

**In the spring semester 21/22 the course is conducted on campus (face to face).\***

### ***Regulations***

1. During the course the students are obliged to obey the regulations of study at The Warsaw University of Technology.
2. Only the student who is registered for this course can complete it.
3. The presence at the obligatory classes of the course can be checked.  
Limit of non-attendance is 2 meetings. Justifications of non-attendance should be presented at the next meeting, i.e. after one week, at the latest.
4. There are the two ways of completing the course:
  - a). The first way is by passing the exam, which is held during the examination session. ***But, to be allowed to attend the exam it is necessary to pass at least one regular test or to get 3.0 grading points as a sum obtained from three regular tests\****. The exam consists of two parts, theoretical (a couple of questions) and practical (1 to 3 problems). ***To pass the exam it is necessary to get positive grades from both parts. \*Grading points for the grades less than 3.0 can be in the range: <0, 2.875)!!!***
  - b). The second way is by getting positive grades from all 3 tests held during the course.
5. In extraordinary cases the Head of the Fundamentals of Machine Design Division makes the decision about completing the course.

**\*In case of switching into remote system of teaching, these regulations will be still valid.**

## MD-II\_L-1,T-1,

### Programme

- **Spring design – types, materials, theory of helical compression springs-ends, lengths, active coils, spring index, deflection, rate, stresses, buckling, allowable strength, design for static loading. Rubber springs-work done (energy accumulated), energy dissipation, loop of hysteresis.**
- **Shafts, keys, couplings I - Shaft Loads, Attachments and Stress Concentrations, Shaft Materials, Shaft Power, Shaft Loads, Shaft Stresses, Shaft Failure in Combined Loading, Shaft Design** (General Considerations, Design for Fully Reversed Bending and Steady Torsion, Design for Fluctuating Bending and Fluctuating Torsion), **Keys and Keyways** (Parallel Keys, Tapered Keys, Woodruff Keys, Stresses in Keys, Key Materials, Key Design, Stress Concentrations in Keyways);
- **Shafts, keys, couplings II - Splines, Interference Fits** (Stresses in Interference Fits, Stress Concentration in Interference Fits, *Fretting Corrosion*), **Critical Speeds of Shafts** (*Lateral Vibration of Shafts and Beams—Rayleigh's Method, Shaft Whirl*, Torsional Vibration, *Two Disks on a Common Shaft, Multiple Disks on a Common Shaft*, Controlling Torsional Vibrations), **Couplings** (Rigid Couplings, Compliant Couplings, Torsionally Flexible Couplings - shaft misalignments, jaw, flexible-disk, gear and spline, helical and bellows, linkage, universal joints, rzeppa), **Operation of torsionally flexible coupling under fluctuating periodic torque** (resonance in rotating shafts);

- **Clutches and brakes I, II, & III – classifications, types, materials, disk clutches (uniform wear and pressure approach), cone, overload, band, drum clutches and brakes (self energizing and self locking), engaging friction clutches.**
- **Sliding bearings**
- **Rolling element bearings**
- **Mechanical transmissions – introduction ( belt, chain, friction gears)**
- **Spur gears – velocity law, kinematics of involute gearing, line of action, wheel geometry and tooth dimensions, pitch and modul, backlash and addendum clearance, centre distance. Machining gears (Maag and Fellows cutters), undercutting, minimum number of teeth, contact ratio, introduction to profile shifting.**
- **Loading on spur gears (teeth loading and bearing reactions),**

Additional remarks:

Standard registration procedure is required. Handouts and additional materials (problems, supplements, objectives for chapters, etc.) are displayed on the course website: <https://www.meil.pw.edu.pl/zpk/ZPK/Dydaktyka/Materialy-dla-studentow-Files-for-students/>

See also the "Aerospace Engineering Bachelor Program" at:

<https://www.meil.pw.edu.pl/eng/PAE2/Education/Aerospace-Engineering>

Course teacher

Dr hab. inż. Stanisław Bogdański

Course coordinator

Dr hab. inż. Marek Matyjewski, prof. uczelni

Head of FMD Division

Prof. dr hab. inż. Ryszard Górecki