Military University of Technology, Warsaw, Poland
Faculty of Mechanical Engineering
Field of study: Mechanics and Machinery Design

COURSES OFFERED FOR ERASMUS+ STUDENTS IN THE ACADEMIC YEAR 2022/2023

TH – total number of teaching hours
Semester: W – Winter (23 September – 6 March), S – Summer (22 February – 7 July)

No.	Course name	Studies	Semester	TH	ECTS	Form of credit	Lecturer	Teaching unit
1	PROGRAMMABLE CONTROL OF MECHATRONICS SYSTEMS	M.Sc.	W	30	4	Pass	A. Typiak	IRMD
2	FUNDAMENTALS OF MACHINERY DESIGN 1	B.Sc.	W	34	4	Exam	J. Torzewski	IRMD
3	FUNDAMENTALS OF MACHINERY DESIGN 2	B.Sc.	S	30	3,5	Exam	J. Torzewski	IRMD
4	HYDRAULICS SYSTEMS FOR MOBILE APLICATIONS	B.Sc.	W	45	5,5	Pass	M. Łopatka	IRMD
5	FUNDAMENTALS OF FLUID MECHANICS	B.Sc.	S	30	4	Pass	A. Rubiec	IRMD
6	3D DESIGN IN CATIA	B.Sc.	S	45	4	Pass	K. Cieślik	IRMD
7	DYNAMICS SIMULATIONS WITH MULTIBODY SOFTWARE	B.Sc.	S	44	4	Pass	A. Rubiec	IRMD
8	ASSEMBLY DESIGN IN CATIA	B.Sc.	S	45	4	Pass	M. Przybysz	IRMD
9	CONSTRUCTION AND EARTHMOVING EQUIPMENT	B.Sc.	S	44	4	Pass	M. Łopatka	IRMD
10	THEORY OF LAND LOCOMOTION	B.Sc.	S	44	4	Pass	M. Łopatka	IRMD
11	DESIGN OF ROBOTS MANIPULATORS AND CONSTRUCTION EQUIPMENT ATTACHMENTS	B.Sc.	S	45	4	Pass	P. Krogul	IRMD
12	ALTERNATIVE PROPULSION SYSTEMS	B.Sc./M.Sc.	W	30	3,5	Exam	L. Szczęch	IVT

13	HYBRID AND ELECTRIC PROPULSION SYSTEMS	B.Sc./M.Sc.	S	30	4	Exam	F. Polak	IVT
14	ENGINES OF MECHANICAL VEHICLES	B.Sc./M.Sc.	S	30	4	Exam	L. Szczęch	IVT
15	COMBUSTION ENGINES AND HYBRID PROPULSION SYSTEMS	B.Sc.	W/S	48	6	Pass	F. Polak	IVT
16	HYBRID AND ELECTRIC VEHICLES MAINTENANCE AND SAFETY	B.Sc./M.Sc.	W/S	20	2,5	Pass	F. Polak	IVT
17	BASICS OF PRACTICAL METROLOGY	B.Sc.	W/S	30	4	Pass	A. Trzeciak	IVT
18	INTRODUCTION TO DIGITAL MEASUREMENTS	M.Sc.	W/S	30	4	Pass	A. Trzeciak	IVT
19	CONSTRUCTION OF MILITARY VEHICLES	B.Sc./M.Sc.	W	30	3,5	Exam	K. Papliński	IVT
20	CONSTRUCTION AND OPERATION OF STABILISERS AND FCS	B.Sc./M.Sc.	S	20	2,5	Pass	K. Papliński	IVT
21	INTRODUCTION TO DYNAMICS AND CONTROL SYSTEMS OF AUTOMOBILES	B.Sc./M.Sc.	W	30	3,5	Pass	D. Żardecki	IVT
22	INTRODUCTION TO AUTOMATICS AND ROBOTICS	B.Sc./M.Sc.	S	30	3,5	Pass	D. Żardecki	IVT
23	MECHANICAL VIBRATIONS	B.Sc.	W	30	4	Pass	Z. Hryciów	IVT
24	DEVICES FOR TRANSPORT AND DISTRIBUTION OF SERVICE FLUIDS	B.Sc./M.Sc.	W/S	30	4	Pass	K. Gocman	IVT
25	MICRO- AND NANOTRIBOLOGY	B.Sc./M.Sc.	S	20	2,5	Pass	K. Gocman	IVT
26	FUNDAMENTALS OF TRIBOLOGY	B.Sc.	W	30	4	Exam	T. Kałdoński	IVT
27	ENGINEERING MECHANICS 1	B.Sc.	W	36	4	Pass	Ł. Mazurkiewicz	IMCE
28	ENGINEERING MECHANICS 2	B.Sc.	S	42	4,5	Pass	P. Baranowski	IMCE
29	STRENGTH OF MATERIALS 1	B.Sc.	W	36	4	Pass	P. Szurgott	IMCE
30	STRENGTH OF MATERIALS 2	B.Sc.	S	42	4,5	Exam	R. Gieleta	IMCE
31	NUMERICAL METHODS FOR ENGINEERS	B.Sc.	W/S	44	5,5	Pass	E. Szymczyk	IMCE
32	FEM AND SIMULATION OF LINEAR PROBLEMS OF MECHANICS	B.Sc./M.Sc.	W	44	5,5	Pass	W. Krasoń	IMCE
33	MULTIBODY SIMULATION IN MECHANICAL ENGINEERING	B.Sc. /M.Sc.	S	36	4	Pass	W. Krasoń	IMCE

34	FUNDAMENTALS OF VALIDATION OF NUMERICAL MODELS	B.Sc.	W/S	30	4	Pass	G. Sławiński	IMCE
35	NUMERICAL MODELLING OF MATERIALS	B.Sc.	S	30	4,5	Pass	D. Miedzińska	IMCE
36	COMPUTER-BASED FATIGUE CALCULATIONS	M.Sc.	W	30	4	Pass	A. Leski	IMCE

Teaching units:
IRMD – Institute of Robots and Machine Design
IVT – Institute of Vehicles and Transportation
IMCE – Institute of Mechanics and Computational Engineering

Language, level: English, B2

Subject:	**PROGRAMMABLE CONTROL OF MECHATRONICS SYSTEMS**
Faculty:	Mechanical Engineering
Department:	Institute of Robots and Machine Design

Studies:	Language:
M.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	30	14/+	—	16/+	—	—
ECTS points				**4**		

Author(s): prof. Andrzej TYPIAK
Leading lecturer: prof. Andrzej TYPIAK

CONTENTS

Introduction to PLCs. Hardware configuration of PLCs. Communication in the PLC system. Representation of input data. Graphical and textual programming languages.

