ALEKSANDRAS STULGINSKIS UNIVERSITY
FACULTY OF AGRICULTURAL ENGINEERING
Institute of Power and Transport Machinery Engineering

STUDY SUBJECT DESCRIPTION

TRIBOTECHNICS

Study cycle:  BSc  Number of ECTS credit points: 3,0
(BSc, MSc, PhD)

Prerequisites and purpose:
Basic knowledge of mechanical engineering and material science is required. This lecture is suitable for students of mechanical engineering, machinery design and material science branches.

Learning outcomes:
After completing the course students should obtain the knowledge of theoretical fundamentals and practical methods for decisions making according tribotechnical problems in design and maintenance of machines and develop the ability to apply them to practical situations:

- have a clear overall picture about the basics of tribotechnics and related sciences, theoretical background about processes in tribological system, mechanisms and forms of interaction of friction surfaces;
- have enough knowledge about the surface and lubrication materials applied for different agricultural, transportation, industrial and other machines;
- be introduced with main tribotechnical materials and the methodology of its application in friction pairs;
- have good knowledge about the technologies and methods to increase the tribological reliability of machinery elements and friction joints;
- know the basic principles of maintenance and trends important for reliable tribological operation of machinery.
Syllabus

- **Theory** (32 hours):
  

- **Laboratory works** (32 hours)
  1. **Evaluation of surface quality of the details** (14 hours)
  2. **Tribological testing of materials and lubricants** (24 hours)
  3. **Technological improvement of details' surface** (2 hours)

- **Private study** (56 hours)
  1. **Individual home work** 10 hours
  2. **Preparation for laboratory works** 4 hours
  3. **Work on course project** 14 hours
  4. **Examination** 28 hours

**Course project:**

Themes of project taken from separate list in frame of subject contents. It should include description of the theme, the practical examples, conclusions and list of references. Size of project: 8-12 pages (format A4), font ≤ 13 pt with the pictures.

**Teaching and learning methods:**

Lectures, supported by PowerPoint presentation and slides. Scripts referring to the actual topics are distributed during lectures.

**Registration for course:**

Two weeks before the beginning of the course.

**Methods and timing of assessment:**

<table>
<thead>
<tr>
<th>The structure of achievements assessment</th>
<th>Importance coefficient</th>
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<tbody>
<tr>
<td>Control assignment</td>
<td>0,20</td>
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<tr>
<td>Laboratories</td>
<td>0,20</td>
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<tr>
<td>Examination</td>
<td>0,60</td>
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</tbody>
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Oral examination, upon appointment. Registration for examination should be made with lecturer personally or by phone.
READING REFERENCES

MAIN LIST


SUPPLEMENTARY LIST


* Available in Library of Aleksandras Stulginskis University

Study programme designed by
Assoc. prof. dr. Raimundas Rukuiža Signature: …………………………….

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TRIBOTECHNICS

CONTENT DESCRIPTION

Lessons (32 hours)

1. Introduction (4 %)
   - Perception of tribology and tribotechnics
   - Object of tribotechnics
   - Main tribological concepts
   - Trends of tribotechnics
   - Practical aims of tribotechnics
   - Importance of tribotechnics

2. Details’ surfaces and its interaction (10 %)
   - Friction surfaces and its quality
   - Surface geometry, roughness
   - Residual stresses
   - Physical and chemical properties of surface
   - Interaction of surfaces

3. Friction of joints (12 %)
   - Friction perception
   - Sorts of friction
   - Sliding and rolling friction
   - Dry and lubricated friction
   - Lubrication types
     - Boundary lubrication
     - Fluid-film lubrication
     - Elastohydrodynamic lubrication
     - Mixed lubrication
     - Hydrostatic lubrication
     - Gas-static lubrication
     - Gas-dynamic lubrication
   - Friction modes in sliding bearing
   - Friction types in machinery and joints
4. Wear of machine elements (14 %)
   - Wear perception
   - Disintegration of surfaces
   - Types of wear
     - Mechanical wear
       - Abrasive wear
       - Adhesive wear
       - Fatigue wear
       - Erosive wear
       - Cavitation wear
       - Fretting wear
     - Corrosive mechanical (tribo-chemical) wear
     - Hydrogen wear
     - Electro-erosive wear
   - Wear mechanisms
   - Wear characteristics
   - Regularities of wear
   - Wear stages
   - Wear of typical details and joints

