Module (Finite Element Method - ANSYS) Catalogue

2022-2023

College/ Institute	**Erbil Technical engineering college**	
Department	**Mechanical and Energy Eng. Dept.**	
Module Name	**Finite Element Method - ANSYS**	
Module Code	**FEM704**	
Degree	**Technical Diploma** □ **Bachler** ■ **High Diploma** □ **ster** □ **PhD** □	
Semester	**7**	
Qualification	**PhD**	
Scientific Title	**Assistant Professor**	
ECTS (Credits)	**5**	
Module type	**Prerequisite** □ **Core** ■ **Assist.** □	
Weekly hours	**4**	
Weekly hours (Theory)	**(2)hr Class**	**( )Total hrs Workload**
Weekly hours (Practical)	**(2)hr Class**	**( )Total hrs Workload**
Number of Weeks	**20**	
Lecturer (Theory)	**Assist. Prof. Dr. Younis Khalid**	

E-Mail & Mobile NO.	**younis.khdir@epu.edu.iq - 07504790685**
Lecturer (Practical)	**Mr. Bashir Eskaner Kareem**
E-Mail & Mobile NO.	**bashir.kareem@epu.edu.iq - 07501134682**
Websites	**https://academicstaff.epu.edu.iq/faculty/younis.khdir**

Course Book

Course Description	"Finite element method (FEM)" is one of numerical analytical methods to obtain an approximate solution of partial differential equations that are difficult to solve analytically. First, an object of interest is divided into elements that each has a simple shape and a finite size. Next, physical quantities (temperature, stress, etc.) of each element are approximated by a simpler equation, and then the equations for the elements are combined to construct simultaneous equations. By solving the obtained simultaneous equation under the boundary conditions of the physical quantities at surfaces of the elements, the distribution of the physical quantities over the object are obtained. Since an object is subdivided to polyhedrons, FEM can be conveniently applied to complicated-shape objects. In electron microscopy, the method is used for calculation of mechanical strength and thermal distribution, calculation of distributions of magnetic fields and electrostatic fields of magnetic lenses and electrostatic lenses, etc. In the development of lens polepieces, aberration coefficients are obtained by calculation of electron trajectories using the magnetic field distributions obtained by FEM, and then the shapes of magnetic poles are optimized.

	Basic concepts of finite element methods; element equations for basic structural elements; implementation and application of FEM in 1-D and 2-D structural analysis and heat conduction.
Course objectives	This course contributes to the following program learning outcomes: The underlying theory of the Finite Element Method and its applications will be explained and illustrated in lectures. Computational laboratory sessions will reinforce the content covered in lectures and in your personal study, and to assist you in completing the assignments, using a mathematical software package such as commercial Finite Element Method package ANSYS. • To provide the fundamental concepts of the theory of the finite element method so as to learn basic principles of finite element analysis procedure: • To develop proficiency in the application of the finite element method (modelling, analysis, and interpretation of results) to realistic engineering problems through the use of a major commercial general-purpose finite element code. • To learn the theory and characteristics of finite elements that represent engineering structures. • To learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses performed by others. • Learn to model complex geometry problems and solution techniques.
Student's obligation	Class attendance, each student should practically participate in each lecturer.
Required Learning Materials	Computer program : MS ANSYS

<table>
<tr><td rowspan="13">Evaluation</td><td colspan="2">Task</td><td>Weight (Marks)</td><td>Due Week</td><td>Relevant Learning Outcome</td></tr>
<tr><td colspan="2">Paper Review</td><td></td><td></td><td></td></tr>
<tr><td rowspan="6">Assignments</td><td>Homework</td><td>5%</td><td>4,6</td><td></td></tr>
<tr><td>Class Activity</td><td>2%</td><td></td><td></td></tr>
<tr><td>Report</td><td>5%</td><td></td><td></td></tr>
<tr><td>Seminar</td><td>5%</td><td>8</td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td></td></tr>
<tr><td>Project</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Quiz</td><td>8%</td><td>5,7</td><td></td></tr>
<tr><td colspan="2">Lab.</td><td>10%</td><td>3,5,7,9,11,13</td><td></td></tr>
<tr><td colspan="2">Midterm Exam</td><td>35%</td><td>10</td><td></td></tr>
<tr><td colspan="2">Final Exam</td><td>40%</td><td>16</td><td></td></tr>
<tr><td colspan="2">Total</td><td>100%</td><td>16</td><td></td></tr>
<tr><td>Specific learning outcome:</td><td colspan="5">This course will develop your Technical Competence capability. Upon successful completion of this course, you should:
1. Be able to use the commercial Finite Element package ANSYS to build Finite Element models and solve a selected range of engineering problems.
2. Be able to validate a Finite Element model using a range of techniques.
3. Be able to communicate effectively in writing to report (both textually and graphically) the method used, the implementation and the numerical results obtained.
4. Be able to discuss the accuracy of the Finite Element solutions.
5. Students have a basic understanding of the principles and concepts related to finite element methods.
6. Students are able to implement finite element methods for simple 1-D problems such as truss analysis and 1-D heat conduction either by hand calculation or by programming.
7. Students are able to numerically solve for stresses, strains and deformation of a structural component due to axial load, torsion, and bending, acting individually or in combination.
8. Students are able to numerically solve for temperature profile and heat flux in 1-D and 2-D heat conduction problems.</td></tr>
</table>

