UNIVERSITY OF MISKOLC

Faculty of Mechanical Engineering and Informatics

MSc Programme in Mechanical Engineering

Course descriptions

Differential Equations
Origin of differential equations, ordinary and partial differential equations, classifications. Equations of first order, variables separable and reduction to variables separable. Equations of first order and first degree, linear equations and those reducible to that form. Equations of first order and first degree, exact equations and reduction to exact equations. Differential equation of a family of curves, trajectories. Homogeneous linear equations. Non-homogeneous linear equations with constant coefficients. Boundary value problems for n-th order linear differential equations. Linear and quasilinear partial differential equations. Complex numbers. Functions, limits and continuity. Complex differentiation and the Cauchy-Riemann equations. Complex integration and Cauchy's theorem. Infinite series, Taylor and Laurent series.

Theory of Elasticity
Governing equations of the linear theory of elasticity (strain-displacement relations, generalized Hooke's law, equations of equilibrium). Boundary conditions. Formulation of boundary-value problems in elasticity. Lamè-Navier's equation. Compatibility equations. Beltrami-Michell's equation. Stress functions. Principle of superposition, Clapeyron's theorem. Reciprocity relations, Betti's theorem. Incompressible materials. Equations in polar coordinates for two- and three-dimensional problems. Stresses in circular disks. Analytical solutions. Energy methods. Principle of virtual work and principle of complementary virtual work. Uniqueness of solution. Principle of minimum potential energy. Rayleigh-Ritz method. Torsion of cylindrical bars (general solutions, membrane analogy, thin-walled open and closed cross-sections). Anisotropic elastic bodies, analytical solutions. Elasticity problems of multi-layered piezoelectric beams. Application of Castigliano's theorem for piezoelectric beams.
The subject covers the fundamental principles and methods of elasticity and helps in making correct decisions in the process of engineering modelling and finite element simulations of different problems in mechanical engineering.

Materials Science
The main groups of materials: fundamental materials (metals, ceramics, polymers) and their relative importance. Basic knowledge of structure of materials: metals (special alloys); ceramic and polymer materials: crystalline and amorphous structures; main types of composites concerning their composition, structure and morphology. *Properties and application fields:* structure specific properties; technical application of monolithic and

composite materials, application oriented properties. *Mechanical behaviour:* the materials science background of mechanical behaviour, deformation mechanisms, material models; application oriented damage mechanisms according to the main groups of materials. The relationship between the structure/properties/function/processing and their interactions. Environment protection, recycling. Development trends in materials sciences.

Engineering Fluid Mechanics and Heat Transfer

General properties of fluids, surface tension, capillarity, Newton's law of viscosity. Hydrostatics, pressure variation in a fluid at rest. Thrust on submerged plane and curved surfaces. Continuity. Eulerian equation of motion. Bernoulli equation. Momentum theorem. Navier-Stokes equations. Friction losses in pipes, minor losses. Introduction to Computational Fluid Dynamics (CFD). Forms of heat transfer: conduction, convection, radiation. One-dimensional steady-state conduction in a composite wall or in cylindrical shells. Variable thermal conductivity. Convective heat transfer. Energy equation. Hydrodynamically and thermally developed laminar flow: Couette flow, flow and heat transfer in a pipe.

Environmental Management

Basic concepts of the environmental protection and the waste management. Integration of environmental protection in the environmental management. Environmental impacts of systems, processes or products. Working out and optimization for environment-friendly technologies with primary and secondary technologies. Input-output balance of material and input-output balance of energy for production and treatment technologies. Shankey diagrams. The Eco-Management and Audit Scheme (EMAS) and the ISO 14000 environment management systems and standards. Ecological and production balance. Life cycle assessment methods for innovation in the area of enviro-management. Prognoses and models with LCA analyses and the conscious application of scientific methods. The application of the new LCA software GaBi 5 and the CML 2001 method for the life-cycle impact assessment. Complex mathematical model for examination of the environment-friendly processes on the basis of load of environment, energy efficiency and economic viewpoints. Combining the different LCA software with mathematical programming languages. Analysis for Economic Input-Output Life Cycle Assessment (EIO-LCA), Life Cycle Cost (LCC) and Life Cycle Cost Analysis (LCCA) methods. New and effective solution-decision trend for chemical environment protection and for the issues of the management of wastes from chemical processes. Cost effectiveness, economical and intensity increasing in the field of environmental management.
The theoretical and the practical values of this subject: Increase the competence of the students in the section of the environmental protection, the environmental management and the green chemistry.

