Course description

1 General information

Course name	Heat Engines
Course code	M4-HE
Level of study (B.Sc, M.Sc., Ph.D.)	B.Sc.
ECTS	6
Course manager	Dr eng. Jerzy Dutczak – Motor Vehicles Chair
Course length	One (1) semester
Coordinator for international programs	erasmus@mech.pk.edu.pl

2 Prerequisites

- The basic knowledge of mechanics and thermodynamics

3 Program

Type	Lectures	Classes	Labs	Computer labs	Project	Seminar
Hours	45	0	30	0	0	0

4 Contents

Lectures		
No.		Hours
1	Division of heat engines, internal and external combustion piston engines, flow engines, rocket engines.	1
2	Principles of piston engines and flow engine work – the differences.	2
3	Ideal and real piston engine cycles. Theoretical cycles of flow engines and their practical implementation.	2
4	Formation and combustion of burning mixtures in piston and flow engines. Exhaust gas components emission. Fuelling systems in piston and flow engines.	4
5	Differences among the properties of fuels applied in piston and flow combustion engines. Aviation fuels, rocket solid and liquid fuels.	3
6	Piston engine operating parameters and characteristics.	4
7	Application of flow engines: turbine engines for vehicle propulsion, jet engines – ramjet, pulse, rocket, turbojet, multi-flow turbojet, turboprop, turbofan.	5
8	Inlets of flow engines. Intake air dedusting.	2
9	The principle of operation of the stage of the flow machine. Compression processes in an axial and radial compressors – speed triangles. The phenomenon of compressor stall and methods of counteracting.	3
10	Types of flow engines combustion chambers. Combustion chamber inner processes.	3
11	Principle of operation and division of turbines. Axial and radial turbines. Multi-stage turbines.	2
12	Exhaust systems of flow engines. Afterburners (thrust augmenters, boosters). Exhaust noise suppressors. Thrust reversers.	2
13	Thrust vectoring, STOVL and VTOL aircrafts.	2
10	Non-conventional propulsion systems in contemporary aviation.	4
11	Applications of piston and turbojet engines in contemporary drones.	4
12	Future aviation and space propulsion concepts.	2
	$\sum =$	45

Laboratories		
No.		Hours
1	Speed and load characteristic of spark ignition (SI) engine.	2
2	Load characteristic of SI engine.	2
3	Regulation characteristic of mixture composition (lambda) of SI engine with exhaust gas composition measurements	2
4	SI engine exhaust gas catalytic converter efficiency.	2
5	Load characteristic of compression ignition (CI) engine.	2
6	Ignition advance angle characteristic of SI engine.	2
7	Effect of fuel injection advance angle on CI engine work parameters.	2
8	Measurement of indicated pressure run in working engine.	2
9	Overview of the construction of flow engines based on the exhibits of the Polish Aviation Museum in Krakow.	6
10	Testing of valveless pulse engine.	2

11	Measurement of air and fuel flow as well as exhaust gas temperature before the turbine of the AI-9 turbojet engine.	2
12	Measurements of PM emission of CI engine.	2
13	Effect of EGR system on operating parameters of CI engine	2
	∑ =	30

5 Learning Outcomes (skills and knowledge)

- Basic knowledge of flow engines work, knowledge of flow engines types and construction, main issues of contemporary jet propulsion systems in aviation and possibilities of space application.

6 Assessment policy (examination)

- Theoretical and real working cycles of flow engines, principles of work of differences types of flow engines, multi-flow engines, compression process in axial compressor – triangle of speed, compressor stall, combustion chambers inner processes, exhaust systems – work of exhaust nozzle, thrust reversers.

7 Literature

- Heywood J., Internal Combustion Engines Fundamentals, Mc Graw-Hill Book Compant, New York 1988
- Jack L. Kerrebrock, Aircraft Engines and Gas Turbines, MIT Press 1992
- The Jet Engine, Renault Printing Co Ltd, Birmingham England 1996
- Rolls-Royce Model 250 C20R Engine Training Manual, Rolls-Royce Corporation 2000