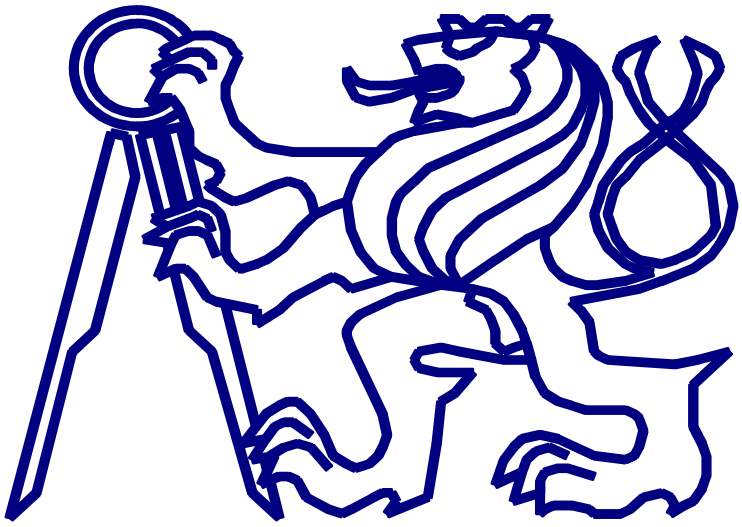
CZECH TECHNICAL UNIVERSITY IN PRAGUE

FACULTY OF MECHANICAL ENGINEERING



MASTER OF AUTOMOTIVE ENGINEERING

PROGRAM OF THE 2ND YEAR

Advanced Powertrains

Winter semester

Topics	Contact hours	Repartition L./E.	ECTS Credits
INTERNAL COMBUSTION ENGINES	91	4 + 3	7
EXPERIMENTAL METHODS AND MEASUREMENTS	65	2 + 3	4
HYBRID POWERTRAINS	39	2 + 1	3
ELECTRIC ACCESSORIES OF ICE	39	2 + 1	3
TECHNOLOGY OF PRODUCTION OF ICE	26	1 + 1	2
THEORY OF ICE AND SIMULATION	65	4 + 1	5
FOREIGN LANGUAGE I.	78	0 + 6	3
			27

Students who already absolved the topic ICE during the first year, they have to choose one topic from the following list:

Topics	Contact hours	Repartition L./E.	ECTS Credits
THERMOMECHANICS	65	3 + 2	5
MATHEMATICS III	52	2 + 2	4

From the following group ***o n e*** topic should be chosen:

Topics	Contact hours	Repartition L./E.	ECTS Credits
MECHANICS III	52	2 + 2	6
AUTOMATIC CONTROL	65	3 + 2	5
ARTIFICIAL INGELLIGENCE AND NEURAL NETWORKS	52	2 + 2	5

Summer semester

Topics	ECTS Credits
FIVE MONTH INTERNSHIP	10
DIPLOMA WORK	20

INTERNAL COMBUSTION ENGINES

Type		Compulsory	**Semester**		winter
Contact hours	(78) 4 + 2	**Number of credits**		5	
Type of termination		Assessment + Exam	**Form**		Lectures + exercises

Lecturers

Prof. Ing. Jan Macek, DrSc.
Ing. Antonín Mikulec

Anotation

TARGET
The course target is to provide fundamental information dealing with recent concepts of vehicle powertrains, especially combustion engines (ICE) and tools for their realization, especially considering mixture formation, combustion and gas exchange principles.

CONTENTS
Fundamentals of internal combustion engines (ICE): principles of thermodynamics, principles of combustion, formation of pollutants, gas exchange, super- and turbocharging; description of tools for fuel injection, mixture formation, valve gears, combustion realization, exhaust aftertreatment.

- Thermodynamics of open system, types of engines, definition of main parameters.
- Engine torque control, stability of engine-load interaction, basic engine maps
- Thermodynamics of piston ICE, T-s diagram assessments of efficiency, Carnot cycle, real cycles
- Thermodynamics of piston ICE, T-s diagram assessments of efficiency, Carnot cycle, real cycles
- Fuels, thermochemistry and chemical kinetics
- Combustion processes and basic types of flames. Pollutant formation.
- Compression and expansion process and heat transfer to walls
- Charge exchange process and parameters. Definition of ICE partial efficiencies.
- Mixture formation and control for SI and CI engines. Ignition and injection system design.
- Combustion chamber design. Valve trains and charge exchange equipment design
- Turbocharging and supercharging - devices and design
- Engine pollutants and exhaust gas aftertreatment
- Engine testing and ICE maps

Study materials

Lecturing material and hand-outs
Stone, R. Introduction to Internal Combustion Engines. SAE 1988-2003, ISBN 0-7680-0495-0 (basic textbook)
Heywood, J.B.: Internal Combustion Engine Fundamentals. Mac Graw Hill 1988, ISBN 0-07-028637-X
Texts of lectures at Moodle server.

EXPERIMENTAL METHODS AND MEASUREMENTS

Type		Compulsory	**Semester**	winter	
Contact hours	65 (2 + 3)	**Number of credits**	4		
Type of termination		Assessment + Exam	**Form**	Lectures + exercises	

Lecturers

Ing. Jiří Vávra, PhD.