	9. Students are able to numerically solve for stresses, strains and deformation of a structure under either plane-stress or plane strain conditions. 10. • Students are able to use commercial software package to perform structural analysis and heat transfer modeling, and are able to conduct engineering design in a team work environment.
Course References:	▪ Key references: 1. Fundamentals of Finite Element Analysis David V. Hutton. MacGrew-Hill, 2004. 2. The finite element method. volume 1,2,3. Zienkiewicz O.C, Taylor R.L., 2000. 3. Introduction to the finite element method Evgeny Barkanov., 2001 4. A First Course in the Finite Element Method Fourth Edition Daryl L. Logan. Thomson, 2007. 5. Introduction to finite elements in engineering, Tirupathi R. Chandrupatla, Ashok D. Belegundu. Pearson, 2012. 6. Textbook of finite element analysis, P. Seshu, PHI Learning Private Limited, India, 2012. 7. Finite Element Analysis theory and application with ANSYS, Saeed Moaveni, Pearson, 2015. 8. Finite Element Procedures, Klaus-jurgen Bathe. 2016. 9. ▪ Magazines and review (internet): 10. https://open.umich.edu/find/open-educational-resources/engineering/introduction-finite-element-methods 11. http://www.open.edu/openlearn/science-maths-technology/introduction-finite-element-analysis/content-section-0

Course topics (Theory)	**Week**	**Learning Outcome**
Course Content: Introduction	1	
Review of basic numerical methods	2	
Finite element analysis of 1-D problems a. axially loaded bar	3	
b. heat conduction	4	
Finite element analysis of truss structure	5	
Finite element analysis of bending beam a. Shape functions	6	
b. Element equation	7	
c. Solution procedure and methods	8	

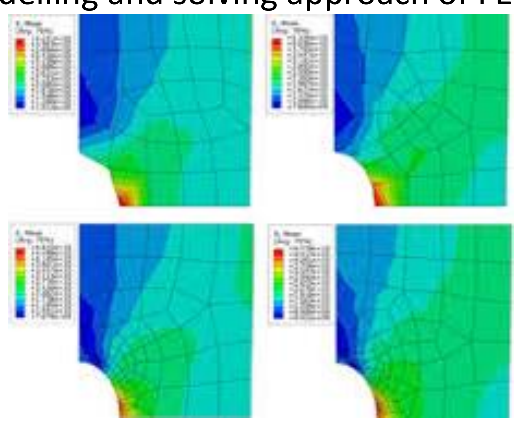
Finite element analysis of 2-D problems a. Formulation of 2-D heat conduction	9	
b. Interpolation function and 2-D elements	10	
c. Assembly of stiffness matrix	11	
d. Solution of 2-D heat conduction problems	12	
7. Finite element analysis of 2-D problems	13	
Applications in plane stress/plane strain a. Review of linear elasticity theory	14	
b. Finite element model of plane stress/plane strain	15	
8. Advanced topics	16	
Practical Topics	**Week**	**Learning Outcome**
Static Structural Analysis Stress Analysis on Static Structural Stress Analysis in simple rode simply supported beam	1	
cantilever beam Simply supported with concentration load	2	
Simply supported with distribution load Pressure on plates with and without holes Moment Analysis rotation shaft Stress Analysis on Spur Gear Stress Analysis in Table and Chair	3	
Stress analysis on transient structure	4	
Rigid Dynamic Analysis Crank slider mechanism	5	
Universal Joint analysis in Rigid dynamic	6	
Thermal Analysis Steady state thermal	7	
Temperature distribution on 2D plate Temperature distribution on 3D plate	8	
Heat transfer through composite wall Heat transfer through fins	10	