EFFECTS OF EDUCATION

The student has basic knowledge of computer architecture and methodology and techniques of programming.
The student knows the basics of programming controllers to the extent necessary to design digital control systems used in power equipment.
The student is able to formulate the algorithm and use low-level languages for programming controllers working in the energy systems.

PRECEDING COURSES

Subject:	**FUNDAMENTALS OF MACHINERY DESIGN 1**
Faculty:	Mechanical Engineering
Department:	Institute of Robots and Machine Design

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	34	16/x	18/+	—	—	—
ECTS points				**4**		

Author(s): dr Janusz TORZEWSKI
Leading lecturer: dr Janusz TORZEWSKI

CONTENTS

Fatigue strength, definitions, determining of fatigue strength. Checking calculations, determining a real factor of safety. Design of mechanical elements. Permanent joints, kind of joints, calculation of riveted joints. Welded joints, types, computational dimensions of joints, calculating joints at fixed and variable loadings. Screw joints, thread contour, standardization, forces operating in the screw joint, strength calculations of screws and the thread. Elastic joints: types of joints, calculation of basic dimensions, strength calculations. Pin joints: classification, principles of design engineering.

EFFECTS OF EDUCATION

To teach about:
Influence of loadings on the machine elements, fatigue strength, design methodology, to introduce the calculation and selection of several specific machine elements that are fundamental to a wide range of engineering.
To acquaint with:
• selection of engineering materials for specific machine elements;
• calculation of various machine elements;
• scope of available technologies to the designer.

PRECEDING COURSES

Engineering Graphics, Strength of Materials, Engineering Materials in Mechanical Engineering, Manufacturing Techniques and Mechanics

Subject:	**FUNDAMENTALS OF MACHINERY DESIGN 2**
Faculty:	Mechanical Engineering
Department:	Institute of Robots and Machine Design

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	30	16/x	14/+	—	—	—
ECTS points				**3,5**		

Author(s): dr Janusz TORZEWSKI
Leading lecturer: dr Janusz TORZEWSKI

CONTENTS

Axles and shafts: classification, principles of design and shaping axles and shafts, strength calculations. Clutches, types of clutches (couplings): rigid couplings, flexible couplings, friction clutches, calculating basic dimensions of clutches. Rolling bearings: standardization and division of bearings, load distribution in rolling bearing, durability and capacity of roller bearings, an assortment of rolling bearings, principles of assembling of bearings. Slide bearings: classification, types of friction in bearings, distribution of pressures on the circumference of shaft neck in case of semi-dry friction. Belt and chain transmission, structure, calculations, selection. Toothed gears: division, meshing laws, tooth cycle, conjugate tooth profile, tooth contact ratio. Basic rack tooth profile, transitional line of tooth flank, limiting the number of teeth, correction of teeth. Strength calculations of gear transmissions. Equivalent loads. Bending calculation, surface strength calculation, thermal calculation.

EFFECTS OF EDUCATION

To teach about:
Design and manufacture of mechanical elements in machine building. Strength calculations using computer-aided design of machines.
To acquaint with:
• design basis of selected parts and assemblies of machines,
• determining the design features of the machine systems through design,
• use the knowledge base in engineering design

PRECEDING COURSES

Engineering Graphics, Engineering Materials in Mechanical Engineering, Manufacturing Techniques and Mechanics

Subject:	**HYDRAULICS SYSTEMS FOR MOBILE APPLICATIONS**
Faculty:	Mechanical Engineering
Department:	Institute of Robots and Machine Design

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	45	18/+	18/+	9/+	—	—
ECTS points				**5,5**		

Author(s): dr Marian ŁOPATKA
Leading lecturer: dr Marian ŁOPATKA

CONTENTS

Basics of hydrostatics and hydrodynamics. Functional diagrams. Displacement pumps and motors – construction and characteristic. Hydraulic cylinders. Working liquids. Filtration. Design of power hydrostatic drives. Hydrostatic systems control. Hydrokinetic elements – construction and characteristic, criteria of choice.

EFFECTS OF EDUCATION

Theoretical knowledge of processes and phenomena proceeding in hydraulic systems, construction of elements used in hydraulic drives and control systems and maintenance principles of hydraulic drives and control systems in mobile applications.
Practical skill in designing simple hydraulic systems for mobile applications and choosing hydraulic elements, filtration systems and working liquids.

PRECEDING COURSES

Theory of Machines, Mechanics, Vehicles Engineering.

Subject:	**FUNDAMENTALS OF FLUID MECHANICS**
Faculty:	Mechanical Engineering
Department:	Institute of Robots and Machine Design

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	30	14/+	8/+	8/+	—	—
ECTS points				**4**		

Author(s): dr Arkadiusz RUBIEC
Leading lecturer: dr Arkadiusz RUBIEC

CONTENTS

Introduction to fluid mechanics. Properties of fluids. Pressure and fluid statics. Hydrostatic forces acting on the plane. Buoyancy and stability of floating bodies. Euler equation. Conservation of mass. Bernoulli principle. Impact of Jet apparatus. Vapour pressure and cavitation. Navier – Stokes equation. Flow in pipes. Reynold's number. Laminar and turbulent flow. Bernoulli principle modification for viscous fluids. Losses in pipes. Introduction to flow over bodies.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:
• The origin and meaning of fluid mechanics,
• Theoretical description and analysis of pressure and hydrostatic forces,
• Basic knowledge and investigation methods of stability of floating bodies,
• Theoretical description of energy conservation principle in fluids,
• Theoretical knowledge about viscous fluids flow in pipes and its investigation methods.

PRECEDING COURSES

Mathematics, Physics, Mechanics of solids.

Subject:	**3D DESIGN IN CATIA**
Faculty:	Mechanical Engineering
Department:	Institute of Robots and Machine Design

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	45	5/+	—	40/+	—	—
ECTS points				**4**		

Author(s): dr Karol CIEŚLIK
Leading lecturer: dr Karol CIEŚLIK

CONTENTS

Working principles in the CATIA software. CATIA Sketch chosen functions. CATIA Part Design chosen function. Modelling solid objects using a Sketch. Modelling solid objects by modifying the 3D model. Hybrid modelling. Analysis of model correctness. Creating technical documentation based on the 3D model.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:
• Created and modelling 3D parts,
• Possibilities of using software for designing and modelling elements,
• Rules for creating technical documentation,
• Modeling of 3D parts based on technical documentation.

PRECEDING COURSES

Mathematics, Engineering graphics, Knowledge of norms regulating the principles of reflecting technical objects in drawings.

