



## COURSE DESCRIPTION CARD - SYLLABUS

Course name

FEM Simulations [S2ETI2>SymKompMES]

### Course

Field of study

Education in Technology and Informatics

Year/Semester

1/1

Area of study (specialization)

–

Profile of study

general academic

Level of study

second-cycle

Course offered in

Polish

Form of study

full-time

Requirements

compulsory

### Number of hours

Lecture

15

Laboratory classes

30

Other

0

Tutorials

0

Projects/seminars

0

### Number of credit points

3,00

### Coordinators

dr hab. inż. Hubert Jopek  
hubert.jopek@put.poznan.pl

### Lecturers

dr hab. inż. Hubert Jopek  
hubert.jopek@put.poznan.pl

### Prerequisites

Knowledge of linear algebra, in particular concepts such as space, transformation. Knowledge of analysis, including numerical analysis. Knowledge of mechanics and strength of materials, heat transfer and differential equations. Ability to use a mathematical apparatus to the degree required from an engineer. Understanding the essence of higher education. The ability to effectively search for valuable information on the Internet.

### Course objective

The aim of the course is to present the Finite Element Method against a wider background of numerical methods as an effective tool for solving differential equations of physics. The method is based on the problems of mechanics, which is justified for historical and educational reasons.

### Course-related learning outcomes

Knowledge:

1. has an extended and deepened knowledge of mathematics, useful for modeling and computer simulation of the course of processes, as well as the operation of devices and systems
2. knows the current state of research and development in the field of selected issues related to

functional materials, their potential applications in industry

Skills:

1. is able to use mathematical knowledge as well as analytical and simulation methods to quantify the parameters of devices and model their operation, as well as to analyze selected processes;
2. is able to choose a programming language suitable for a given programming task

Social competences:

1. can think and act in a creative and entrepreneurial way.

### Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Passing the laboratories on the basis of developing a selected engineering problem using the finite element method

Passing the lecture on the basis of a test.

Assessment criteria/assessment: in accordance with the study regulations

### Programme content

Mathematical and physical foundations necessary for finite element method (FEM) analysis, including linear spaces, coordinate system transforms, and tensor algebra. The principles of FEM, the weighted residual method, and the virtual work principle are discussed. Students learn about the process of geometry discretization, CAD/FEM data formats, and perform two-dimensional and three-dimensional analyses, with an introduction to nonlinear issues.

### Course topics

1. Przestrzenie liniowe, transformacje układów współrzędnych. Algebra tensorów. Elementy opisu mechaniki ośrodków ciągłych.
2. Wprowadzenie do MES - koncepcja, metoda residuów ważonych, rozwiązywanie układów równań algebraicznych. Zasada prac wirtualnych,
3. Dyskretyzacja geometrii. Formaty danych służące do reprezentowania geometrii w programach CAD oraz MES
4. Analiza MES zagadnień dwuwymiarowych mechaniki
5. Analiza MES dla zagadnień trójwymiarowych mechaniki
6. Wstęp do analizy nieliniowej.

### Teaching methods

1. Traditional lecture or webinar
2. Laboratory exercises: practical exercises, numerical calculations and simulations, discussion, teamwork.

### Bibliography

Basic:

1. G. Rakowski, Z. Kacprzyk, Metoda Elementów Skończonych w mechanice konstrukcji. OWPW, Warszawa 2016.
2. G.R. Liu, S.S. Queek, The Finite Element Method, Second Edition: A Practical Course. Butterworth-Heinemann, 2014.
3. Mechanika techniczna. Komputerowe metody ciał stałych, pod red. M. Kleibera, PWN, Warszawa 1995.

Additional:

1. O.C. Zienkiewicz: Metoda Elementów Skończonych. Arkady Warszawa 1972 r.
2. K.J. Bathe, Finite Element Procedures. Prentice-Hall, Inc. A Simon & Schuster Company, Englewood Cliffs, New Jersey 1996.

### Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00