GPa.			
48 1KT15ME	For a plane truss shown in Fig.2.13 determine the	8	CO2	L2
	horizontal and vertical displacement, stresses in each			
	element take $E = 20$ GPa and $A = 200$ mm ² .			
49 1KT15ME	write down the general guidelines for selecting the	8	CO2	L2
	interpolation polynomial.			
50 1KT15ME	derive stiffness matrix for a 1-D bar element under axial	8	CO2	L3
51 1VT15ME	IOading.		<u> </u>	1.2
DI INIJME	linear triangular element		COZ	LS
52 1KT15ME	Using lagrangian method, derive the shape functions of	8	CO2	13
	guadrilateral element.	•		
53 1KT15ME	Evaluate the values of $\omega_1, \omega_2, \xi_1, \wedge \xi_2$ used in gauss	8	CO2	L3
	quadrature two point method			
54 1KT15MF	Describe the general algorithm of Gaussian elimination		C02	13
	method for the solution of linear algebraic equations		202	
55 1KT15ME	Explain in brief the penalty method of imposing	8	CO2	L3
	boundary conditions.		-	-
56 1KT15ME	For the bar shown in Fig. 2.11 determine (i) nodal	8	CO2	L3
	displacement & (ii) Stresses in each element Take E =			
	200GPa & A = 300 mm ² .			

D2. TEACHING PLAN - 2

Module - 3

Title:	Beams and Torsion of Shafts	Appr	8Hrs
		Time:	
a	Course Outcomes	-	Blooms
-	The student should be able to:	-	Level
1	Analysis of beams and Shaft under different kind of loading.	CO3	L4
b	Course Schedule	-	-
Class No	Module Content Covered	CO	Level
1	Boundary conditions, Load vector, Hermite shape functions, Beam stiffness matrix based on Euler-Bernoulli beam theory.	CO3	L2
2	Examples on cantilever beams, propped cantilever beams	CO3	L2
3	Numerical problems on simply supported, fixed straight and stepped beams using direct stiffness method with concentrated and uniformly distributed load.	CO3	L2
4	Finite element formulation of shafts, determination of stress and twists in circular shafts.		
c	Application Areas	со	Level
c	Application Areas Analysis of shaft parts	CO	Level
c 1 2	Application Areas Analysis of shaft parts Structural analysis of bars and beams	CO CO3 CO3	Level
c 1 2	Application Areas Analysis of shaft parts Structural analysis of bars and beams	CO CO3 CO3	Level
c 1 2 d	Application Areas Analysis of shaft parts Structural analysis of bars and beams Review Questions	CO CO3 CO3	Level
c 1 2 d 1	Application Areas Analysis of shaft parts Structural analysis of bars and beams Review Questions Derive the stiffness matrix for a beam element.	CO CO3 CO3	Level
c 1 2 d 1 2	Application Areas Analysis of shaft parts Structural analysis of bars and beams Review Questions Derive the stiffness matrix for a beam element. Derive Hermite shape functions of a beam element and show the variation of the shape function over the element.	CO 3 CO3 - CO3	Level
c 1 2 d 1 2 3	Application AreasAnalysis of shaft partsStructural analysis of bars and beamsReview QuestionsDerive the stiffness matrix for a beam element.Derive Hermite shape functions of a beam element and show the variation of the shape function over the element.Determine the maximum deflection in the uniform c/s of cantilever beam Shown in Fig 3.3 by assuming a beam as a single element.Take E = 7×10^9 N/m² & I = 4×10^{-4} m ⁴ .	CO CO3 CO3 - CO3 CO3	Level
c 1 2 d 1 2 3 4	Application AreasAnalysis of shaft partsStructural analysis of bars and beamsReview QuestionsDerive the stiffness matrix for a beam element.Derive Hermite shape functions of a beam element and show the variation of the shape function over the element.Determine the maximum deflection in the uniform c/s of cantilever beam Shown in Fig 3.3 by assuming a beam as a single element.Take E = 7×10^9 N/m² & I = 4×10^{-4} m ⁴ .Derive the stiffness matrix for a circular shaft subjected to pure torsion	CO3 CO3 - CO3 CO3 CO3	-
c 1 2 d 1 2 3 3	Application AreasAnalysis of shaft partsStructural analysis of bars and beamsReview QuestionsDerive the stiffness matrix for a beam element.Derive Hermite shape functions of a beam element and show the variation of the shape function over the element.Determine the maximum deflection in the uniform c/s of cantilever beam Shown in Fig 3.3 by assuming a beam as a single element.Take E = 7×10^9 N/m² & I = 4×10^{-4} m ⁴ .Derive the stiffness matrix for a circular shaft subjected to pure torsion.	CO 3 CO3 - CO3 CO3 CO3	-
c 1 2 d 1 2 3 4	Application AreasAnalysis of shaft partsStructural analysis of bars and beamsReview QuestionsDerive the stiffness matrix for a beam element.Derive Hermite shape functions of a beam element and show the variation of the shape function over the element.Determine the maximum deflection in the uniform c/s of cantilever beam Shown in Fig 3.3 by assuming a beam as a single element.Take E = 7×10^9 N/m² & I = 4×10^{-4} m ⁴ .Derive the stiffness matrix for a circular shaft subjected to pure torsion.	CO3 CO3 - CO3 CO3 CO3	