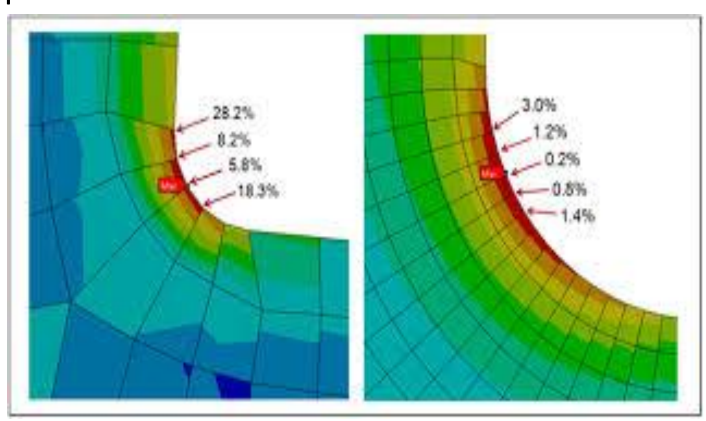
Temperature distribution with transient thermal analysis	11	
Fluid Flow (Fluent) Fluid flow - laminar Fluid flow – turbulent Fluid flow through nozzle	12	
Fluid flow through elbow Fluid flow in 3D pipe	13	
Fluid flow with heat transfer	14	
Mixing flow in pipe Mixing flow with elbow air flow through duct	15	
Computational Fluid Dynamic (CFD)	16	