Project Management

This course examines project management roles and environments, the project life cycle and various techniques of work planning, and control and evaluation to achieve project objectives. The tools currently available to project managers are discussed throughout this course.
Course Objectives:
To provide a brief introduction to general issues of project management.

- To provide insights into problem solving and persuasive presentation of solutions.
- To increase awareness of how people people work as team members and as individuals.

1. Basics of project management (definitions and typology of project management)
2. Functions of project management (introduction of functions, which need to be deal with by project manager and the project team)
3. Phases of projects (definition of project phases and milestones)
4. Determination of project goals (defining accurate and measurable objectives)
5. Activities of project planning (time planning, planning of communication, risk management
6. Phases of implementation (activities in the implementation phase of projects)
7. Human resource management in projects (team forming, conditions of efficient team work
8. Project management in practice (case studies, follow up activities)

Machine Structures and Design

Significant computations to eliminate the fatigue failure. Fundamentals of design theory and methodology. Theory of three-dimensional gearing. Axoids and axes of meshing. Gear drives connecting intersecting axes. Geometrical design and manufacturing methods for bevel gears. Generating and forming processes. Strength calculation of straight and spiral bevel gears. Gears connecting nonparallel nonintersecting axes using cylindrical and bevel gears. Design of crossed helical gears. Design of hypoid gears. Types of worm gearing. Geometric calculation and manufacturing methods. Strength calculation of worm gearing.

Manufacturing Processes and Systems

Basic concepts and main characteristics of manufacturing processes and systems. The main tasks of technological design and production planning, and the relationship between them. The theoretical basis for technological design, regularities and methodology. Process and information background of technology pre-planning, operation sequence, operation and operation-element planning. Impact of the manufacturing environment to the technology planning. The modern technological procedures, tools and techniques of machinery. Types and structure of manufacturing systems. Technological, organizational and methodological fundamentals of manufacturing system design. Systems of the flexible automated manufacturing. Optimization and simulation in design of manufacturing processes and systems.

Measurement, Signal Processing and Electronics

The aim of the course is to provide up-to-date knowledge in electronics and sophisticated measurement systems and also to increase proficiency in practical implementation of the computerised measurement equipment. The course focuses to basic theories and application of computerised measurement systems, sensors and transducers, signal conditioning methods and its electronic circuits, sample & hold circuit, ADC methods and equipment. Study of multifunctional data acquisition equipment, characteristics of analogue input and output, digital I/O will be also included. Basics of signal processing will be introduced including analysis in time and frequency domain. Laboratory work aims to provide practical experience in use of sensors for measurement of electrical and non-electrical quantities also in development of control software in LabView.

Materials Handling Machines and Systems

Definition of material handling, objectives of material handling. Classification of materials handling equipment. Cranes. Trucks. Conveyors. Storage and warehousing. Basic storage equipment. The unit load concept. Productivity ratios and material handling. Basic facility location problems: single and multi-facility placement problems. Location analysis. Route

planning methods. Equipment selection, flow lines and packaging. Simulation of material handling systems. Robotised material handling.

Methodical Design

Progression of design methodology. Various design approaches, models and their quality aspects. Development of CAD systems. Ranges of the CAD, various CAxx technologies. Development flow chart of manufacturing devices. The design requirement lists. Defining functions and function structures. Methods of finding solution principles. Methods of combining and selecting solution principles. The step of designing in case of manufacturing devices, digital prototype. The design rules. The rules of production-correct design, DFM(x) requirements. Reverse-engineering design technique. Rapid-prototyping technologies. Rapid tooling technologies.