Titlor	Heat Transfer and Eluid Elow	Appr	10 Hrc
nue.		Appi	TOHIZ
		Time:	
а	Course Outcomes	-	Blooms
-	The student should be able to	-	Level
1	Analysis of heat transfer in composite sections	CO4	L4
b	Course Schedule	-	-
Class	Module Content Covered	СО	Level
No			
1	Basic equations of heat transfer: Energy balance equation, Rate	CO4	L2
	equation: conduction, convection, radiation, energy		
	generated in solid, energy stored insolid.		
2	1D finite element formulation using vibrational method, Problems	CO4	L3
	with temperature gradient and heat fluxes		
3	heat transfer in composite sections, straight fins.	CO4	L2

4	Flow through a porous medium, Flow through pipes of uniform and stepped sections, Flow through hydraulic net works.	CO4	L3
5			
С	Application Areas	CO	Level
1	Analysis of temperature gradient in fins ,boilers		
2	Heat conduction through composite wall and pipes in industries		
d	Review Questions	-	-
1	Explain types of boundary conditions in heat transfer problems.	CO4	L2
2	Derive the element conductivity matrix for one dimensional heat	CO4	L2
	flow element.		
3	Derive the element matrix, using Galerkin's approach for heat	CO4	L2
	conduction in one dimensional element.		
4	Discuss the various steps involved in the finite element analysis of	CO4	L2
	one dimensional heat transfer problem with reference to a straight		
	uniform fin.		
5	Derive the stiffness matrix for one dimensional fluid element.	CO4	L2
6	Determine the temperature distribution in the rectangular fin as	CO4	L2
	shown in Fig.4.6. Assume steady and only conduction process. Take		
	heat generated inside the fin as 400 w/m°C.		
7	Determine the temperature distribution in the composite wall using	CO4	L3
	1D heat elements use penalty approach of handling boundary		
	conditions as shown in Fig.4.7 Given $K_1 = 25$ W/m°C, $k_2 = 35$		
	W/m°C, $k_3 = 55$ W/m°C, $h = 30$ W/m²C, $T_{\infty} = 900$ °C, $A = unit$ area.		
8	For the smooth pipe of variable cross section shown in Fig. 4.8	CO4	L3
	determine the fluid heads at the junctions, the velocities in each		
	pipe and the volumetric flow rate. The fluid heads at the junctions.		
	the velocities in each pipe and the volumetric flow rate. The fluid		
	heads at the junctions		
е	Experiences	-	-
1			

E2. CIA EXAM – 2

a. Model Question Paper - 2

Crs Code	ρ.	17ME61	Sem:	VI	Marks:	30	Time:	75 minut		
Cour	rse:	Finite elem	hent analys	is						
-	-	Note: Ans	swer any 2	question	s, each ca	arry equal	marks.	Mark	CO	Level
								S		
1	а	Derive the	stiffness m	atrix for a	beam elen	nent.		7	CO3	L2
	b	Determine	the maxim	num deflec	tion in the	uniform c/s	of cantilev	er 8	CO3	L2
		beam Sho	wn in Fig 3	.3 by assu	ming a be	am as a sir	ngle elemer	nt.		
		Take E = 7	/x10 ⁹ N/m ²	$\& I = 4 \times 10$	⁻⁴ m ⁴ .		-			
					OR				CO3	
2	а	Derive the	e stiffness	matrix for	a circular	shaft subje	ected to pu	re 7	CO3	L2
		torsion.				-	-			
	b	Derive He	rmite shape	e functions	of a bean	n element a	and show th	ne 8	CO3	L2
		variation o	of the shape	function c	over the ele	ment.				
3	а	Derive the	e element o	conductivit	y matrix fo	or one dim	ensional he	at 7	CO4	L2

		flow element.			
	b	Determine the temperature distribution in the composite wall using	8	CO4	L2
		1D heat elements use penalty approach of handling boundary			
		conditions as shown in Fig.4.7 Given $K_1 = 25$ W/m°C, $k_2 = 35$			
		W/m°C, $k_3 = 55$ W/m°C, $h = 30$ W/m²C, $T_{\infty} = 900$ °C, $A = unit$ area.			
		OR		CO4	
4	a	Derive the stiffness matrix for one dimensional fluid element.	7	CO4	L2
	b	Determine the temperature distribution in the rectangular fin as	8	CO4	L2
		shown in Fig.4.6. Assume steady and only conduction process. Take			
		heat generated inside the fin as 400 w/m°C.			

b. Assignment -2

Note: A distinct assignment to be assigned to each student.