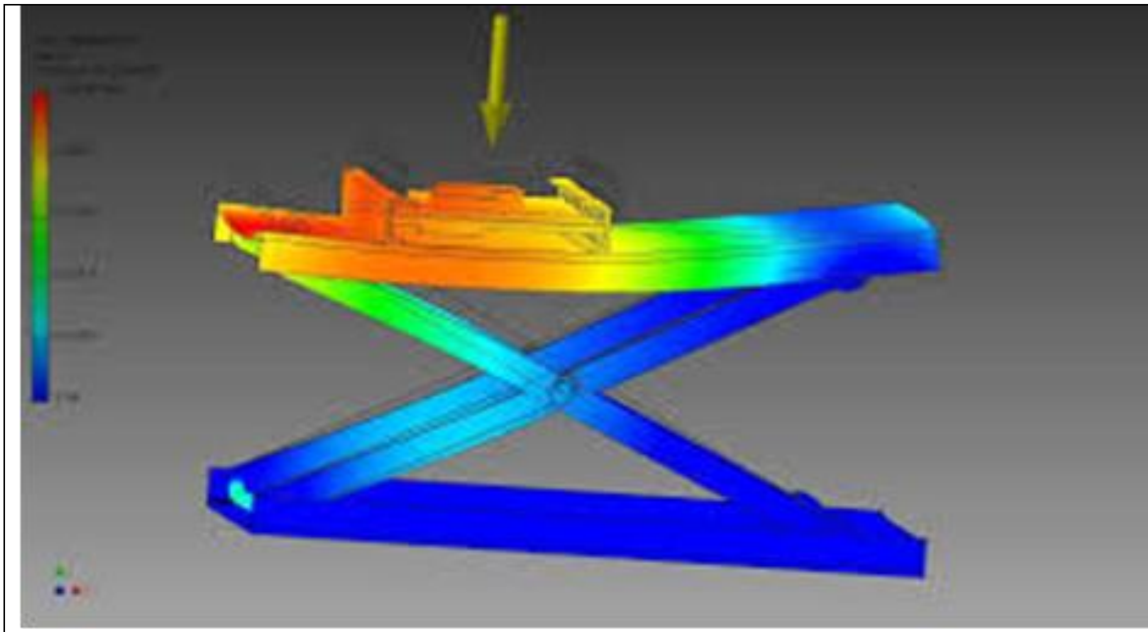
Questions Example Design

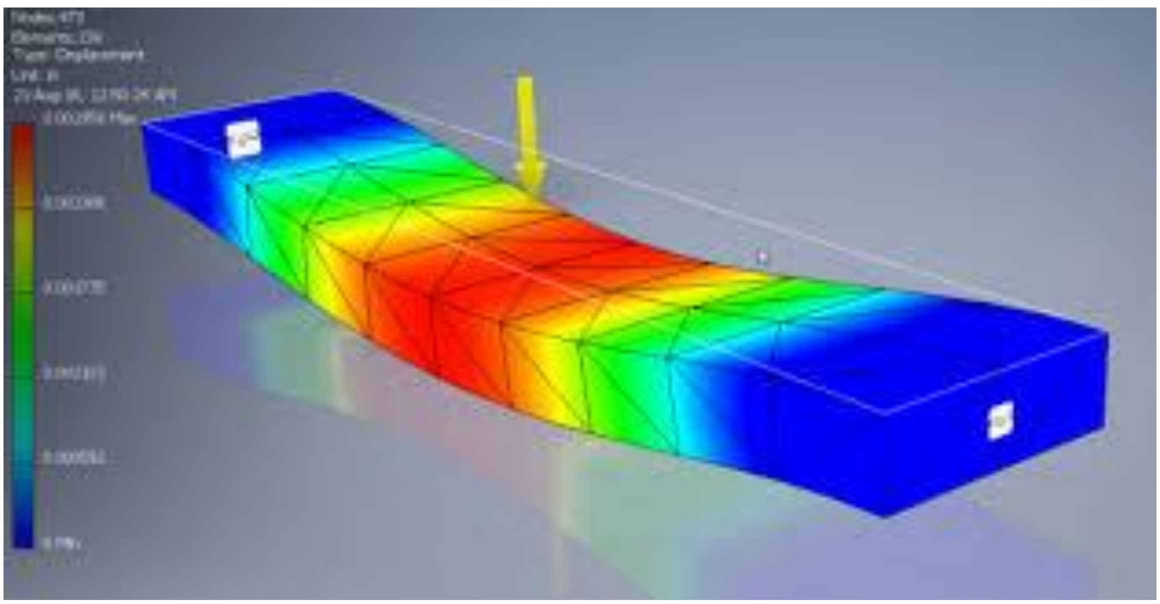
1. The finite element method (FEM) is a numerical technique for finding approximate solutions of partial differential equations (PDE) of physics and engineering by discretization of the domain of analysis into elements. The technique has very wide application, and has been used on problems involving stress analysis, fluid mechanics, heat transfer, diffusion, vibrations, electrical and magnetic fields, etc.

Modelling and solving approach of FEM



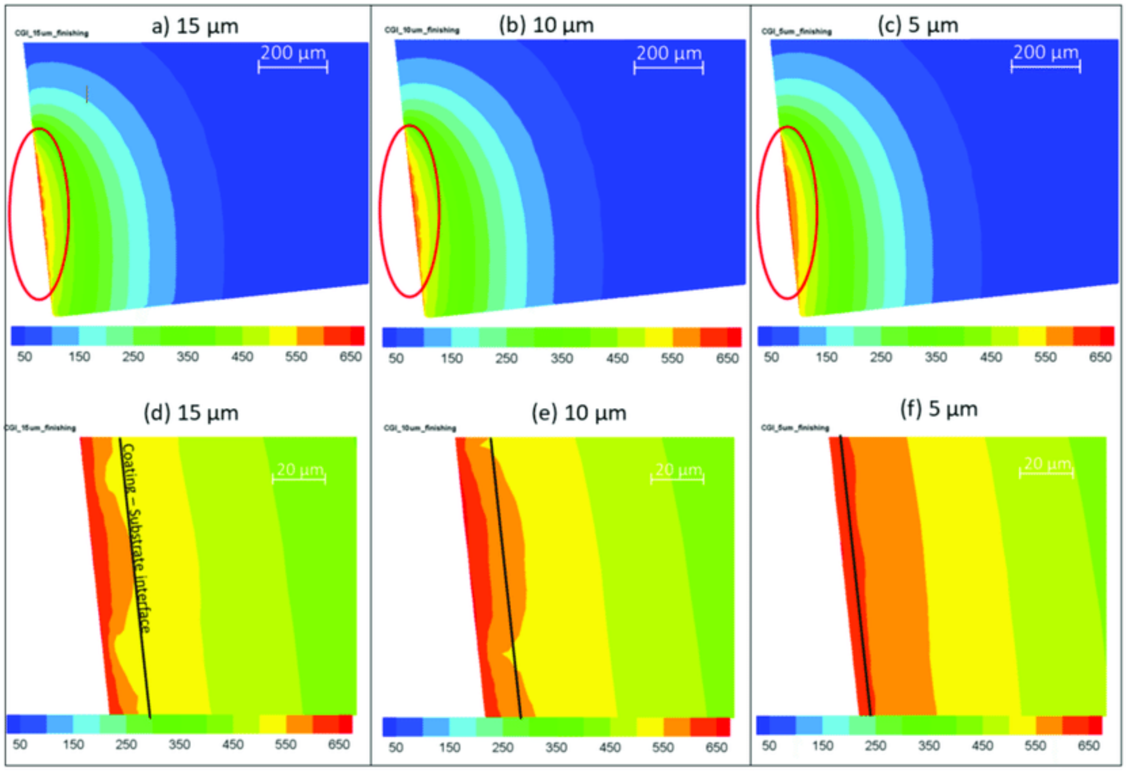






Thermal process (practical example)

Temperature distribution over a plate using ANSYS package.



Extra notes:

External Evaluator

I reviewed all the topics of the subject, it is satisfied the qualification of first semester of the Finite Element Method (ANSYS).

Assist. Prof. Dr. Gailan Ismail Hassan