Engineering Systems and Modelling

Code: MK5GRMOG05GX18-EN

ECTS Credit Points: 5

Evaluation: exam

Year, Semester: 1st spring semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+3

Topics:

Fundamentals of systems engineering, technical systems, characteristics of systems, classification of signals and systems. Fundamentals and principles of modelling. Connection between the real systems and models. Process and characteristics of mechanical modelling. Load models, material models and structural models. System models applied in control engineering, control of systems. Investigation of the modelling uncertainties, uncertainty models and its applications. Stochastic models of mechanical engineering systems. Modelling of the random effects in engineering systems. Theoretical background of Fuzzy systems and its application in the modelling of engineering systems. Fuzzy controllers. Dynamic modelling of mechanical engineering systems via finite element method. Generating the matrices of the governing equation of motion. Investigation of free and forced structural vibrations of engineering systems via finite element method. Finite element modelling of mechanical problems. Derivation of stiffness matrix, load vector and the equilibrium equation. Finite element analysis of

nonlinear problems. Handling of material and geometrical nonlinearities. Solution techniques of nonlinear problems. Finite element calculations of nonlinear elastic structures.

Literature:

Compulsory:

- Mankovits T.: Numerical Analysis of Engineering Structures (Linear Elasticity and the Finite Element Method), University of Debrecen, 2014.

Recommended:

- Bonet J., Wood E.D.: Nonlinear continuum mechanics for finite element analysis. 2nd edition. Cambridge University Press, 2008.

Schedule

1st week: Registration week	
2nd week: **Lecture:** Fundamentals of systems engineering, technical systems, characteristics of systems, classification of signals and systems. **Practice:** Practical problems related to technical systems.	**3rd week:** **Lecture:** Fundamentals and principles of modelling. Connection between the real systems and models. **Practice:** Modelling case-studies.
4th week: **Lecture:** Process and characteristics of mechanical modelling. Load models, material models and structural models. **Practice:** Mechanical modelling case-studies.	**5th week:** **Lecture:** System models applied in control engineering, control of systems. **Practice:** Generating and application of control engineering system models.
6th week: **Lecture:** Investigation of the modelling uncertainties, uncertainty models and its applications. Practice: Application of uncertainty models.	**7th week:** **Lecture:** Stochastic models of mechanical engineering systems. Modelling of the random effects in engineering systems. Practice: Application and characteristics of stochastic models.
8th week: 1st drawing week	
9th week:	**10th week:**

Lecture: Theoretical background of Fuzzy systems and its application in the modelling of engineering systems. Fuzzy controllers. **Practice:** Practical problems related to generating and application of Fuzzy systems.	**Lecture:** Dynamic modelling of mechanical engineering systems via finite element method. Generating the matrices of the governing equation of motion. **Practice:** Practical problems related to the finite element dynamic modelling. Generating the finite element models.
11th week: **Lecture:** Investigation of free and forced structural vibrations of engineering systems via finite element method. **Practice:** Practical problems related to the finite element dynamic modelling. Solution and evaluation of the finite element models.	**12th week:** **Lecture:** Finite element modelling of mechanical problems. Derivation of stiffness matrix, load vector and the equilibrium equation. **Practice:** Practical examples for the finite element modelling of engineering structures. Pre-processing, solution and post processing.
13th week: **Lecture:** Finite element analysis of nonlinear problems. Handling of material and geometrical nonlinearities. Solution techniques of nonlinear problems. **Practice:** Contact problems.	**14th week:** **Lecture:** Finite element calculations of nonlinear elastic structures. **Practice:** Finite element analysis of hyperelastic materials. **2nd test.**
15th week: 2nd drawing week	

Requirements

A, for a signature:

Attendance at lectures is recommended, but not compulsory.

Participation at practice is compulsory. Students must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't make up a practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, being discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments to the course with them to each practice class. Active participation is evaluated by the teacher in every class. If a student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

During the semester there are two tests: the 1st test in the 7th week and the 2nd test in the 14th week. Students have to sit for the tests.

B, for grade:

The course ends in an examination.

The minimum requirement of the 2 tests and the examination is respectively 50%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following (score/grade): 0-49 % = fail (1); 50-64 % = pass (2); 65-79 % = satisfactory (3); 80-89 % = good (4); 90-100 % = excellent (5). If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

An offered grade: it may be offered for students if the average grade of the two mid-term tests is at least good (4).