	Model Assignment Questions							
Crs C	Code: 17ME6	L Sem: VI	Marks:	5 / 10	Time:	90 - 120) minut	es
Cour	se: Finite e	lement analysis						
Note	: Each stude	nt to answer 2-3	assignments. Ea	ach assignm	nent carries e	qual ma	rk.	
SNo	USN		Assignment De	escription		Mark	СО	Level
						S		
1	1KT15ME	Derive the stiff	ness matrix for a	i beam elen	nent.	7	CO4	L2
2	1KT15ME	Derive Hermite	e shape function	s of a bean	n element ar	d 8	CO4	L2
		show the var	iation of the s	shape func	tion over th	e		
		element.						
3	1KT15ME	Determine the	maximum defle	ction in the	uniform c/s	of 7	CO4	L2
		cantilever bear	m Shown in Fig	3.3 by ass	uming a bea	n		
		as a single ele	ment. Take E =	7x10 ⁹ N/m	$h^2 \& I = 4 \times 10^{10}$)-4		
		m⁴.						
4	1KT15ME	Derive the stiff	fness matrix for	a circular s	haft subjecte	d 8	CO4	L2
		to pure torsion.	•					
5	1KT15ME	Explain types	of boundary co	nditions in	heat transfe	er 7	CO4	L2
		problems.						
6	1KT15ME	Derive the e	element condu	ctivity ma	trix for or	ie 8	CO4	L2
		dimensional he	at flow element.					
7	1KT15ME	Derive the eler	nent matrix, usir	ng Galerkin'	s approach fo	or 7	CO4	L2
		heat conductio	n in one dimensi	onal eleme	nt.			
8	1KT15ME	Discuss the va	rious steps invo	lved in the	finite elemer	nt 8	CO4	L2
		analysis of one	e dimensional he	eat transfer	problem wit	:h		
		reference to a	straight uniform	fin.				
9	1KT15ME	Derive the sti	ffness matrix f	or one din	nensional flu	id 7	CO4	L2
		element.						
10	1KT15ME	Determine the t	emperature distri	bution in the	e rectangular	8	CO4	L2
		fin as shown	in Fig.4.6. Ass	ume stead	y and only			
		conduction proc	ess. Take heat ge	enerated insi	de the fin as			
		400 w/mºC.						
11	1KT15ME	Determine the	temperature dis	tribution in	the composit	e 7	CO4	L2
		wall using 1D	heat elements	use penalt	y approach (of		
		handling bound	dary conditions	as shown ir	n Fig.4.7 Give	n		
		$K_1 = 25 \text{ W/m}^{\circ}\text{C}$	C, k ₂ = 35 W/m°C	C, k₃ = 55 \	$N/m^{\circ}C, h = 3$	0		
		$W/m^{2}C, T_{\infty} = 90$	00°C, A = unit ar	ea.				

12	1KT15ME	For the smooth pipe of variable cross section shown in Fig. 4.8 determine the fluid heads at the junctions, the velocities in each pipe and the volumetric flow rate. The fluid heads at the junctions, the velocities in each pipe and the volumetric flow rate. The fluid heads at the junctions.	8	CO4	L2
13	1KT15ME	Derive the stiffness matrix for a beam element.	7	CO4	L2
14	1KT15ME	Derive Hermite shape functions of a beam element and show the variation of the shape function over the element.	8	CO4	L2
15	1KT15ME	Determine the maximum deflection in the uniform c/s of cantilever beam Shown in Fig 3.3 by assuming a beam as a single element. Take $E = 7x10^9 \text{ N/m}^2 \& I = 4x10^{-4} \text{ m}^4$.	7	CO4	L2
16	1KT15ME	Derive the stiffness matrix for a circular shaft subjected to pure torsion.	8	CO4	L2
17	1KT15ME	Explain types of boundary conditions in heat transfer problems.	7	CO4	L2
18	1KT15ME	Derive the element conductivity matrix for one dimensional heat flow element.	8	CO4	L2
19	1KT15ME	Derive the element matrix, using Galerkin's approach for heat conduction in one dimensional element.	7	CO4	L2
20	1KT15ME	Discuss the various steps involved in the finite element analysis of one dimensional heat transfer problem with reference to a straight uniform fin.	8	CO4	L2
21	1KT15ME	Derive the stiffness matrix for one dimensional fluid element.	7	CO4	L2
22	1KT15ME	Determine the temperature distribution in the rectangular fin as shown in Fig.4.6. Assume steady and only conduction process. Take heat generated inside the fin as 400 w/m°C.	8	CO4	L2
23	1KT15ME	Determine the temperature distribution in the composite wall using 1D heat elements use penalty approach of handling boundary conditions as shown in Fig.4.7 Given $K_1 = 25 \text{ W/m}^\circ\text{C}$, $k_2 = 35 \text{ W/m}^\circ\text{C}$, $k_3 = 55 \text{ W/m}^\circ\text{C}$, $h = 30 \text{ W/m}^2\text{C}$, $T_\infty = 900^\circ\text{C}$, $A = \text{unit area}$.	7	CO4	L2
24	1KT15ME	For the smooth pipe of variable cross section shown in Fig. 4.8 determine the fluid heads at the junctions, the velocities in each pipe and the volumetric flow rate. The fluid heads at the junctions, the velocities in each pipe and the volumetric flow rate. The fluid heads at the junctions.	8	CO4	L2
25	1KT15ME	Derive Hermite shape functions of a beam element and show the variation of the shape function over the element.	7	CO4	L2
26	1KT15ME	Determine the maximum deflection in the uniform c/s of cantilever beam Shown in Fig 3.3 by assuming a beam as a single element. Take $E = 7x10^9 \text{ N/m}^2 \& I = 4x10^{-4} \text{ m}^4$.	8	CO4	L2
27	1KT15ME	Derive the stiffness matrix for a circular shaft subjected to pure torsion.	7	CO4	L2
28	1KT15ME	Explain types of boundary conditions in heat transfer problems.	8	CO4	L2
29	1KT15ME	Derive the element conductivity matrix for one	7	CO4	L2