Subject:	**DYNAMICS SIMULATIONS WITH MULTIBODY SOFTWARE**
Faculty:	Mechanical Engineering
Department:	Institute of Robots and Machine Design

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	44	10/+	—	14/+	20/#	—
ECTS points				**4**		

Author(s): dr Arkadiusz RUBIEC
Leading lecturer: dr Arkadiusz RUBIEC

CONTENTS

The theoretical background of machine dynamics. Degrees of freedom. Lagrange vs d'Alembert methods. Principles of modelling using multibody software. Simplifying assumptions. Multibody model structure. Global and local coordinates systems. Adding parts (geometry and mass properties). Joints modelling (ideal and with friction). Joint and general motions. Applied forces and torques modelling. Flexible connections between parts (translational and rotational with linear and nonlinear characteristics). Design variables and local measures. Numerical step size setting. Simulations and results analysis.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:
• Meaning of dynamics,
• Principles of machine dynamics modelling,
• Theoretical knowledge about equations of motion,
• Basic knowledge and investigation methods of dynamics simulations using Multibody software,
• Simulations results analysis,
• Practical use of multibody software in the machinery design process.

PRECEDING COURSES

Mathematics, Physics, Mechanics of solids, Fundamentals of tribology, Fundamentals of machinery dynamics.

Subject:	**ASSEMBLY DESIGN IN CATIA**
Faculty:	Mechanical Engineering
Department:	Institute of Robots and Machine Design

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	45	5/+	—	40/+	—	—
ECTS points				**4**		

Author(s): dr Mirosław PRZYBYSZ
Leading lecturer: dr Mirosław PRZYBYSZ

CONTENTS

Creating 3D parts. Creating of assembly. Kinematic analysis of mechanisms. Simulation of mechanism movement. Analysis of structural strength. Creating technical drawings.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:
• Creating mechanism assemblies;
• Analysis of mechanism kinematics and working range;
• FEM analysis in Catia v5.

PRECEDING COURSES

Mathematics, Physics, Mechanics, Strength of materials, Construction materials in mechanical engineering, Manufacturing technologies, Basics of machine design, Computer-aided design CAD.

Subject:	**CONSTRUCTION AND EARTHMOVING EQUIPMENT**
Faculty:	Mechanical Engineering
Department:	Institute of Robots and Machine Design

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	44	16/+	4	16/+	—	8/+
ECTS points				**4**		

Author(s): dr Marian ŁOPATKA
Leading lecturer: dr Marian ŁOPATKA

CONTENTS

Soil and ground properties. Tracked and wheeled tractors' construction and performance. Construction and operation of bulldozers, loaders, graders, scrapers, excavators, hauliers and cranes. Calculation of loads and main parameters of construction and earth-moving equipment. Chosen problems of research and development. Productivity and efficiency of operation. Estimation of operation cost.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:
- Soil and ground properties,
- Construction of tractors and attachments,
- Driveline selection,
- Methods of operational loads determining,
- Methods of operational cost estimation.

PRECEDING COURSES

Mathematics, Physics, Mechanics, Strength of materials, Fluid mechanics, Construction materials in mechanical engineering, Metrology, Manufacturing technologies.

Subject:	**THEORY OF LAND LOCOMOTION**
Faculty:	Mechanical Engineering
Department:	Institute of Robots and Machine Design

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	44	16/+	12	8/+	—	8/+
ECTS points				**4**		

Author(s): dr Marian ŁOPATKA
Leading lecturer: dr Marian ŁOPATKA

CONTENTS

Mechanics of tracks and pneumatics tires. Traction, grade and rolling resistance – motion limitation. Drivelines of vehicles. Construction and calculation of steering systems of tracked and wheeled vehicles. Vehicle stability. High mobility demand. Estimation of ground pressure and terrain mobility. Construction of wheeled and tracked gear systems. Gear system selection. Engine and transmission selection. Pulling power and efficiency. Stability of movement. Vehicle ride models.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:
- Mechanics of wheels and tracks,
- Construction and properties of gear systems,
- Selection of engine and driveline,
- High mobility demand,
- Vehicle modelling.

PRECEDING COURSES

Mathematics, Physics, Mechanics, Strength of materials, Fluid mechanics, Construction materials in mechanical engineering, Metrology, Manufacturing technologies.

Subject:	**DESIGN OF ROBOTS MANIPULATORS AND CONSTRUCTION EQUIPMENT ATTACHMENTS**
Faculty:	Mechanical Engineering
Department:	Institute of Robots and Machine Design

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	45	10/+	—	—	35/#	—
ECTS points				**4**		

Author(s): dr Piotr KROGUL
Leading lecturer: dr Piotr KROGUL

CONTENTS

Design basics of robot manipulators and construction equipment attachments. Chosen problems of a drive system design of robots manipulators and construction equipment attachments. Analytical and computer design methods of robot manipulators and construction equipment attachments (MSC Adams, Catia V5, Easy 5). Strength analysis in the design process of robot manipulators and construction equipment attachments with the use of the finite element method. Kinematic design of robots manipulators and construction equipment attachments.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:
• Design basics of robots manipulators and construction equipment attachments,
• Chosen problems of a drive system design of robots manipulators and construction equipment attachments,
• Analytical and computer design methods of robots manipulators and construction equipment attachments (MSC Adams, Catia V5, Easy 5),
• Strength analysis in the design process of robots manipulators and construction equipment attachments with the use of the finite element method,
• Kinematic design of robot manipulators and construction equipment attachments.

PRECEDING COURSES

Mathematics, Physics, Mechanics, Strength of materials, Fluid mechanics, Construction materials in mechanical engineering, Service fluids.

Subject:	**ALTERNATIVE PROPULSION SYSTEMS**
Faculty:	Mechanical Engineering
Department:	Institute of Vehicles and Transportation

Studies:	Language:
B.Sc./M.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	30	16/x	8/+	6/+	—	—
ECTS points				**3,5**		

Author(s): dr Filip POLAK
Leading lecturer: dr Leszek SZCZĘCH

CONTENTS

Alternative propulsion systems – introduction. Alternative fuels for automotive applications. Hydrogen storage systems. Jet propulsion and rotary engines. Hybrid vehicle parameters and characteristics. Electric engine parameters and characteristics. Fuel cells in vehicles. Hydrogen-powered vehicles. Matching propulsion system to a vehicle. Energy storage systems. Matching battery to a vehicle. Electrical HV safety during vehicle maintenance. Ecological problems of alternative propulsion systems.

EFFECTS OF EDUCATION

To teach:
• construction of hybrid vehicles;
• construction of electric vehicles;
• fuel cells in vehicles and hydrogen storage systems.
To acquaint with:
• matching engine to a vehicle;
• matching battery to a vehicle.

PRECEDING COURSES

Fundamentals of machine dynamics, Fundamentals of machine structures, Construction and operation of internal combustion engines, Theory of internal combustion engines.

