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
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	30	0	0	0	30	0

3 Contents

Lectures		
No.		Hours
1	TOLERANCES AND FITS Factors affecting tolerances and fits. Production processes and 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 and LEFM approaches to failure. Measuring and estimating fatigue failure criteria. Woehler's Smith's and Haigh's diagrams. Notches and stress concentrations. Designing of machine elements for high-cycle fatigue.	3
3	WELDED JOINTS Frame and solid structures. Methods of welding. Soldering and brazing of machine elements. Fillet welds and butt welds. Designing of dimensions of welding joints. Numerical calculations of fillet and butt welds.	2
4	SCREWS AND FASTENERS Standard thread forms, stresses in threads – axial, shear and torsional. Types of screw fasteners, manufacturing of fasteners and screws. Power screws – applications, friction coefficients, screw efficiency, Preloaded fasteners subjected to tension. Determining of the joint stiffness, controlling preload. Ball screws.	3
5	KEYS AND SPLINES Key and spline materials, stresses in keys and splines. Parallel, tapered and Woodruff keys. Stress concentration in key- and spline-seats.	1
6	SHAFTS General considerations, examples of applications. 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. Shafts attachments. Lateral vibration of shafts, notion of critical speed for rotating elements, torsional vibrations of shafts. Controlling of lateral and torsional vibrations	3
7	COUPLINGS AND BRAKES Types of brakes and clutches. Materials for various clutches and brakes. Clutch or brake selection and specification. Disk clutches, disc brakes. Multidisc clutches – construction and applications. Short-shoe and long-shoe drum brakes, calculations of brakes. Band brakes.	3

8	LUBRICATION AND BEARINGS Hydrodynamic lubrication theory, Reynolds Equation for eccentric journal bearings. Sommerfeld solutions for sliding bearings. Design and calculations of hydrodynamic bearings. Rolling-element bearings, types of rolling bearings, damage and failure of rolling bearings. Dynamic load rating *C* . Combined radial and thrust loads in rolling bearings, equivalent force, Palmgren's formulae. Assembly and Disassembly procedures for rolling bearings, Applications - choice of rolling bearing type, calculation procedures for rolling bearings. Special bearings	4
9	SPUR, HELICAL AND BEVEL GEARS Gear tooth nomenclature. The fundamental law of gearing. Kinematics and geometry of gears, the involute tooth form. Rack and pinion, changing center distance, backlash, interference and undercutting problems. Gear manufacturing and materials. Loading and stresses (contact and bending) in spur gears. Design of spur gears. Helical gears – geometry, forces, and stresses. Bevel gears – geometry and nomenclature, forces and stresses.	5
10	BELT DRIVES AND CHAIN DRIVES Kinematics of belt and chain drives. Stresses in belts and chain elements. Types of belt drives – flat or V-transmission belts. Exemplary design of V-belt drive, design of chain drive.	2
10	SPRINGS, INTERFERENCE FITS Spring configurations, spring materials. Helical compression springs, nomenclature, deflection, rate and stresses in coils. Designing of helical compression springs for static and fatigue loadings. Helical extension springs. Helical torsion springs. Stresses and stress concentration in interference fits, fretting corrosion.	2

Project		
No.		Hours
1	Design of a one-stage spur gear. Choice of the material for gears, introductory calculation of shafts, calculations of spur gear – choice of the rotating axis distance (contact stresses) and choice of the module (bending stresses). Detailed verification calculation of the gear transmission. Calculations and choice of diameters for rotating input and output shafts, choice and verification calculations of rolling bearings. Simplified verification of the spur gear housing. Preparation of CAD drawing of the spur gear. OR 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 + Design of the multidisc clutch actuated mechanically or hydraulically or pneumatically. Calculations of the clutch shaft, friction clutch package and details of the coupling mechanism. Preparation of the CAD drawing.	30 15 +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;
- Student possess the elementary knowledge about welds, keys, splines, fasteners, interference fits etc.,
- Student possess the knowledge about gear transmissions;
- Student possess the knowledge about machine parts and elements for machine power transmissions – clutches, brakes and gears;
- Student has the skills how to design a frictional clutch, shaft;
- Student has the skills how to design a spur gear unit.

4 Assessment policy (examination):

- Test checking the acquired knowledge concerning designing of machine elements
- Student solves simple design case studies

5 Literature

1. Robert L. Mott, Machine Elements in Mechanical Design, Prentice Hall.
2. Robert L. Norton, Machine Design, An Integrated Approach, Pearson, Education International.
3. Robert C. Juvinall, Kurt M. Marshek, Fundamentals of Machine Component Design, John Wiley & Sons
4. Jack A. Collins, Henry Busby, George Staab, Mechanical Design of Machine Elements and machines, John Wiley & Sons.