		dimensional heat flow element.			
30	1KT15ME	Derive the element matrix, using Galerkin's approach for	8	CO4	L2
		heat conduction in one dimensional element.			
31	1KT15ME	Discuss the various steps involved in the finite element	7	CO4	L2
		analysis of one dimensional heat transfer problem with			
		reference to a straight uniform fin.			
32	1KT15ME	Derive the stiffness matrix for one dimensional fluid	7	CO4	L2
		element.			
33	1KT15ME	Determine the temperature distribution in the rectangular	8	CO4	L3
		fin as shown in Fig.4.6. Assume steady and only			
		conduction process. Take heat generated inside the fin as			
		400 w/m°C.			
34	1KT15ME	Determine the temperature distribution in the composite	7	CO4	L3
		wall using 1D heat elements use penalty approach of			
		handling boundary conditions as shown in Fig.4.7 Given			
		$K_1 = 25 \text{ W/m}^\circ\text{C}, k_2 = 35 \text{ W/m}^\circ\text{C}, k_3 = 55 \text{ W/m}^\circ\text{C}, h = 30$			
		W/m ² C, $T_{\infty} = 900^{\circ}$ C, A = unit area.			
35	1KT15ME	For the smooth pipe of variable cross section shown in	8	CO4	L3
		Fig. 4.8 determine the fluid heads at the junctions, the			
		velocities in each pipe and the volumetric flow rate. The			
		fluid heads at the junctions, the velocities in each pipe			
		and the volumetric flow rate. The fluid heads at the			
		junctions.			

D3. TEACHING PLAN - 3

Title:	Axi-symmetric Solid Elements	Appr	8 Hrs
		Time:	
a	Course Outcomes	-	Blooms
-	The student should be able to:	-	Level
1	Understand the stiffness matrix, eigen values and eigen vectors a xi-symmetric body	CO5	L2
b	Course Schedule	-	-
Class No	Module Content Covered	CO	Level
1	Derivation of stiffness matrix of axisymmetric bodies with triangular elements.CO5	CO5	L2
2	Numerical solution of axisymmetric triangular element(s) subjected to surface forces, point loads, angular velocity, pressure vessels.	CO5	L2
3	Formulation for point mass and distributed masses, Consistent ele- ment mass matrix of one dimensional bar element, truss element, axisymmetric triangular element.	CO5	L2
4	quadrilateral element, beam element. Lumped mass matrix of bar element, truss element, Evaluation of eigen values and eigen vec- tors, Applications to bars, stepped bars, and beams.	CO5	L2
		CO5	L2
С	Application Areas	СО	Level
1	Dynamic analysis of bars and beam	CO5	L2
2	Formulation for point mass and distributed masses in different element	CO5	L2
d	Review Questions	-	-
1	What is an axi-symmetric element? Mention its characteristics.	CO5	L2
2	Derive the stiffness matrix of an axi-symmetric element using	CO5	L2

	potential energy approach.		
3	Explain the evaluation of eigen values and eigen vectors using	CO5	L2
	characteristic polynomial technique.		
4	Derive the Consistent mass matrix for bar element	CO5	L2
5	Derive the Consistent mass matrix for bar element	CO5	L2
6	Derive the consistent mass matrix for truss element	CO5	L2
7	what are the properties of eigen vectors	CO5	L2
8	Differentiate between Consistent mass matrix and lumped mass	CO5	L2
	matrix.		
9	Determine the eigen value of the stepped bar as shown in Fig. 5.8	CO5	L2
	Take E = 200 GPa, weight density 7850 kg/m ³		
е	Experiences	-	-
1			

E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code	e:	17ME61	Sem:	VI	Marks:	30	Time:	75	minut	es		
Cou	rse:	Finite elen	inite element analysis									
-	-	Note: Ans	swer any	/ 2 quest	ions, each d	arry e	qual marks.		Mark	СО	Level	
1	а	What is an	i axi-sym	metric ele	ment? Menti	on its c	haracteristics.		7	CO5	L2	
	b	Derive the	Consiste	nt mass n	natrix for bar	eleme	nt		8	CO5	L2	
											L2	
2	а	Derive the	e stiffnes	s matrix	of an axi-s	ymmet	ric element ι	using	8	CO5	L2	
		potential e	energy ap	proach.								
	b	Differentia	te betwe	en Consi	stent mass	matrix	and lumped r	mass	7	CO5	L2	
		matrix.					-					
											L2	
3	а	Explain th	e evalua	tion of e	gen values	and ei	gen vectors ι	using	7	CO5	L2	
		characteris	stic polyn	omial tecl	nnique.			_				
	b	Derive the	consiste	nt mass n	natrix for true	ss elem	ent		8	CO5	L2	
											L2	
4	а	Determine	the eige	n value o	f the steppe	d bar a	s shown in Fig	. 5.8	7	CO5	L2	
		Take E = 200 GPa, weight density 7850 kg/m ³										
	b	what are the properties of eigen vectors							8	CO5	L2	