Subject:	**HYBRID AND ELECTRIC PROPULSION SYSTEMS**
Faculty:	Mechanical Engineering
Department:	Institute of Vehicles and Transportation

Studies:	Language:
B.Sc./M.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	30	16/x	8/+	6/+	—	—
ECTS points				**4**		

Author(s): dr Filip POLAK
Leading lecturer: dr Filip POLAK

CONTENTS

Hybrid and electric propulsion systems – introduction. Hybrid vehicle parameters and characteristics. Electric engine parameters and characteristics. Fuel cells in vehicles. Hydrogen storage systems. Matching propulsion system to a vehicle. Energy storage systems. Matching battery to a vehicle. Charging systems. Electrical infrastructure for electric vehicles. Electrical HV safety during vehicle maintenance. Ecological problems of alternative propulsion systems.

EFFECTS OF EDUCATION

To teach:
• construction of hybrid vehicles;
• construction of electric vehicles;
• construction of charging systems;
• fuel cells in vehicles and hydrogen storage systems.
To acquaint with:
• matching engine to a vehicle;
• matching battery to a vehicle.

PRECEDING COURSES

Fundamentals of machine dynamics, Fundamentals of machine structures, Construction and operation of internal combustion engines, Theory of internal combustion engines, Theory of electric engines.

Subject:	**ENGINES OF MECHANICAL VEHICLES**
Faculty:	Mechanical Engineering
Department:	Institute of Vehicles and Transportation

Studies:	Language:
B.Sc./M.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	30	16/x	6/+	8/+	—	—
ECTS points				**4**		

Author(s): dr Leszek SZCZĘCH
Leading lecturer: dr Leszek SZCZĘCH

CONTENTS

Working cycles of internal combustion engines. Internal and external combustion engines. The ideal air standard Otto, Diesel and dual (Sabathe or Seiliger) cycles. Comparison between thermodynamic and mechanical cycles. Indicator diagram of two and four-stroke engines. Engines parameters and characteristics. Engine performance parameters. Engine power. Engine efficiency. Comparison parameters of the engine. Engine heat balance. Parameters of air-fuel (A/F) ratio mixture. Carburettor and injection A/F mixture creation. A/F mixture ignition and combustion. Stages of combustion of a homogeneous mixture. Abnormal combustion – knocking. Factors affecting abnormal combustion. Fuel feeding in CI (compression ignition - diesel) engines. Creating of A/F mixture in CI engines. Fuel injection parameters. CI engine control. Stages of combustion of a heterogeneous mixture. Process of Self-ignition. Combustion chambers of CI engines. Governors function in CI engines. Construction of mechanic and electronic governors. Governor tasks in CI engines. Fuel dose correction. Air feeding of internal combustion engines. Engine charging. Induction and exhaust process in naturally-aspirated and forced inducted engines. Mechanical-charging and turbo-charging. Resonance charging. Ecological problems of IC engine work. Toxic components exhaust gases. Assessment methods for toxic emissions. Catalysts and exhaust filters. Noise.

EFFECTS OF EDUCATION

To teach:
• construction of main engine components;
• methods of finding of engine main parts load.
To acquaint with:
• matching engine to a vehicle.

PRECEDING COURSES

Fundamentals of machine dynamics, Fundamentals of machine structures.

Subject:	**COMBUSTION ENGINES AND HYBRID PROPULSION SYSTEMS**
Faculty:	Mechanical Engineering
Department:	Institute of Vehicles and Transportation

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	48	20/+	14/+	14/+	—	—
ECTS points				**6**		

Author(s): dr Filip POLAK
Leading lecturer: dr Filip POLAK

CONTENTS

Classification of heat engines. Performance indicators of internal combustion engines. General construction and operation of internal combustion engine systems. General construction and operation of turbine engines in vehicle propulsion. Construction of piston rod systems. Construction of engine valve trains. Construction of power supply systems for spark-ignition engines. Construction of power supply systems of compression ignition engines. Construction of power supply systems. Construction of air supply, exhaust and supercharging systems. Hybrid drives. Solution of fuel cell solutions in vehicles. Electric drive systems in vehicles. Measurement of engine and drive system parameters.

EFFECTS OF EDUCATION

To teach:
• construction of main engine components;
• construction of hybrid vehicles;
• construction of electric vehicles;
To acquaint with:
• construction and assembly of main engine components.

PRECEDING COURSES

Fundamentals of machine dynamics, Fundamentals of machine structures.

Subject:	**HYBRID AND ELECTRIC VEHICLES MAINTENANCE AND SAFETY**
Faculty:	Mechanical Engineering
Department:	Institute of Vehicles and Transportation

Studies:	Language:
B.Sc./M.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	20	8/+	6/+	6/+	—	—
ECTS points				**2,5**		

Author(s): dr Filip POLAK
Leading lecturer: dr Filip POLAK

CONTENTS

Categories, types and construction of hybrid and electric vehicles. Construction of hybrid and electric powertrains of vehicles of different brands.Hazards and safe operation of hybrid and electric vehicles.
Rules of conduct during service, diagnostics and evaluation of electric and hybrid vehicles. Electrical HV safety during vehicle maintenance.

EFFECTS OF EDUCATION

To teach:
• safety procedures during maintenance of hybrid and electric vehicles;
• construction of HV systems;
• construction of batteries safety systems;
• construction of onboard safety systems;
•
To acquaint with:
• safety procedures during vehicle maintenance;
• safety rules and first aid.

PRECEDING COURSES

Fundamentals of machine structures, Construction and operation of internal combustion engines, Theory of internal combustion engines, theory of hybrid and electric propulsion systems, theory of electric engines, theory of energy storage systems.

Subject:	**BASICS OF PRACTICAL METROLOGY**
Faculty:	Mechanical Engineering
Department:	Institute of Vehicles and Transportation

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	30	12/+	12/+	6/+	—	—
ECTS points				**4**		

Author(s): Adrian Trzeciak
Leading lecturer: Adrian Trzeciak

CONTENTS

Metrology – idea and basic definitions. SI units of measurement. Value of the measured quantity. Measurement process. Measurement methods. Rules of conduct when developing the measurement result. Rules for rounding the result of calculations. Significant digits.
Measurement of geometric quantities. Callipers, micrometres, dial gauges and other mechanical gauges.
Uncertainty of direct and indirect measurement. The standard uncertainty of type A Principles of giving the measurement result. Outliers of measurement data. Expanded uncertainty. Principles of drawing up charts. Approximation and its methods.
The standard uncertainty of type B. Difference between uncertainty and error.
Uncertainty of indirect measurement.
Development of a complex measurement problem when testing an internal combustion engine.

