The University of Jordan
School of Engineering

Department	Course Name	Course Number	Semester
Mechanical Engineering	Introduction to Finite Element Method	0904493	

2019 Course Catalog Description

Preliminary aspects of finite element method, basic concepts of the finite element method (strong and weak forms, Hamilton's principle, implicit and explicit methods). Formulation techniques, assembly of element equations, solution of equations with applications in 1D and 2D problems in: trusses, beams, frames, plane stress and strain problems, heat transfer, fluid flow and thermal stresses. Use a modern professional software to solve various problems in the field of mechanical engineering.

Instructors

Name	E-mail	Sec	Office Hours		Lecture Time	

Text Books

	Text book 1	Text book 2
Title	Practical Finite Element Analysis for Mechanical Engineers	
Author(s)	Dominique Madier	
Publisher, Year, Edition	FEA Academy, 2020, 1st Edition	

References

Books	1.Saeed Moaveni, *Finite Element Analysis: Theory and Application with ANSYS (2015)*, Pearson Education Limited. 2.J. Fish and T. Belytschko, *A First Course in Finite Elements (Paperback) (2007).* 3.Daryl L. Logan "A First Course in the FEM" Fourth Edition, (2007) 4.J. N. Reddy, *An introduction to the FEM (2005).* 5.K. H. Huebner, D. L. Dewhirst, D. E. Smith, T. G. Byrom, *The FEM for Engineers (2001).* 6.J. T. Oden, E. B. Becker, G. F. Carey, *Finite Elements: An Introduction. Volume I (1981).* 7.K.-J. Bathe, *Finite Element Procedures (Part 1-2) (Paperback) (1995).* 8.O. C. Zienkiewicz, R. L. Taylor, J.Z. Zhu, *The FEM: Its Basis and Fundamentals, 6th Ed. (2005).* 9.O. C. Zienkiewicz and R. L. Taylor, *The FEM for Solid and Structural Mechanics, 6th Ed. (2005).* 10.T. J. R. Hughes, *The FEM: Linear Static and Dynamic Finite Element Analysis (Paperback) (2000).*
Journals	**Finite Elements** in Analysis and Design - **Journal** - Elsevier
Internet links	NAFEMS - International Association Engineering Modelling (www.nafems.org)

Prerequisites

Prerequisites by topic	Calculus, differential equations, Dynamics, Strength of materials, Numerical analysis, Heat transfer
Prerequisites by course	Engineering Numerical Methods (0904302) and Strength of Materials I (0934372)
Co-requisites by course	
Prerequisite for	

Topics Covered

Week	Topics	Chapter in Text	Sections
1	Introduction to the FEM.	**1,2,3,4**	

2-3	Basics of FEM Theory: The equilibrium equation, Displacement method, Principle of minimum potential energy, Element stiffness matrix, Direct and Iterative solutions	**5**	
4	FEA solution approach	**6**	
5-6	Elements for FEA and Meshing	**7,8,9**	
7	Material Modelling	**10**	
8	Boundary Conditions	**11**	
9	Rigid Body Elements	**12**	
10-11	Modelling: Joints, Contact,	**13,14**	
12	FEA Validation	**16,17,18,19**	
13-16	Static Analysis	**20,21,22**	

Mapping of Course Outcomes to ABET Student Outcomes

SOs	Course Outcomes
1	1. Solve differential equations, develop global stiffness- matrices and shape functions for 1D and 2D using FEM
2	2. Decide when it is the right time to apply the FEM to design, model and solve engineering 1D and 2D problems (structural, fluid, elasticity and thermal problems)
3	3. Interact with other people when working on projects and Improve the students' skills in developing oral communication skills
7	4. Improve the student's skills through the projects provided by this course; that is by learning software like ANSYS, ABAQUS or FEMAP, engaging in long-life learning 5. An ability to use a modern engineering technique which is necessary for solving various engineering problem Learn how to interpret data by comparing the FEM solution with other available solution

Evaluation

Assessment Tools	Expected Due Date	Weight
Project		30%
Activities		20%
Final Exam		50%

Contribution of Course to Meet the Professional Components

The course offers students the chance to build their skills in formulating and performing kinematics and kinetics analysis of particles and rigid bodies. In addition, it is needed for the higher-level courses like Mechanics of Machines, Mechanical Vibrations and other graduate courses.

Computer Usage

Students will be required to use a finite element program such as ANSYS, FEMAP, ABAQUS and mathematical software like Maple or Matlab.

Project

All students are required to complete a project. Your topic cannot be re-defined in a substantive manner once your abstract is submitted and approved. The final project includes an oral (in class) presentation as well as a final report. In addition, technical details, drawings, computer programs etc. should be submitted on a CD. The final project (15% of the total grade), will involve an oral presentation (in class) as well as a final report (max. 10 pages).

In your final-project report you will be required to

- Write an abstract of a chosen an engineering problem
- Develop a simple mathematical model for the system, Develop the finite element model.
- Solve the problem using **ANSYS/ FEMAP** or any other FEM code (you may write one).
- Discuss whether the mathematical model you chose gives you physically meaningful results. If not, revise your model and perform analysis to improve your results.
- Write your conclusions and submit the final report.
- Presentations will be in the last week of the semester

Project grade will depend on

- Originality of the idea, techniques used final-report and critical discussion.

Relationship to Student Outcomes

SOs	1	2	3	4	5	6	7
Availability	X	X	X				X

Relationship to Mechanical Engineering Program Objectives (MEPOs)

MEPO1	MEPO2	MEPO3	MEPO4	MEPO5

ABET Student Outcomes (SOs)

1	An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2	An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3	An ability to communicate effectively with a range of audiences
4	An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5	An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6	An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7	An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Updated by ABET Committee, 2021