Anotation

TARGET

The course deals with the application of basic principles, instruments and data acquisition systems used in the experimental R&D in the field of internal combustion engines. Classes will be taught in a form of lectures combined with laboratory exercises and demonstrations.

CONTENT

- Measuring chain, measurement uncertainties and error
- Force, torque and mass measurement
- Frequency – speed and positron
- Pressure
- Temperature
- Flow-rate
- Vibration and oscillation, basic acoustics, noise and sound
- Characteristics of combution engines
- Engine test-bench integration, automated data acquisition, types of dynamometers
- Acquisition and evaluation of fast changing pressures, measuring chain description, application of the 1st law of thermodynamics for a basic combustion analysis
- Exhaust gas composition, environmental impact of combustion engine operation
- Exhaust gas analysis, gaseous components and particulate matters
- Legislation base

Study materials

1. Lecturing material and hand-outs
2. Available literature and materials from suppliers of measuring systéme
3. Heywood, J.B., Internal Combustion Engine Fundamentals, McGraw-Hill, 1988.

HYBRID POWERTRAINS

Type	Compulsory	**Semester**	winter
Contact hours	39 (2+1)	**Number of credits**	3
Type of termination	Assessment + Exam	**Form**	Lectures + exercises

Lecturers

Ing. Josef Morkus, CSc.
Doc. Ing. Pavel Mindl, CSc., prof. Ing. Zdeněk Čeřovský, DrSc.

Anotation

TARGET
Introduction into the transportation technology and electric circuit theory.

The lectures are focused on advanced electrical and hybrid-electrical vehicle powertrains and its basic componets. There are analysed basic electric traction machines, energy sources and its optimal control and advanced vehicle powertrains design. A laboratory trainings are included.

CONTENT

- Introduction into the hybrid drives and its history
- Basic topology, main components of hybrid drives
- DC electric machines, basic principle of operation
- AC electric machines - induction motors, basic principle of operation
- AC electric machines - synchronous motors, basic principle of operation
- AC electric machines - switched reluctance motors, basic principle of operation
- Electronic invertors for different types of motors
- Advanced accumulators of electric energy
- Mechanical components, transmissions and flywheels
- Passenger hybrid vehicles and its design
- Commercial hybrid vehicles and railway hybrid vehicles
- Hybrid powertrains control
- Economy and perspectives of hybrid powertrains

Study materials

1. Lecturing material and hand-outs
2. Ehsani,M- Gao, Y- Emadi,A.: Modern Electric,Hybrid Electric and Fuel Cell Vehicles, CRC Press Taylor and Francis Group
3. Westbrook, M.H.: The Electric Car - Development and future of battery, hybrid and fuel cells cars. IEE London, Poiwer and energy Series ISBN 0 85296-013-1

ELECTRIC ACCESSORIES OF ICE

Type	Compulsory	**Semester**	winter
Contact hours	39 (2+1)	**Number of credits**	3
Type of termination	Assessment + Exam	**Form**	Lectures + exercises

Lecturers

Ing. Lukáš Novák Ph.D.

Anotation

TARGET

Basic engine management system, design and select the components for an ignition system and implement a strategy for on-board diagnostics. In car network and embeded processor system for real time aplication with use of sophisticated peripheral devices.

CONTENT

- Electrical Power Supply in Vehicle Electrical Systems.
- Starter Motors and Circuits. Integrated Starter Generators.
- Semiconductor Devices and Power Electronic Circuits.
- Distributorless and Electronic Ignition Systems.
- Microcomputer Instrumentation and Control.
- Micro-actuators and microsensors, micromotors, accelerometers and pressure sensors.
- Magnetoelectric and Piezoelectric Actuators.
- Electronic Fuel Injection Systems.
- Diesel-Engine Management, Systems and Components.
- Emissions Control Systems. Advance Diagnostic Systems.
- Adaptive Operating and Prediction Strategy of the ECM.
- Vehicle Networking Systems.
- Future Automotive Electronic Systems.

Study materials

1. Ribbens, W.,B.: Understanding Automotive Electronics. Newnes 2003
2. Danton, T.: Automobile Electrical and Electronic Systems. Butterworth-Heinemann 2012
3. Bonnick, A.: Automotive computer Control Systems. Butterworth-Heinemann 2001.

TECHNOLOGY OF PRODUCTION OF ICE

Type	Compulsory	**Semester**	winter
Contact hours	26 (1+1)	**Number of credits**	2
Type of termination	Assessment	**Form**	Lectures + exercises

Lecturers

Ing. Petr Vondrouš
Ing Jan Tomíček

Anotation

TARGET

The subject is focused on production technologies used in engine factories of todays automotive companies. Frequently used Al, Ni alloys, low alloy steels are introduced. Technologies of casting, forging, sintering for semi-finished product and machining, assembly for final production are explained.