b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

	Model Assignment Questions									
Crs C	Code:	17ME61	Sem:	VI	Marks:	5 / 10	Time:	90 - 120	minut	es
Cour	se:	Finite ele	ement ana	lysis						
Note	: Eacl	h student	to answe	er 2-3	assignments. Ea	ch assignm	nent carries e	qual ma	rk.	
SNo	l	JSN			Assignment De	scription		Mark	СО	Level
								S		
1	1KT1	5ME	What is	an	axi-symmetric	element?	Mention it	s 7	CO5	L2
			characteri	stics.						
2	1KT1	5ME	Derive the	e stiff	ness matrix of a	n axi-symn	netric elemer	nt 8	CO5	L2
			using pote	ential	energy approach	۱.				
3	1KT1	5ME	Explain th	e eva	luation of eigen	values and	eigen vector	rs 7	CO5	L2
using characteristic polynomial technique.										
4	1KT1	5ME	Derive the	Con	sistent mass mat	rix for bar e	element	8	CO5	L2

_ _			-	005	
5	IKI15ME	Derive the Consistent mass matrix for bar element	/	CO5	
6	1KT15ME	Derive the consistent mass matrix for truss element	8	CO5	
/	1KT15ME	what are the properties of eigen vectors	/	CO5	
8	1KT15ME	Differentiate between Consistent mass matrix and	8	CO5	L2
		lumped mass matrix.			
9	1KT15ME	Determine the eigen value of the stepped bar as shown	7	CO5	L2
		in Fig. 5.8 Take E = 200 GPa, weight density 7850 kg/m ³			
10	1KT15ME	What is an axi-symmetric element? Mention its	8	CO5	L2
		characteristics.			
11	1KT15ME	Derive the stiffness matrix of an axi-symmetric element	7	CO5	L2
		using potential energy approach.			
12	1KT15ME	Explain the evaluation of eigen values and eigen vectors	8	CO5	L2
		using characteristic polynomial technique.			
13	1KT15ME	Derive the Consistent mass matrix for bar element	7	CO5	L2
14	1KT15ME	Derive the Consistent mass matrix for bar element	8	CO5	L2
15	1KT15ME	Derive the consistent mass matrix for truss element	7	CO5	L2
16	1KT15ME	what are the properties of eigen vectors	8	CO5	L2
17	1KT15ME	Differentiate between Consistent mass matrix and	7	CO5	12
		lumped mass matrix	-		
18	1KT15ME	Determine the eigen value of the stepped bar as shown	8	CO5	12
		in Fig. 5.8 Take $F = 200$ GPa, weight density 7850 kg/m ³	C C		
19	1KT15ME	What is an axi-symmetric element? Mention its	7	CO5	12
		characteristics	,	005	66
20	1KT15ME	Derive the stiffness matrix of an axi-symmetric element	8	C05	12
20	INTIGHT	using notential energy approach	0	005	LZ
21	1KT15ME	Explain the evaluation of eigen values and eigen vectors	7	CO5	12
21	INTIME	using characteristic polynomial technique	,	005	LZ
22		Derive the Consistent mass matrix for har element	Q	CO5	12
22		Derive the Consistent mass matrix for bar element	7	CO5	12
23		Derive the consistent mass matrix for truss element	2 2	C05	12
24	1KT15ME	what are the properties of eigen vectors	7	C05	12
25	1KT15ME	Differentiate between Consistent mass matrix and	2 2	C05	12
20	IKIISML	lumped mass matrix	0	COJ	LZ
27		Determine the eigen value of the stepped har as shown	7	CO5	12
21	TKITOME	in Eig. 5.8 Take $E = 200$ CPa weight density 7550 kg/m ³	,	COJ	LZ
20		What is an axi symmetric element? Mention its	0	CO5	12
20	IKIIJML	what is an axi-symmetric element: Mention its	0	COS	LZ
20		Characteristics.	7	COF	12
29	INIJME	berive the sumess matrix of an axi-symmetric element	/	005	LZ
20		Using potential energy approach.	0	COF	12
50	TKITOME	Explain the evaluation of eigen values and eigen vectors	0	COS	LZ
1		using characteristic polynomial technique.	7	COL	1.2
10		Derive the Consistent mass matrix for bar element	/		
22		Derive the consistent mass matrix for truce element	0 7		
22		what are the properties of eigen vectors	/		
24		what are the properties of eigen vectors	0 7		
55	TKITOME	Dimerentiale between Consistent mass matrix and	/	CUS	LZ
20		iumped mass matrix.	0	COF	1.2
30	TKIT2MF	Determine the eigen value of the stepped bar as shown	8	CO2	LZ
		In Fig. 5.8 Take E = 200 GPa, weight density 7850 kg/m ³			

F. EXAM PREPARATION

1. University Model Question Paper

Course:	Finite elemen	t analysis				Month / Year	DEC /2019
Crs Code:	17ME61	Sem:	VI	Marks:	100	Time:	180
							minutes

