Mechanical Engineering Department
B. Tech. Semester VII

Course Name: **Software simulation-2** **Course Code: BTME19752**
Type of course: **Minors – Computer Aided Modeling and Simulation**
Prerequisite: Solid Modelling, Software simulation-1
Rational of course: This course will enable the students to use concept of simulation for all disciplines of Physics**,** Structural**,** Vibration**,** Fluid Dynamics and Heat Transfer with actual engineering problems by computer modelling and simulation software tools.

Teaching and Examination Scheme:

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	100
0	2	4	4	--	--	--	60	40	

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

Contents:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1.	**Introduction to Finite Element Analysis:** History of FEA, analytical and numerical FEA, necessity of FEA, types of analysis, discretization and other approximation in FEA, necessity of meshing, convergence and mesh refinement, mesh transition.	**2**	**5 %**
2.	**GUI Software:** Software overview, graphic control and selection, project schematic, file management, software behaviour: solution status monitor, outline tree view, progress pane.	**4**	**15 %**
3.	**Design Modeler:** Introduction to Design Modeler, graphics window, types of planes and sketches, CAD modeling connections, generating the mesh and	**6**	**20 %**

Sr. No.	Topics	Teaching Hrs.	Module Weightage
	optimizing the modal to refine mesh, global and local meshing controls, defining and assigning materials, boundary conditions.		
4.	**Modal Analysis:** Introduction to modal analysis , need of modal analysis, theory of harmonic analysis, harmonic response analysis using mode superposition method, theory of random vibration analysis, theory of response spectrum analysis, theory of explicit dynamic analysis.	**6**	**20 %**
5.	**Structural Analysis:** Basics of static structural analysis, theory of fatigue analysis, theory of topology optimization, material properties, define contact, analysis setting, loads and support generation, results and post processing.	**6**	**20 %**
6.	**Thermal and Fluid Flow Analysis:** Theory of steady state thermal analysis, theory of transient thermal analysis, CFD simulation, incompressible and compressible fluid flow analysis, convective heat transfer analysis, multiphase fluid flow analysis, material properties, thermal contact and boundary conditions, results and post processing.	**6**	**20 %**

Percentage Distribution of Marks as per Bloom's Taxonomy (Theory/Practical):

Percentage Distribution of Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	**25**	**25**	**20**	**10**	**5**

Legends: R: Remembrance, **U:** Understanding; **A:** Application, **N:** Analyze, **E:** Evaluate **C:** Create and above Levels

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary from above table.

Learning Resources:

Sr. No.	Title of book /article	Author(s)	Publisher	Publication Year	Publication Edition
1.	Fundamentals of Finite Element Analysis	Hutton	McGraw Hill	2004	1st
2.	Finite Element Analysis in engineering	S.md.jalalu deen	Anuradha Pubilications	2016	2nd
3.	A First Course in the Finite Element Methods	Logan daryl L.	Cengage Learning India Private Limited	2012	5th
4.	ANSYS Mechanical APDL for Finite Element Analysis	Mary Kathryn Thompson, John M. Thompson	Butterworth-Heinemann	2017	1st
5.	Finite Element Analysis	G Lakshmi Narasaiah	BS Publications	2020	2nd

Course Outcomes (CO):

CO. No.	CO Statements After learning this subject, students will be able to	Marks % weightage
CO-1	Explain the fundamental concepts of the theory of the Finite Element Analysis.	5
CO-2	Examine features available in Finite Element Analysis software.	15
CO-3	Capable of designing, optimizing and analyzing a component.	20
CO-4	Apply the FE analysis for practical applications in static and dynamic condition.	20
CO-5	Perform structural analysis for given application.	20
CO-6	Apply the FE method for thermal and fluid flow analysis problem.	20

Mapping of (CO's) with Program Outcomes (PO's):

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO-1	3	3	1	2	2	2	2	1	1	1	1	1
CO-2	2	2	3	2	3	2	1	1	1	1	1	1
CO-3	3	2	3	2	3	2	1	1	1	1	1	1
CO-4	2	3	3	2	2	1	1	1	1	1	2	1
CO-5	2	2	3	2	3	2	1	1	1	1	1	1
CO-6	3	2	3	2	3	2	1	1	1	1	1	1
Rationale*	**15**	**14**	**16**	**12**	**16**	**11**	**7**	**6**	**6**	**6**	**7**	**6**

Rationale - Mapping of CO's with PO's:
This course will give basic understanding of engineering knowledge, problem analysis & design and development of solutions by using modern tool usage with real life problems.

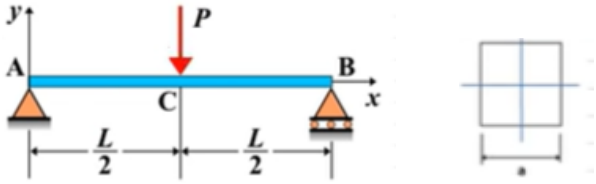
This course highly maps with Program outcomes 1, 2, 3, 4, 5, and 6. It states that the course will develop Engineering knowledge, Problem analysis, Design / development of solutions, Conduct investigations of complex problems, Modern tool usage, an engineer and the society. Finally it will lead to convert conceptual knowledge of mechanical engineering to real life application and with the use of modern computing tools and apply their technical, managerial and other soft skills in their professional life.

List of Practical:

1. Design and analyze for Rectangular bar profile with a center hole in static structural simulation
2. Solve cantilever beam problem and compare the result of analytical and static structural simulation method
3. Perform Modal analysis for Structural components
4. Determine the displacements and stresses in a Structural components for Random Vibration Analysis
5. Exercise for Steady state thermal analysis of a simple plate
6. Simulate fluid flow through a rectangular channel
7. Design, analyze and optimize for Car Model for crash analysis using Explicit Dynamic
8. Exercise for topology optimization in a Bracket

Student Activities:

1. Compare the result of analytical and simulation method for the problem stated below;
   A simply supported beam AB is subject to a constant distributed load P over the section AB, a concentrated force P at point C. The cross section of the square beam (40x40) is shown below.
   The parameters are as below;
   Length of beam (L): 1000 mm; Line pressure load on beam (P): 5 N/mm; Young's Modulus (E): 210000 N/mm$^{2;}$ Distance from neutral axis to extreme fibers (c): 20 mm; Moment of inertia (I): 213333 mm^4; Section modulus (Z): 10667 mm^3



   Calculate displacement, stress and shear force by analytical and simulation approach.
2. Perform a 2D linear elastic static analysis of a plate with a hole
3. Prepare report for Transient thermal analysis of Heat sink
4. Presentation of Modal and Random Vibration Analysis for square channel.
5. Flow & Heat transfer simulation for various engineering applications.

Major Equipment:

1. Computational facilities

List of Open Source/learning website:

1. https://nptel.ac.in/courses/105105041
2. https://nptel.ac.in/courses/112104193
3. https://nptel.ac.in/courses/112104205
4. https://courses.ansys.com/
5. https://www.ualberta.ca/index.html
6. https://www.mscsoftware.com/training-materials
7. http://expertfea.com/tutorials.html
8. https://www.simuleon.com/abaqus-tutorials/
9. https://altairuniversity.com/modeling/hypermesh-related/
10. https://discoveryforum.ansys.com/
11. https://www.cfd-online.com/

List of Software:

1. 3D Modeling and simulation Software