Logistics Systems

Introduction to logistics. Logistics principles and aims. Logistics tendencies and challenges. Key logistics processes and operations. Material and information flow in the logistics systems. Logistics sub-systems: procurement logistics, manufacturing logistics, distribution logistics, recycling logistics. Supply Chain management. Typical manufacturing systems and logistics services. Push and pull philosophies. JIT and Kanban principle in manufacturing and procurement. Lean manufacturing. Transportation infrastructures and operations. Principles and operations of warehousing, inventory management. Logistics costs. Logistics controlling.

Computer Aided Process Planning

Computer Aided Engineering methods in forming processes. Analysis of the technological processes from the point of view of Computer Aided Process Planning. The various methods of Computer Aided Process Planning: the variant and the generative approach. Application of knowledge based systems in the process planning of forming processes. Technological databases: development, structure and handling of technological databases. The balance of interactivity and programmed process planning (batch processing) in manufacturing processes. The documentation requirements. Connection between CAD, CAPP and CAM systems. Application of commercial CAD systems to support the tool design. The concept of Computer Integrated Manufacturing.

Materials Selection

The aim and scope of Materials Selection. The role of materials selection in fulfilling functional, technological, economic and environmental aspects in design, process planning and manufacturing processes. Effect of material properties on design and manufacturing processes, and on the reliability of engineering structures. The development and evolution of material selection procedures. The nature of the selection process. Computer Aided Materials and Process selection. Conventional and electronic material databases. Sources of information on materials. Procedures for implementing networked materials database systems. Topics of efficient data management, distribution and accessibility. Interoperability of materials databases at Intranet and Internet level. Facilitating efficient data transfer, incorporating aspects of data-pipelining from test facilities to database systems. Accessibility and

confidentiality issues of Materials Databases.

Project B
In the Project B tasks, students are dealing with a given industrial problem from a special field of the computer aided design and manufacturing. During the solution of the Project B task consultant from the industry and/or the department help, but students need to be initiative and later self-sufficient. Solution templates do not exist for the project design tasks, because each job is unique.

Degree Thesis A
In the Degree Thesis A tasks, students are self-sufficiently dealing with a given industrial problem from a special field of the computer aided design and manufacturing. During the solution of the Degree Thesis consultant from the industry and/or the department help, but students need to be initiative and later self-sufficient. Solution templates do not exist for the Degree Thesis, because each job is unique.

Probability Theory and Mathematical Statistics
To master basic concepts in probability theory, including discrete and continuous random variables and their distributions, density functions, expectations, mean, and variance. To investigate important specific discrete and continuous distributions. To understand basic sampling distribution theory and implications of the Central Limit Theorem. To continue to develop mathematical problem-solving skills and to apply these skills to the solving of application problems in probability. Know various statistical topics, such as frequency distribution, elementary probability theory including discrete and continuous probability distributions, estimation, hypothesis testing, and regression analysis. Be able to apply the gained knowledge to the solution of practical problems in civil engineering areas through evaluation and selection of appropriate statistical techniques. Be able to use statistical software, such as Statistica for Windows, to solve problems. Know how to read and interpret computer-generated statistical outputs.
Concept of probability. Conditional probability. Independence of events. Random variables, distribution, cumulative distribution function, density function. Moivre-Laplace theorem. Law of large numbers. Conditional distribution and density function. Independent random variables. Distribution of minima and maxima. Central limit theorems. Sample space. Sample, sampling methods. Monte Carlo methods. Point estimations, unbiased estimations, efficiency, consistency, sufficiency. Rao-Cramer inequality. Rao-Blackwell.Kolmogorov-theorem. Interval estimations. Hypothesis testing, uniformly best tests. Parametric and non-parametric tests. Testing homogeneity and independence. Correlation and regression analysis.