EFFECTS OF EDUCATION

To teach:
• How to properly measure the quantity of interest;
• How to assess the measurement uncertainty;
• How to properly construct a chart;
To inform about:
• How the base SI units are defined;
• Types of basic measurement instruments

PRECEDING COURSES

Fundamentals of mathematics, Fundamentals of thermodynamics.

Subject:	**INTRODUCTION TO DIGITAL MEASUREMENTS**
Faculty:	Mechanical Engineering
Department:	Institute of Vehicles and Transportation

Studies:	Language:
M.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	30	12/+	12/+	6/+	—	—
ECTS points				**4**		

Author(s): Adrian Trzeciak
Leading lecturer: Adrian Trzeciak

CONTENTS

Types of basic measuring transducers and their applications. Properties of measuring transducers. Construction of the measuring track. Introduction to LabView. Building a simple measurement application.
Types of basic measurement signals and their properties. Continuous and discrete signals. The stages of digital processing of the measurement signal. Sinusoidal signal. Signal spectral analysis. Filtering the measurement signal. Evaluation of the degree of signal disturbance. Building a complex measurement application with the option of saving measurement data to a file.
Processing of measurement data in Excel and Matlab environment. Automation of data processing and estimation of measurement uncertainty. Automation of charting. Inference in the correctness of the obtained measurement data.

EFFECTS OF EDUCATION

To teach:
• How to properly measure the quantity of interest;
• building a digital measurement system
• building measurement app in LabView
• effective postprocessing measurement data
To inform about:
• Importance of digital measurements in everyday life
• Types of basic transducers and sensors

PRECEDING COURSES

Introduction to metrology

Subject:	**CONSTRUCTION OF MILITARY VEHICLES**
Faculty:	Mechanical Engineering
Department:	Institute of Vehicles and Transportation

Studies:	Language:
B.Sc./M.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	30	15/x	15/+	—	—	—
ECTS points				**3,5**		

Author(s): dr Krzysztof PAPLIŃSKI
Leading lecturer: dr Krzysztof PAPLIŃSKI

CONTENTS

Vehicle's basic structure (application). Modularity. Hull structure. Drive frame. Powerpack (engine, transmission, cooling unit). Power line. Braking system. Steering system. Hydraulic system. Pneumatic system. NBC and air conditioning system.

EFFECTS OF EDUCATION

To teach:
• structure of the vehicle (the basic parts);
• construction of power pack and power line;
• construction of main systems of the vehicle.
To inform about:
• main operation rules.

PRECEDING COURSES

The construction of motor vehicles, The automation.

Subject:	**CONSTRUCTION OF AND OPERATION OF STABILISERS AND FCS**
Faculty:	Mechanical Engineering
Department:	Institute of Vehicles and Transportation

Studies:	Language:
B.Sc./M.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	20	10/+	10/+	—	—	—
ECTS points				**2,5**		

Author(s): dr Krzysztof PAPLIŃSKI
Leading lecturer: dr Krzysztof PAPLIŃSKI

CONTENTS

Requirements for fire control systems. Disturbances acting on the stabilized gun. Functional diagrams of fire control systems. Design and operation of sensors and actuators used in fire control systems. Principles of operation of some fire control systems.

EFFECTS OF EDUCATION

To teach:
• main structure of fire control systems;
• main components of fire control systems;
• functional diagrams of fire control systems.
To inform about:
• main operation rules of some fire control systems.

PRECEDING COURSES

The construction of motor vehicles, The automation.

Subject: **INTRODUCTION TO DYNAMICS AND CONTROL SYSTEMS OF AUTOMOBILES**
Faculty: Mechanical Engineering
Department: Institute of Vehicles and Transportation

Studies:	Language:
B.Sc./M.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	30	20/+	10/+	—	—	—
ECTS points				**3,5**		

Author(s): prof. Dariusz ŻARDECKI
Leading lecturer: prof. Dariusz ŻARDECKI

CONTENTS

A car as an element of the Driver-Vehicle-Road system and a complex dynamical system and an object of control. A survey of methods of tests and analyses of car dynamics and control. Problems of modelling of car dynamics and control. Modelling of dynamics of vehicle motion. Modelling of actions of chosen car subsystems. Modelling of driver dynamics. Complex modelling of a dynamics of the Driver-Vehicle-Road system. Reference models for controllers for car automatic systems. Synthesis of algorithms for chosen car automatic systems. Problems of dynamics and control of autonomic cars.

EFFECTS OF EDUCATION

To teach:
• Defining of model problems (in time/frequency domain) due to car dynamics and control.
To acquaint students with:
• Modern methods of tests and analyses of car dynamics and control.
• Control theory and control system devices due to car lateral dynamics and control.

PRECEDING COURSES

Mathematics, Physics.

Subject:	**INTRODUCTION TO AUTOMATICS AND ROBOTICS**
Faculty:	Mechanical Engineering
Department:	Institute of Vehicles and Transportation

Studies:	Language:
B.Sc./M.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	30	20/+	6/+	4/+	—	—
ECTS points				**3,5**		

Author(s): prof. Dariusz ŻARDECKI
Leading lecturer: prof. Dariusz ŻARDECKI

CONTENTS

General information about automatics and robotics (the idea of open / closed-loop control, SISO / MIMO structures, control/sensor devices, history and nowadays). Methods of modelling of linear/non-linear elements and systems (equations, characteristics, Laplace / Fourier transformations, transfer functions, schematic diagrams and their simplifications). Static and dynamic properties of elements and systems (time/frequency characteristics of elements, simplified analysis of systems with using characteristics of elements). Classic control systems and their elements (regulators and correctors, input/output devices). Analysis of control systems in time/frequency domain (stability, indexes, sensitivity). Modern control systems (optimal / adaptive / robust control, digital processing, mechatronic input / output devices). Automatics for complex systems and processes (the hierarchical idea of control, universal controllers, computers and networks in automatics). Example applications of control systems and automatics (car, central heating, etc.). Robots and manipulators – general description (mechanical structures, problems of kinematics, dynamics and steering, programming by computer). Robots and manipulators in different branches (industry, science, medicine, military).

EFFECTS OF EDUCATION

To teach:
• defining of control tasks and systems, modelling of systems in time/frequency domains, carrying out of control system analysis.
To acquaint students with:
• control theory, control system devices, robots and manipulators, applications of automatics and robotics.

PRECEDING COURSES

Mathematics, Physics.