CONTENT

- Introduction to engine - parts, size, materials - Al alloys, low alloy steels, Ni alloys
- Casting - high pressure die casting, low pressure die casting - principle, design of part, examples
- Casting - precision casting methods - lost wax, lost foam, investment casting - principle, examples
- Closed die forging, cros wedge rolling - principles, design of parts
- Forged parts - crankshaft, camshaft, piston
- Sintering of automotive parts - principle, metals, examples - conrod, clutch lining, bearings
- Heat treatment of engine parts - cementing, hardening, nitriding
- Machining of prismatic parts, milling - engine block
- Machining of rotational parts, turning - crankshaft, piston
- High precision machining technologies - grinding, honing
- Assembly of engine, Production planning
- Metrology

Quality assesment of engine

Some of the topics would be covered partially by the excursions to industrial companies - Aisin, Skoda MB

Study materials

1. S. Kalpakjian – Manufacturing Processes
2. M. P. Groover – Fundamentals of modern manufacturing

THEORY OF ICE AND SIMULATION

Type	Compulsory	**Semester**	winter
Contact hours	62 (4+1)	**Number of credits**	5
Type of termination	Assessment + Exam	**Form**	Lectures + exercises

Lecturers

Doc. Ing. Oldřich Vítek, Ph.D.

Anotation

TARGET

Theoretical description of internal combustion engine (ICE) is presented - description of important physical phenomena including their mathematical models.

CONTENT

- Basic conservation laws - mass, momentum and energy.
- Basics of ICE combustion - laminar/turbulent flame, physical/chemical induction time.
- Application of thermodynamic laws to combustion case - 1st law of thermodynamics, "chemical" enthalpy and lower heating value of fuel, adiabatic flame temperature. Basics of combustion chemistry - equilibrium, kinetics.
- Chained chemical reactions, chemical mechanism of hydrogen/hydrocarbon, introduction to pollutant production in ICE.
- Combustion in ICE - time evolution (rate of heat release), different combustion systems (SI, CI, HCCI, CAI, PCI, etc).
- In-cylinder turbulence and its influence on in-cylinder transport processes.
- SI engine combustion - rate of heat release (ROHR), turbulent flame structure, influence of turbulence, thermodynamic analysis (single/multi-zone model), Tabaczynski model, mixture ignition, influence of ROHR on ICE thermodynamic cycle (including cyclic variations), incorrect combustion modes (knocking, incomplete combustion, etc.), limits of stable ICE operation.
- CI engine combustion - high-pressure fuel injection, combustible mixture formation, fuel jet time evolution, fuel drops (size distribution, SMD, time decay, evaporation), fuel jet interaction with walls and with in-cylinder large-scale flow strucutre(s), ROHR, influence on ICE thermodynamic cycle.
- Combustion chamber geometry shape - SI/CI engines, influence on in-cylinder flow structure.
- Homogeneous combustion (HCCI), CAI, etc. - general properties, advantages/disadvantages, simplified description.
- Pollutant production in ICE - pollutant formation of general point of view, specifics of different combustion systems (SI, CI, etc.), NOx formation in SI engine (Zeldovich model), CO formation, unburnt hydrocarbons formation, estimate of exhaust gas composition.
- Energy fluxes in ICE - heat transfer (Woschni, Eichelberg), detailed thermodynamic analysis, warm-up of exhaust manifold.
- Mechanical losses in ICE - mechanical efficiency, simplified models.

Study materials

1. Keywood, J.B.: Internal Combustion Engine Fundamentals. McGraw-Hill, London, England. 1988. ISBN 0-07-028637-X.
2. Macek, J. - Suk, B.: Spalovací motory I. Skripta ČVUT.

FOREIGN LANGUAGE I.

Type	Elective	**Semester**	winter
Contact hours	78 (0+6)	**Number of credits**	3
Type of termination	Assessment	**Form**	exercises

Lecturers

Externisté z Institut Francais de Prague (francouzština)
PhDr. Marie Černíková (čeština pro cizince)

Anotation

Pour FRANCAIS
OBJECTIF

L'objectif global de la formation au français lors de la première année est de faire acquérir aux étudiants, a priori non francophones au recrutement, un niveau de compréhension de la langue française,écrite et parlée, suffisant pour leur permettre de poursuivre la deuxième année d'études en France.

L'objectif du premier semestre est de familiariser les étudiants avec les bases de la langue française. Des enseignants français encadrent les étudiants par groupe de 15 maximum.

CONTENU

Grammaire de base
Orthographe
Prononciation et élocution
Vocabulaire de la vie courante
Enseignement à partir de textes et d'enregistrements, exercices écrits et de conversation…

For CZECH
TARGET

The course is aimed at students of all nationalities encountering Czech for the first time. It serves as a practical gateway to the language and forms a solid fondation for futher study. The students will learn the basic Czech quickly to be able to start using the language in everyday situations. The Czech grammer is simplified to the maximum while the objective is the communicative focus.

The course is organized into small group maximum 7 students.

CONTENT

Basic grammar
Orthography and pronunciation
Basic communication situations: for instance "Kde se sejdeme?", "V restauraci, hotelu, doma, v obchodě", "Transport", "Hledání cesty", "Moje rodina"...

Study materials

Lecturing material and hand-outs