Course description

1 General information

Course name	Machine Design
Course code	
Level of study (B.Sc, M.Sc., Ph.D.)	B.Sc., M.Sc.
ECTS	4
Course manager	DSc., PhD., MSc., Bogdan SZYBIŃSKI, Prof. PK
Course length	One (1) semester
Coordinator for international programs	erasmus@mech.pk.edu.pl

2 Prerequisites

- Basic knowledge in Mechanics, Strength of Materials, Technology and Material Engineering

2 Program

Type	Lectures	Classes	Labs	Computer labs	Project	Seminar
Hours	15	0	15	0	15	0

3 Contents

Lectures		
No.		Hours
1	BASICS OF DESIGN. TOLERANCES AND FITS Basic rules of designing. Factors affecting tolerances and fits. Cost of manufacturing. Preferred basic sizes and choice of accuracy class. Clearance, interference and transition fits.	2
2	FATIGUE FAILURE OF MACHINE COMPONENTS Mechanism of fatigue failure – crack initiation and propagation stage. Stress-life, strain-life approaches to failure. Woehler's, Smith's and Haigh's diagrams. Notion of stress concentration, measures for notches in machine elements. Designing of machine elements for high-cyclic fatigue cases.	3
3	SHAFTS, KEYS, SPLINES General considerations, shaft materials, loadings, stresses. Failure of shafts under combined loadings. Shafts as beams and torsion bars. Design calculations for fully reversed bending and fluctuating and steady torsion. Calculation of shafts with uniform strength. Choice of diameters for step-wise shaft, control of stress concentration in shafts' notches. Notion of critical speeds for rotating elements. Connections between shafts and gears, pulleys, etc.	3
4	BEARINGS Hydrodynamic lubrication theory - Reynolds Equation for eccentric journal bearings. Design and calculations of hydrodynamic bearings. Rolling-element bearings, types of rolling bearings, dynamic load rating C . Combined radial and thrust loads in rolling bearings, equivalent force, Palmgren's formulae. Applications - choice of rolling bearing type, calculation procedures for single and systems of rolling bearings.	3
5	DETACHABLE CONNECTIONS Thread forms, terminology and standards. Power screws and threaded connections. Stresses in threads, choice and calculations of threaded connections subjected to various loads. Thread loosening and locking. Initial tension in threaded connections.	2
6	PERMANENT CONNECTIONS Welded joints, methods of welding. Fillet welds and butt welds. Designing and analytical calculations of dimensions of welded joints. Soldering and brazing of machine elements. Rivets. Adhesive joints.	2

Labs		
No.		Hours
1	Introductory remarks. Health and safety rules in the lab of Machine Design	1
2	Bolt efficiency test.	2
3	Limit load capacity of the friction joint.	2
4	Stress concentration in machine elements with notches.	2
5	Critical speed of the rotating shaft with disc with unbalance.	2
6	Testing the moment of friction in roller bearings.	2
7	Strain gauge test of a welded I-beam.	2
8	Pass a subject.	2

Project		
No.		Hours
1	Design of the shaft for the two-stage spur gear. Identification of loadings, diagrams for bending, torsion and equivalent moments distribution, calculations of the shaft diameters, construction of the shaft with uniform strength. Choice of diameters for the consecutive shaft journals, final CAD design of the shaft.	15

3 Learning Outcomes (skills and knowledge):

- Student possess the elementary knowledge about tolerances and fits;
- Student possess the knowledge about fatigue phenomena, fatigue resistance and calculations for fatigue of machine elements with notches in the high-cycle fatigue regime;
- Student possess the knowledge about the calculations of shafts subjected to bending and torsion and is able to design the real shape of the shaft following the rules of designing and imposed requirements;
- Student possess the knowledge about choice and calculations of various types of bearings;
- Student possess the knowledge about fasteners and threaded connections;
- Student possess the elementary knowledge about welds, keys, splines, fasteners, interference fits etc.

4 Assessment policy (examination):

- Test checking the acquired knowledge concerning designing of machine elements
- Student is able to solve simple design case studies

5 Literature

1. Steven R. Schmid, Bernard J. Hamrock, Bo O. Jacobson, Fundamentals of Machine Elements, CRC Press.
2. Robert L. Mott, Machine Elements in Mechanical Design, Prentice Hall.
3. Robert L. Norton, Machine Design, An Integrated Approach, Pearson Education International.
4. Robert C. Juvinall, Kurt M. Marshek, Fundamentals of Machine Component Design, John Wiley & Sons
5. Jack A. Collins, Henry Busby, George Staab, Mechanical Design of Machine Elements and Machines, John Wiley & Sons.