-	Note	Answer all FIVE full questions. All questions carry equal marks.	Mark	CO	Leve
			S	601	
		Define FEM, explain basic steps involved in FEM.	/	<u>CO1</u>	<u>L2</u>
	b	using Galerkin's method, obtain an approximate solution of the	8	COI	L2
		differential equation.			
		$\frac{d^2u}{d^2u} = 10x^2 = 5.0 \le x \le 1.atu(0) = 0.u(1) = 0.000$			
1		dx^2			
		OR			
	а	Determine the maximum deflection of the beam as shown in fig	8	C01	L2
		1.8 Take E = 200 GPa & I = 2×10^{-9} m ⁴ . Use Rayleigh ritz method.			
	b	Explain simplex, Complex and multiplex elements.	7	C01	L2
	2	Derive the interpolation function of quadratic bar element in	7	<u> </u>	12
	a	natural co-ordinate system	/	COZ	LZ
	h	Derive the stiffness matrix for CST element	8	C02	12
		OR	0	002	L2
	а	For a stepped bar loaded as shown in Fig. 2.12 determine (i) Nodal	8	CO2	L3
2		displacements. (ii) elemental stresses (iii) support reactions. Take			
		E= 200 GPa.			
	b	For a plane truss shown in Fig.2.13 determine the horizontal and	7	CO2	L2
		vertical displacement, stresses in each element take $E = 20$ GPa			
		and A= 200 mm ² .			
			8		
		Derive the stiffness matrix for a beam element.	7	<u>CO3</u>	<u>L2</u>
	a	been Chaun in Fig. 2.2 by accurating a hear of a single element	8	CO3	L3
		beam Snown in Fig 3.3 by assuming a beam as a single element. Take $\Gamma = 7v10^9 \text{ Mm}^2 \Omega + 4v10^4 \text{ m}^4$			
2		$\frac{1}{1} \frac{1}{1} \frac{1}$			
	а	Derive the stiffness matrix for a circular shaft subjected to pure	8	CO3	L2
		torsion.	-		
	b	Derive Hermite shape functions of a beam element and show the	7	CO3	L2
		variation of the shape function over the element.			
	а	Derive the element conductivity matrix for one dimensional heat	7	CO4	L2
		flow element.			
	b	Determine the temperature distribution in the composite wall using	8	CO4	L3
		ID heat elements use penalty approach of handling boundary			
		conditions as snown in Fig.4.7 Given $K_1 = 25$ W/m°C, $K_2 = 35$			
4		$VV/M^{\circ}C, K_3 = 55 VV/M^{\circ}C, M = 30 VV/M^{\circ}C, T_{\infty} = 900^{\circ}C, A = UML area.$			
	a	Derive the stiffness matrix for one dimensional fluid element	8	CO4	12
	b	Determine the temperature distribution in the rectangular fin as	7	C04	 L2
		shown in Fig.4.6. Assume steady and only conduction process. Take			
		heat generated inside the fin as 400 w/m°C.			
	а	What is an axi-symmetric element? Mention its characteristics.	7	CO4	L2
	b	Derive the Consistent mass matrix for bar element	8	CO4	
	С	Derive the stimness matrix of an axi-symmetric element using	/	CO4	L2
		potential energy approach.			
5	2	7	005	12	
	a	matrix	'	000	LZ
	b	Explain the evaluation of eigen values and eigen vectors using	8	C05	L2
	~	characteristic polynomial technique.	2	200	
	С	Derive the consistent mass matrix for truss element	7	C05	L2