Modern Physics
The special theory of relativity and Lorentz-transformation. The basic concepts of relativistic dynamics, mass-energy equivalence. Experimental basics of quantum mechanics. Black-body radiation. Specific heat of solid objects. Photoelectric effect, the concept of photon. Compton effect. The pressure of light. Radioactivity, alpha beta and gamma decay. The measurement of radioactive decay. Rutherford experiment and

emission spectrum of gases. Bohr-model of hydrogen atom. De-Broglie hypothesis, wave-particle duality. Electron interference experiment. Heisenberg uncertainty principle. Schrödinger equation of quantum mechanics. Tunnel-effect. X-rays. Quantum optics, the theory of lasers. Nuclear interaction, binding energy. The operation of nuclear power plants.

Mechanical Vibrations

Principles of modelling dynamical systems. Centric and eccentric impact of rigid bodies, the Maxwell-diagram. Modelling of mechanical vibrations, methods for the derivation and solution of the equations of motion. Vibrating systems with one degree of freedom (free vibrations, forced vibrations, damped free- and forced vibrations). Vertical vibrations of machine foundations. Active systems of vibration protections. Vibration of discrete systems with more degrees of freedom (equations of motion, natural frequencies, vibration modes). Eigenvalue-problems and their solutions, properties of the eigenvalues and eigenvectors. Vibration of continuous systems. Longitudinal, bending and torsional vibrations of elastic beams. Rayleigh-damping. Critical angular speed of rotating shafts. Laval problems. Bearing reactions of rotating shaft-bearings systems. Dynamic analysis of slider-crank mechanisms. Balancing a multi-cylinder engine. Introduction to the measurement of dynamical parameters.

The subject covers the fundamental principles and methods necessary to understand, analyse and solve different vibration problems and to make correct modelling decisions in the finite element simulations of vibrational problems in mechanical engineering.

Industrial Quality Assurance

The importance of quality in the process of product production, transportation, usage, etc. Measurability of quality, types of parameters determining of quality (quality parameters). Tasks of planning, developing and assurance of quality: analysing of information, formation of product concept, production planning, feasibility analysis, assuring of sources (machine, tool, technology, human researches), planning of inspection technology. Quality assurance of purchasing, choosing and qualification of deliverers. Quality assurance of production processes. Quality assurance, quality protection in the process of transportation, storage, and packaging. Methods and instruments for helping quality assurance.

Advanced Materials Processing

Advanced materials processing for primary shaping. Technology of powder metallurgy, characteristic metallic, ceramic and composite products. Advanced casting processes used in machine part manufacturing. Properties and design principles of cast products. Theoretical basis of plastic deformation. Cold and hot metal forming for metallurgical purposes and machine parts manufacturing. Introduction to welding theories. The most important fusion and pressure welding processes. Thermal cutting and joining processes as relatives to welding. Heat treating processes of machinery. Heat and material transport. Annealing processes. Hardening and strengthening processes. Toughening processes. Structure and properties modification in surface layers with thermal, physical and chemical methods. Nanotechnology.

Automated Machine Tools

Definition of automation. Discrete and continuous systems, methods for describing and handling them. Basic types of controllers. Principle of Numerical Control (NC). History of NC. NC generations. Functions of NC controllers. Controlled machine functions. Geometry

of NC machine tools. Coordinate systems: machine CS, programmer's CS, tool CS. Programming methods. Structure of NC programs. Codes, programming tips. WOP in CNCs. Manufacturing cells, manufacturing systems as higher level of automation in machinery. Simulation of discreet systems (e.g. manufacturing cells): event-based simulation. Theory of interpolation. Interpolation methods. 2-3-5D interpolation.

iCAD Systems 1

Structure of the integrated CAD systems, typical features. Managing processes in iCAD environment, typical strategies. Sketching, geometrical constraints, dimensioning. Part modelling. Different modelling techniques. Surface modelling principles. Creating assemblies, assembly constraints, assembling strategies. Documenting iCAD works. Possibilities for enhancement of the designing process, managing teamwork. Portability of CAD files, compliance between CAD systems, file types and conversions. Examples from the field of designing manufacturing devices. Students re allowed to distinguish between Pro/R, CATIA and NX.