Subject:	**MECHANICAL VIBRATIONS**
Faculty:	Mechanical Engineering
Department:	Institute of Vehicles and Transportation

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	30	14/+	8/+	8/+	—	—
ECTS points				**4**		

Author(s): dr Zdzisław HRYCIÓW
Leading lecturer: dr Zdzisław HRYCIÓW

CONTENTS

Fundamental concepts in vibration and modelling: Introduction to modelling and analysis, Introduction to mechanical vibration, Harmonic motion, Lagrange's equations. Free vibration of single degree of freedom systems: Undamped vibration, Simple harmonic motion, Damped vibration. Forced harmonic excitation of single degree of freedom systems: Undamped vibration, Damped vibration, Base excitation, Rotating unbalance, Coulomb damping. The vibration of multi-degree of freedom systems: Free undamped vibration, Eigenvalue problem, Free damped vibration, Forced vibration, Resonance. Reduction of vibrations: Vibration isolation, Transmissibility, Isolation Efficiency, Passive and active isolation systems. Influence of spring stiffness and damping coefficient on reduction an amplitude of vibration or force transmitted by an object. Shaft vibration. The critical speed of the shaft. Vibration estimation: Frequency-domain methods, Evaluation of human exposure to whole-body and hand-transmitted vibrations. The use of simulation programs (MATLAB – Simulink) for dynamic analysis.

EFFECTS OF EDUCATION

This course is an introduction to the dynamics and vibrations of lumped-parameter models of mechanical systems. After this course, students will be able to: evaluate free and forced vibration of linear multi-degree of freedom models of mechanical systems and matrix eigenvalue problems, solve basic problems of vibration isolations and estimate the level of vibrations.

PRECEDING COURSES

Mathematics 1, Mathematics 2, Engineering Mechanics 1

Subject:	**DEVICES FOR TRANSPORT AND DISTRIBUTION OF SERVICE FLUIDS**
Faculty:	Mechanical Engineering
Department:	Institute of Vehicles and Transportation

Studies:	Language:
B.Sc./M.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter/Summer	30	15/+	8/+	5/+	—	2/-
ECTS points				**4**		

Author(s): dr Krzysztof GOCMAN
Leading lecturer: dr Krzysztof GOCMAN

CONTENTS

Characteristic of automotive, rail and pipeline transport of oil products. Regulations concerning devices for transport and distribution of service fluids. Construction and maintenance characteristic of railroad tank cars for the transport of fuels and oil products. Construction and maintenance characteristic of tank trucks for transport and distribution of fuels. Pipeline transport of crude oil and fuels. Characteristic of pumps used in devices for transport and distribution of service fluids. Characteristic of pumping assemblies. Characteristic of flow-meters, and nozzles used in devices for transport and distribution of service fluids. Maintenance of devices for transport and distribution of service fluids. Development tendencies of devices for transport and distribution of service fluids.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:
- Basic principles of construction of devices for transport and distribution of service fluids.
- Basic maintenance characteristic of devices for transport and distribution of service fluids.
- Regulations concerning devices for transport and distribution of service fluids.
- Basic principles of maintenance of devices for transport and distribution of service fluids.
- Safety, health, environment and fire protection in transport and distribution of service fluids.

PRECEDING COURSES

Construction materials in mechanical engineering, Construction of motor vehicles, Service fluids, Construction of fuel bases and filling stations.

Subject:	**MICRO- AND NANOTRIBOLOGY**
Faculty:	Mechanical Engineering
Department:	Institute of Vehicles and Transportation

Studies:	Language:
B.Sc./M.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	20	10/+	—	6/+	—	4/-
ECTS points				**2,5**		

Author(s): dr Krzysztof GOCMAN
Leading lecturer: dr Krzysztof GOCMAN

CONTENTS

Origin, meaning and development of micro/nanotribology. Microtribological and nanotribological systems (MEMS, NEMS, MSD). Research methods of micro/nanotribological systems (SPM, AFM, STM, SFA). The investigation of micro/nanomechanical and micro/nanotribological properties of solids and thin films (coatings). Chosen problems of biotribology.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:
- The origin and meaning of micro/nanotribology,
- Theoretical description and analysis of friction, wear and lubrication processes in micro and nanoscale,
- Methods of investigation of mechanical properties of materials in micro and nanoscale,
- Methods of investigations of friction, wear and lubrication processes in micro and nanoscale,
- Contemporary tribological problems, including micro- and nanotribology, biotribology.

PRECEDING COURSES

Mathematics, Physics, Chemistry, Mechanics, Strength of materials, Fluid mechanics, Construction materials in mechanical engineering, Metrology, Manufacturing technologies, Service fluids, Fundamentals of tribology.

Subject:	**FUNDAMENTALS OF TRIBOLOGY**
Faculty:	Mechanical Engineering
Department:	Institute of Vehicles and Transportation

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	30	16/x	—	10/+	—	4/-
ECTS points				**4**		

Author(s): prof. Tadeusz KAŁDOŃSKI
Leading lecturer: prof. Tadeusz KAŁDOŃSKI

CONTENTS

Tribology in operation and maintenance of motor vehicles and transport devices. Tribological systems of motor vehicles and transport devices. Solids and liquids as construction elements of tribological systems. Processes of friction in tribological systems. Processes of tribological wear. Lubrication in tribological systems. Methods of investigations of friction and wear. Processes of the corrosive wear of tribological couples, theoretical basics of corrosion of metals.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:
• Description and analysis of friction, wear and lubrication processes of elements of motor vehicles and transport devices.
• Methods of investigations of friction, wear and lubrication processes of elements of motor vehicles and transport devices.
• Distinguishing of sorts of friction, wear and lubrication of elements of motor vehicles and transport devices.
• Preventing of wear of elements of motor vehicles and transport devices during their operation and maintenance.

PRECEDING COURSES

Mathematics, Physics, Chemistry, Mechanics, Strength of materials, Fluid mechanics, Construction materials in mechanical engineering, Metrology, Manufacturing technologies, Service fluids

Subject:	**ENGINEERING MECHANICS 1**
Faculty:	Mechanical Engineering
Department:	Institute of Mechanics and Computational Engineering

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	36	18/+	18/+	—	—	—
ECTS points				**4**		

Author(s): prof. Jerzy MAŁACHOWSKI
Leading lecturer: dr Łukasz MAZURKIEWICZ

CONTENTS

General Principles. Units. Force Vectors. Scalars and Vectors. Vectors operations. Cartesian Vectors. Condition for the Equilibrium of a Particle. The Free-Body Diagram. Three-Dimensional Force Systems. Moment of a Force. Principle of Moments. Moment of a Force about a Specified Axis. Simplification of a Force and Couple System. Conditions for Rigid Equilibrium. Equations of Equilibrium. Constraints and Static Determinacy. Friction. Characteristics of Dry Friction. Rolling Resistance.

EFFECTS OF EDUCATION

Basic knowledge and ability to solve practical problems of statics of force systems, modelling mechanical systems, determination of static resultants. Friction problems. Static analysis of simple bar structures and mechanical systems. A student must pass one homework, three tests on exercises and one test on theory.