8

2. SEE Important Questions

Cou	rse:	Finite elemen	nite element analysis Mo							2019
Crs	Code:	17ME61	Sem:	VI	Marks:	80	Time:		180	
								1	minut	es
	Note	Answer all FIV	'E full quest	ions. All que	stions carry	equal mark	(S.	-	-	
Mo	Qno.	Important Que	estion					Mark	СО	Year
aui								S		
e	1	Dofina FEM a	7	<u> </u>						
	2	With an exam		/ 8	CO1					
	3	Explain princ	inle of	7	C01					
1		virtual work		initiani potei	icial energy				001	
	4	Explain conv	ement	8	CO1					
		model.		90						
	1	What is an int	erpolation f	unction?				7	CO2	
	2	Derive the sl	hape function	on of the ba	r element i	n local co-o	rdinate	8	CO2	
		system.	-							
	3	Derive the i	nterpolation	function o	of quadration	c bar elem	nent in	7	CO2	
2		natural co-orc	linate syste	m.						
	4	Derive the sti	ffness matri	x for CST ele	ement.			8	CO2	
	5	Explain the co	oncepts of is	o, sub and s	uper param	etric eleme	nts.	7	CO2	
	6	Derive the s	hape funct	ion for the	nine – no	oded quadr	ilateral	8	C02	
		element.								
		<u> </u>	<u></u>					-	600	
		Derive the still	8	CO3						
	2	Derive Hermin		03						
	2	Variation of th	0	<u> </u>						
3	2	3 Determine the maximum deflection in the uniform c/s of cantilever								
			$\frac{111}{2} \frac{11}{2} $	$-4 \times 10^{-4} \text{ m}^4$	a beam as	a single ei	ement.			
	1	Take E = 7 X I	7	C03						
		torsion	inness mac			subjected i	o pure	/		
	1	Discuss the v	arious steps	involved in	the finite e	lement ana	lysis of	7	CO4	
	_	one dimensio	nal heat tra	nsfer proble	m with refe	rence to a s	traight			
		uniform fin.					, ci aigii			
	2	Derive the stif	fness matrix	k for one dim	nensional flu	id element.		8		
	3	Determine the	e temperatu	re distributio	on in the re	ctangular fi	n as	7	CO4	
		shown in Fig.4	.6. Assume s	steady and o	nly conduction	on process.	Гаке			
		heat generated	d inside the f	in as 400 w/r	nºC.					
	4	Determine the	e temperatu	ire distributi	on in the co	mposite wa	ll using	8		
4		1D heat eler	nents use	penalty app	broach of h	nandling bo	undary	,		
		conditions as	shown in	Fig.4.7 Give	en $K_1 = 25$	6 W/m°C, k	2 = 35			
		W/m°C, k₃ = 5	55 W/mºC, h	$= 30 \text{ W/m}^{2}\text{ C}$	$C_{, T_{\infty}} = 900^{\circ}$	C, A = unit a	area.			
	5	For the smoo	oth pipe of	variable cro	oss section	shown in F	ig. 4.8	7	CO4	
		determine the	n each							
		pipe and the	volumetric f	low rate. Th	e fluid head	ls at the jur	nctions,			
		the velocities	in each pip	be and the v	olumetric f	low rate. Th	ne fluid			
		heads at the j	unctions.							
5	1	Derive the s	tiffness ma	trix of an a	axi-symmet	ric element	using	7	C05	
		potential ener	gy approac	h.						

2	Explain the evaluation of eigen values and eigen vectors using	8	C05	
	characteristic polynomial technique.			
3	Derive the Consistent mass matrix for bar element	7	CO5	
4	Derive the Consistent mass matrix for bar element	8	CO5	
5	Derive the consistent mass matrix for truss element	7	CO5	
6	what are the properties of eigen vectors	8	CO5	
7	Differentiate between Consistent mass matrix and lumped mass	7	CO5	
	matrix.			
8	Determine the eigen value of the stepped bar as shown in Fig. 5.8	8	CO5	
	Take E = 200 GPa, weight density 7850 kg/m ³			

G. Content to Course Outcomes

1. TLPA Parameters

Table 1: TLPA - Example Course

Mo	Course Content or Syllabus	Conton	• Blooms'	Final	Idontifio	Instructi	Accoccmon
dul	(Split module content into 2 parts which	+	Loarnin	Ploo	d Action	on	t Mothode
uui	(Split module content into 2 parts which bays similar concents)	L Taachin	Leannin		U ACTION	Mothod	to Moneuro
e- #	nave similar concepts)		y Lovola		for	s for	
#		y nours	for	Leve	loarning	S IUI	Learning
			Contont		Learning	Leannin	
4	R	C	Content	_	Г	<u> </u>	
	D Introduction to Finite element	C F	D		Г	G	
L T	Introduction to Finite element		1.2		- Lindorat	-	- Silp Test
	Finite element Analysis Engineering		- LZ		Clamant	Lecture	-
	Finite element Analysis. Engineering				Element	-	-
	applications of Finite element Analysis.				s and	-	
	Boundary conditions: nomogeneous and				nodes		
	non-nomogeneous for structural, neat	•					
	transfer and fluid flow problems. Potential						
	energy method, Rayleign Ritz method,						
	Galerkin's method, Displacement method						
	of finite element formulation.						
	Convergence criteria, Discretization						
	process, Types of elements: 1D, 2D and						
	3D, Node numbering, Location of nodes.						
	Strain displacement relations, Stress						
	strain relations, Plain stress and Plain						
	strain conditions, temperature effects.						
		_					
	Interpolation models: Simplex,	5	-L2		-		
	complex and multiplex elements, Linear				Underst		
	interpolation polynomials in terms of	•			simplex		
	global coordinates 1D, 2D, 3D Simplex				element		
	Elements.				S		
					-		
					complex		
					element		
					S		
					-Pascale		
					triangle		
2	One-Dimensional Elements-Analysis of	5	- L2	L2	-	-	-
	Bars and Trusses,				Underst	Lecture	Assignmen