Metal Forming

Materials Science background of metal forming. Theory of plasticity. Stress state, strain state, yield conditions, stress-strain relationships. Solution methods applied in metal forming. Technology of metal forming. Sheet metal forming. Blanking, piercing, bending, deep-drawing processes. Bulk metal forming. Upsetting, bar- and rod drawing, extrusion. Machinery in metal forming. Application of CADCAM and FEM in metal forming.

iCAD Systems 2

Nowadays, different CAD/CAM solutions play a significant role in process planning of sheet metal products. In this course, first a general overview is given on CAD/CAM program systems and it will be demonstrated how these programs can help the process planning and die designer engineers' work.
By the end of this course the students will acquire the fundamental knowledge:
in various types of CAD/CAM program systems
the basic principles of their working
the main input parameters need to be given and
the main results that can be achieved by using them.
During the course two program codes used in process planning of sheet metal forming will be presented. The first one is the *Autoform FEM code*, which gives possibility of examining feasibility of process planning of sheet metal forming. The second one is *NX Sheet Metal*, which permits of planning of such parametric workpiece, which make design processing procedure faster.

NC Programming

Programming methods of NC machine tools: manual programming, WOP, computer aided programming. Advantages and disadvantages of methods. Process of computer aided NC programming. Introduction to Mastercam program. Menus, windows, bars. Machine and control definition. File handling. Importing and drawing the geometry. Editing the geometry. Coordinate systems, views. Solids, solid operations. Technological operations, handling of operation manager. Machining parameters, setup of work piece. Toolpaths in lathes and milling machines. Checking the NC program. Postprocessing, editing the NC program. Documentation, setup sheets. Examples.

Simulation of Manufacturing Devices
Functional overview of some units applied on the field machine-tools' building, such as ball bearings, slides, lathes, spindles etc. Structural, dynamic and thermal analysis of complex structures composed of units listed above, such as rotating spindles and prismatic shafts, stress concentrations, rotating shafts exposed to cyclic loading, main spindles supported by ball bearings at both ends, vibration analysis of complicated machine beds combined with loading from the cutting process of multi-edge.

Design
Definition of product. Design, development and construction. Definitions of Design. Connection of form and function, the unity of form and function. The main parts of industrial design. Design strategies. Craftsman quality and quality of mass production. Connection of product, environment and culture.

Mechatronical Modelling
Formulation of the system of equations for mechatronics system on energy basis. Energies of conservative mechatronics elements: kinetic co-energy, potential energy, magnetic energy, electric energy, magnetic co-energy, electric co-energy. Virtual works of non-conservative mechatronics elements. Extended Hamilton's principle, Lagrange differential equation of second kind. Derivation of differential equations with charge or flux formulation. Differential equations with state variables. Numerical solution of differential equations in MATLAB/SCILAB environment. Transfer function, response characteristics in the frequency domain.

Project A
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Degree Thesis B
In the Degree Thesis B tasks, students are self-sufficiently dealing with a given industrial problem from a special field of the computer aided design and manufacturing. During the solution of the Degree Thesis consultant from the industry and/or the department help, but students need to be initiative and later self-sufficient. Solution templates do not exist for the Degree Thesis, because each job is unique.

Admission requirements: Please visit: http://englishstudyprogrammes.uni-miskolc.hu

Graduation requirements:

- Students completed all the compulsory, thesis and elective course requirements.
- Students achieved a minimum of 120 ECTS credits.
- Students submitted and successfully defended a Thesis Work.
- Students fulfilled all the administrative and financial requirements towards the University

- At the end of the 2nd semester students must complete a 5-week professional practice

Application/Tuition fee: Please visit: http://englishstudyprogrammes.uni-miskolc.hu

Available Scholarship: Please visit: http://stipendium.uni-miskolc.hu

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