PRECEDING COURSES

Mathematics 1

Subject:	**ENGINEERING MECHANICS 2**
Faculty:	Mechanical Engineering
Department:	Institute of Mechanics and Computational Engineering

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	42	20/+	22/+	—	—	—
ECTS points				**4,5**		

Author(s): prof. Jerzy MAŁACHOWSKI
Leading lecturer: dr Paweł BARANOWSKI

CONTENTS

Centre of Gravity and Centre of Mass for a System of Particles. Composite Bodies. Resultants of a General Distributed Loading. Moments of Inertia. Kinematics. Continuous Motion. Erratic Motion. General Curvilinear Motion. Rigid-Body Motion. Absolute Motion Analysis. Relative-Motion Analysis. Newton's Second Law of Motion. Equations of Motion: Rectangular Coordinates Equations of Motion: Normal and Tangential Coordinates. The Work of a Force. The Work of a Couple Moment. Principle of Work and Energy. Principle of Work and Energy for a System of Particles. Conservative Forces and Potential Energy. Conservation of Energy. Principle of Linear Impulse and Momentum. Conservation of Linear Impulse for a System of Particles. Angular Momentum. The relation between Momentum of a Force and Angular Momentum. Undamped Free Vibration. Undamped Forced Vibration. Viscous Damped Free Vibration. Viscous Damped Forced Vibration.

EFFECTS OF EDUCATION

Basic knowledge and ability to solve kinematic and dynamic problems related to mass particles, rigid bodies and mechanical systems. Characterization of motion of particles and rigid bodies. Dynamic principles of mass particles systems and rigid bodies behaviour. Fundamentals of dynamics of SDOF systems. A student must pass two homeworks, four tests on exercises and a test on theory.

PRECEDING COURSES

Mathematics 1, Mathematics 2, Engineering Mechanics 1

Subject:	**STRENGTH OF MATERIALS 1**
Faculty:	Mechanical Engineering
Department:	Institute of Mechanics and Computational Engineering

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	36	18/+	18/+	—	—	—
ECTS points				**4**		

Author(s): dr Piotr SZURGOTT
Leading lecturer: dr Piotr SZURGOTT

CONTENTS

Geometrical characteristics of planar figures. Determination of reactions and internal forces in beams, plane frames and trusses. 3D orthogonal frames. Static tension test for metals. Conditions of load capacity and usability. Tension and compression of short and thick bars. Torsion of bars of the circular, ring and thin-walled cross-sections. Simple bending with the shear of bars of the rectangular, circular, ring and thin-walled cross-sections. Deflection line of bent beams.

EFFECTS OF EDUCATION

Theory and calculation methods for geometrical characteristics of planar figures, determination of reactions and internal forces in beams, plane frames, trusses and spatial frames. Fundamentals of the strength of materials. Strength analysis of machine elements in simple strength cases concerning internal forces, stress and strain. A student must pass four homeworks, four tests on exercises and one test on theory.

PRECEDING COURSES

Mathematics 1, Engineering Mechanics 1

Subject:	**STRENGTH OF MATERIALS 2**
Faculty:	Mechanical Engineering
Department:	Institute of Mechanics and Computational Engineering

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	42	20/x	16/+	6/+	—	—
ECTS points				**4,5**		

Author(s): dr Roman GIELETA
Leading lecturer: dr Roman GIELETA

CONTENTS

Spatial and plane states of stress. Spatial and plane states of strain. Hooke's law for an isotropic material. Failure theories for an isotropic material. Combined loadings. Displacements in simple beams and plane frames using the method of virtual work (the Maxwell-Mohr method). Statically indeterminate beams and plane frames - force method. Buckling of straight slender bars. Mechanical testing of materials (laboratories).

EFFECTS OF EDUCATION

The student has the knowledge on:
- state of stress and strain analysis of a deformable body,
- strength analysis of machine elements in combined loadings concerning internal forces, stresses and strains.
- determination of displacements in simple beams and plane frames using the Maxwell-Mohr method.
- determination of internal forces in statically indeterminate beams and plane frames.
- determination of critical loads in the compression of straight slender bars.

The student is acquainted with experimental testing of materials:
- tension and compression tests of ductile and brittle materials,
- creep,
- fatigue,
- impact test.

A student must pass three homeworks, four tests on exercises and an exam on theory.

PRECEDING COURSES

Mathematics 1, Engineering Mechanics 1, Strength of Materials 1

Subject:	**NUMERICAL METHODS FOR ENGINEERS**
Faculty:	Mechanical Engineering
Department:	Institute of Mechanics and Computational Engineering

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter/Summer	44	10/+	14/+	20/+	—	—
ECTS points				**5,5**		

Author(s): prof. Elżbieta SZYMCZYK
Leading lecturer: prof. Elżbieta SZYMCZYK

CONTENTS

Introduction to numerical methods and software: Matlab, Excel and FEM software. Accuracy and precision. Error analysis. Sources of errors in exemplary engineering analysis. Well and ill-conditioned problems in mechanics. Curve fitting. Interpolating polynomials. Lagrange, Hermite and spline interpolation. Application of interpolating polynomials in engineering (truss and beam deformation). Approximation methods. Linear regression. Analysis of experimental data. Introduction to numerical integration. The trapezoidal rule. Gauss quadrature. Application in engineering calculations, advantages and disadvantages. Ordinary differential equations – introduction. Explicit and implicit integration. Euler's method. Central difference scheme. Newmark scheme. Case study – numerical solution of the vibration problem. Finite element application in one dimension (beam deflection). Application of FEM and Matlab software.

EFFECTS OF EDUCATION

Theory fundamentals and skills in numerical methods and their engineering applications. To obtain a passing grade the student must be able to: independently develop 1D beam models (using FEM and Matlab software), interpolate beam deformation using shape functions, independently solve a simple 1D equation of motion, evaluate numerical results and write a short report on the features of the beam and its numerical model as well as results interpretation.

PRECEDING COURSES

Mathematics 1, Engineering Mechanics 1, Engineering Mechanics 2, Strength of Materials 1

Subject:	**FEM AND SIMULATION OF LINEAR PROBLEMS OF MECHANICS**
Faculty:	Mechanical Engineering
Department:	Institute of Mechanics and Computational Engineering

Studies:	Language:
B.Sc. / M.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	44	10/+	10/+	24/+	—	—
ECTS points				**5,5**		

Author(s): prof. Wiesław KRASOŃ
Leading lecturer: prof. Wiesław KRASOŃ

CONTENTS

Classification of linear problems of mechanics and methods for linear system analysis. Theoretical and computational aspects of finite element methods (FEM). Introduction to practical problems of linear FE analysis – typical algorithms of FE linear analysis. Examples from areas of linear elasticity, structural mechanics and design of machine components. Basic relations in FE analysis of truss structures. Spring elements-stiffness matrices. 2D and 3D finite elements. Modelling of structure and boundary conditions, FE analysis and the interpretation of the results for 2D and 3D structures.