	Linear interpolation polynomials in terms of local coordinate's for1D, 2Delements. Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates, Constant strain triangle, Four-Nodded Tetrahedral Element (TET 4), Eight-Nodded Hexahedral Element (HEXA8), 2D isoparametric element, Lagrange interpolation functions, Numerical integration: Gaussian quadrature one point, two point formulae, 2D integrals. Fore terms: Body force, traction force and point loads,				and - Cubic and quadrati c element s	- Tutorial -	t - -
2	Numerical Problems: Solution for displacement, stress and strain in 1D straight bars, stepped bars and tapered bars using elimination approach and penalty approach, Analysis of trusses.	5	-L2 -L3	-L3	- Apply stiffness matrix for bars - boundar y conditio n		
3	Beams and Shafts: Boundary conditions, Load vector, Hermite shape functions, Beam stiffness matrix based on Euler- Bernoulli beam theory, Examples on cantilever beams, propped cantilever beams, Numerical problems on simply supported, fixed straight and stepped beams using direct stiffness method with concentrated and uniformly distributed load.	6	- L2 - L3	L3	- Apply - stiffness matrix for beams - boundar y conditio n	- Lecture -	- Assignmen t -
3	Torsion of Shafts: Finite element formulation of shafts, determination of stress and twists in circular shafts.	6	- L2 - L3	-L3	- Apply - stiffness matrix for Shaft		
4	Heat Transfer: Basic equations of heat transfer: Energy balance equation, Rate equation: conduction, convection, radiation, energy generated in solid, energy stored insolid, 1D finite element formulation using vibrational method, Problems with temperature gradient and heat fluxes, heat transfer in composite sections, straight fins.	5	- L2	L2	- Apply stiffness matrix for conducti on ,convect ion and heat generati on	- Lecture -	- Slip Test -
4	Fluid Flow: Flow through a porous medium, Flow through pipes of uniform and stepped sections, Flow through hydraulic net works.	5	- L2	L2	- Underst and - properti es of fluid		

					-fluid flow		
5	Axi-symmetric Solid Elements: Derivation of stiffness matrix of axisymmetric bodies with triangular elements, Numerical solution of axisymmetric triangular element(s) subjected to surface forces, point loads, angular velocity, pressure vessels.	4	- L2	L2	- Underst and - Axi symmet ry solid element s	- Lecture -	- Slip Test -
5	Dynamic Considerations: Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, axisymmetric triangular element, quadrilateral element, beam element. Lumped mass matrix of bar element, truss element, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams.	4	- L2	L2	- Underst and - Dynamic respons e of beam element s		

2. Concepts and Outcomes:

Table 2: Concept to Outcome - Example Course

Mc du e- #	Learning or Outcome from study of the Content or Syllabus	ldentified Concepts from Content	Final Concept	Concer Justificat (What all Le Happened the study Conten Syllabus. A word for lea or outcor	ot ion arning from y of t / short arning me)	CO Components (1.Action Verb, 2.Knowledge, 3.Condition / Methodology, 4.Benchmark)	Course Outcome Student Should be able to
A	1	J	K	L		М	N
	- Study of Numerical Method - Study of elements and nodes	- elements - nodes - boundary condition	Elements and nodes	Understand concept elements boundary conditions	the of and	- Understand - Elements and nodes	Understand the concept of elements and boundary conditions
	- Study of Boundary condition -Study of Simplex and complex elements - Study of <u>pascal</u> triangle	-simplex elements -complex elements -Pascale triangle	Complex and simple elements	Under concept complex multiplex elements	the of and	- Understand - simplex elements -complex elements -Pascale triangle	Under the concept of complex and multiplex elements
	-Study of tet 4 and quad element - Study of interpolation model	-tet 4 element -Quad elements - Interpola	Cubic and quadratic elements	Understand hexa and elements	the tet 4	- Understand - Cubic and quadratic elements	Understand the hexa and tet 4 elements

		-Study of	tion model				
	2	- study of stiffness matrix for bars	-Bars -stiffness matrix for bars - boundary	Analysis of bars and trusses	Apply elimination and penalty approach for bars and trusses	- Apply stiffness matrix for bars - boundary condition	Apply elimination and penalty approach for bars and trusses
		-Study of Beam - study of stiffness matrix for beams -Study of shaft - study of	-Beams -stiffness matrix for beams - boundary condition	loading conditions on beams	Apply the suitable loading condition on beams	- Apply -stiffness matrix for beams - boundary condition	Apply the suitable loading condition on beams
	3	stiffness matrix for torsion of shaft	-torsion of shaft -stiffness matrix for shaft - boundary condition	Stiffness matrix for beams and shaft	Apply the suitable boundary condition of shaft	- Apply -stiffness matrix for Shaft	Apply the suitable boundary condition of shaft
	4	-Study of mode of heat transfer - study of stiffness matrix for conduction , convection and heat generation	-Modes of heat transfer -stiffness matrix for conducti on, convecti on.	Heat transfer through 1 D	Understand the heat transfer in composite sections	- Apply -stiffness matrix for conduction ,convection and heat generation	Understand the heat transfer in composite sections
		-Study fluid flow	- propertie s of fluid -fluid flow	Analysis of flow	Understand flow through pipes Of sections	- Understand -properties of fluid -fluid flow	Understand flow through pipes Of sections
5	5	-Study of axi symmetry solid element -Study of	-axi symmetr y solid elements	stiffness matrix solid element	Understand the stiffness matrix of axi-symmetric body	- Understand - Axi symmetry solid elements	Understand the stiffness matrix of axi-symmetric body
		dynamic response of beam elements	-dynamic response of beam elements	Dynamic consideratio ns	Understand the eigen values and eigen vectors of bars and beam	- Understand - Dynamic response of beam elements	Understand the eigen values and eigen vectors of bars and beam