EFFECTS OF EDUCATION

The purpose of this course is to describe simple methods for computer simulations, and basic study of finite element methods. This feature is being used more and more by the engineering profession for analysis and design. The goal of this course is to demonstrate how FE methods work and how they interact with models. To obtain a passing grade the student must be able to: develop FE model of truss, beam structures and other simple 2D-3D FE models, evaluate both accuracy and relevance of numerical results and write a short report on the features of numerical models and results' interpretation.

PRECEDING COURSES

Engineering Mechanics 1, Engineering Mechanics 2, Strength of Materials 1, Strength of Materials 2

Subject:	**MULTIBODY SIMULATION IN MECHANICAL ENGINEERING**
Faculty:	Mechanical Engineering
Department:	Institute of Mechanics and Computational Engineering

Studies:	Language:
B.Sc. / M.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	36	10/+	8/+	18/+	—	—
ECTS points				**4**		

Author(s): prof. Wiesław KRASOŃ
Leading lecturer: prof. Wiesław KRASOŃ

CONTENTS

Classification of multibody problems of mechanics and methods for multibody system simulation (MBB). Theoretical and computational aspects of multibody analysis. Introduction to multibody dynamics: differential-algebraic equations and system with constraints, numerical integrations. Basic concepts for multibody simulation-simulation of unconstrained/ constrained mechanical systems. Modelling of multibody systems. Velocity and acceleration analysis in dynamic simulation. Introduction to practical problems of multibody analysis. MBB examples from areas of structural mechanics and design of machine components. Modelling of structure and boundary conditions, MBB analysis and the interpretation of the results for 2D and 3D structures.

EFFECTS OF EDUCATION

The purpose of this course is to describe simple methods for multibody kinematic and dynamic simulations, and basic study of multibody methods. This feature is being used more and more by the engineering profession for analysis and design. The goal of this course is to demonstrate how such methods work and how they interact with models. To obtain a passing grade the student must be able to: independently perform planar models for multibody analysis, develop a 3D model of simple structures, evaluate both accuracy and relevance of numerical results and write a short report on the features of numerical models and results' interpretation.

PRECEDING COURSES

Engineering Mechanics 1, Engineering Mechanics 2, Strength of Materials 1, Strength of Materials 2

Subject:	**FUNDAMENTALS OF VALIDATION OF NUMERICAL MODELS**
Faculty:	Mechanical Engineering
Department:	Institute of Mechanics and Computational Engineering

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter/Summer	30	10/+	—	20/+	—	—
ECTS points				**4**		

Author(s): dr Grzegorz SŁAWIŃSKI
Leading lecturer: dr Grzegorz SŁAWIŃSKI

CONTENTS

Fundamental terms related to the validation of numerical models. The problems of numerical models validation. A review of the simulation method in mechanics. Methodology for the development of numerical models of materials and structures within a finite element method. Modelling and variant solutions for initial boundary conditions and loads. Validation methodology (authentication) for numerical models of the mechanical system. Validation tests and simulation experiment planning. Selected validation tests for tension and compression of bars, beams' bending, beams' torsion. Comparative analysis and validation of analytical solutions with solutions for different variants of numerical models within selected validation tests.

EFFECTS OF EDUCATION

Fundamental knowledge and skills within experimental methods and analytical calculations for authentication of the numerical simulations results for selected problems of mechanics. Ability to develop reliable numerical models of materials and structures within a finite element method, including modelling and variant solutions for initial boundary conditions and loads. Ability to compare analytical solutions obtained from scientific literature or obtained from the experiment with solutions for different variants of numerical models within selected validation tests.

PRECEDING COURSES

Engineering Mechanics 1, Engineering Mechanics 2, Strength of Materials 1, Strength of Materials 2, Computer Simulation of Linear Problems of Mechanics

Subject:	**NUMERICAL MODELLING OF MATERIALS**
Faculty:	Mechanical Engineering
Department:	Institute of Mechanics and Computational Engineering

Studies:	Language:
B.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	30	10/+	—	20/+	—	—
ECTS points				**4,5**		

Author(s): prof. Danuta MIEDZIŃSKA
Leading lecturer: prof. Danuta MIEDZIŃSKA

CONTENTS

The subject investigates relationships between the material's structure in micro-scale and their macroscopic properties. Methods of numerical micro-scale and macro-scale modelling of modern materials are presented. Such computation can be used to investigate design materials in ways which cannot be achieved with experimental methods. The material structure models, the homogenization methods and the material constitutive equations, applied in commercial CAE software, are shown for selected materials. The numerical models are developed and analysed. The models are based on microstructure, as well as on global properties of the chosen material. The methods that involve the X-ray tomography are presented and investigated as well.

EFFECTS OF EDUCATION

Theory fundamentals and skills in methods of numerical micro-scale and macro-scale modelling of modern materials. The material structure models, the homogenization methods and the material constitutive equations, applied in commercial CAE software. The methods based on the X-ray tomography. To obtain a passing grade the student must be able to: independently develop 3D FEM model of the chosen advanced material, evaluate both accuracy and relevance of numerical results and write a short report on the features of numerical models and results interpretation.

PRECEDING COURSES

Strength of Materials 1, Strength of Materials 2, Computer Simulation of Linear Problems of Mechanics

Subject:	**COMPUTER BASED FATIGUE CALCULATIONS**
Faculty:	Mechanical Engineering
Department:	Institute of Mechanics and Computational Engineering

Studies:	Language:
M.Sc.	**English**

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	30	12/+	6	12/+	—	—
ECTS points				**4**		

Author(s): prof. Andrzej LESKI
Leading lecturer: prof. Andrzej LESKI

CONTENTS

Introduction to fatigue of materials. S-N curve concept. Fatigue damage calculation. Mean stress corrections. Load spectra analisis. Low and high cycle fatigue. Computational technique in fatigue analisis.

EFFECTS OF EDUCATION

The student has basic knowledge in fatigue of materials and load spectra analisis.
The student knows the basics of fatigue theory. They understen S-N curve and can create it base on experiment data. The student has a knowledge about errors and result scatter in fatigue life assessment.
The student is able to perform simple fatigue damage calculation with mean stress correction application.
The student is able to make use of his/her knowledge in computer base analysis in the area of fatigue calculations.

PRECEDING COURSES

Engineering Mechanics 1, Strength of Materials 1, FEM and Simulation of Linear Problems of Mechanics