5. Self-organisation processes in friction pairs (7 %)
   - Non-wear effect of friction pairs
   - Formation of servovitic film
   - Physical essentials of selective transfer phenomenon
   - Application of non-wear effect
   - Other self-organisation processes in friction pairs

6. Materials for friction pairs (8 %)
   - Classification of materials for friction pairs
   - Frictional and anti-frictional materials
   - Wear resistant materials
   - Polymers
   - Materials for high-temperature operation
   - Ceramic and metal-ceramic materials
   - Diamond-like-carbide (DLC) coating materials
   - Materials for realisation of non-wear effect
   - Selection of materials for friction pairs
7. Lubrication of friction pairs (14 %)
   - Lubricants and its classification
   - Oils and greases
   - Solid lubricants
   - Properties of lubricants
   - Additives of lubricants
   - Metal-cladding lubricants
   - Selection of lubricants
   - Lubrication of typical details and joints
   - Supply and distribution of lubricants
   - Tribological analysis of lubricated joint

8. Methodology and technique of tribological testing (7 %)
   - Outline of engineering materials testing
   - Aims and planning of tribological tests
   - Equipment for tribological tests
   - Tribological testing of lubricants
   - Wear measurement: methods and tools
   - Surface investigation: equipment and examples

9. Designing methods to increase the tribological reliability of details (7 %)
   - Direct and reverse friction pairs
   - Volume and surface sponginess of materials
   - Stiffness of details
   - “Floating” details
   - Load reducing of working surfaces
   - Replacement of sliding friction to the rolling friction
   - Count of thermal deformation
   - Interstices in joints
   - Protection of friction surface from the pollution

10. Technological methods for the increase of wear resistance of details (10 %)
    - Influence of working surface’s geometric parameters on the wear resistance of details
    - Perception and sorts of tribotechnical coatings
    - Thermal, thermochemical and chemical strengthening of friction surfaces
    - Electrochemical coats
    - Deposition at very low pressure
- Overlay welding
- Metalizing
- Ceramic coats
- Finishing anti-friction non-abrasive treatment
- Graphitizing
- Mechanical strengthening of friction surfaces
- Electro-mechanical, electro-thermal and other coating technologies
- Laser processing of surfaces
- Polymeric coats

11. **Influence of machinery service use on the longevity of details and joints (7 %)**
- Breaking-in of machines
- Degradation of lubricants during the operation
- Trends of engine oils service use
- Influence of operation conditions and service on the tribotechnical properties of joints
Laboratory works (32 hours)

1. Evaluation of surface quality of the details (20 %)
Transfer of theoretical knowledge and practical skills on the methodology of evaluation of surface quality of the machine parts. Introduction to methods and tools of the control of geometrical parameters of detail (macro-geometrical parameters, surface roughness), chemical analysis of details’ material, mechanical properties of surface-hardness measurement methodology.

2. Tribological testing of materials and lubricants (50 %)
Presentation the outline of engineering materials testing, aims and planning of tribological tests, formulation of task for investigation of tribological properties of materials (wear resistance, anti-frictionality (frictionality), seizure resistance, frictional thermal stability, compatibility, tribological adjustment). Analysis of operation schemes of friction pairs and its application in equipment and tools for tribological tests. Tribological testing of lubricants: parameters (friction losses, critical load, wear of friction surfaces, critical temperature, temperature of chemical modification) and equipment. Application of wear measurement methods and tools.

3. Technological improvement of details’ surface (30 %)
Displaying of technologies, materials and equipment for improvement of tribological properties of friction surfaces of machine details. Theoretical presentation of procedure and equipment and practical demonstration of different coating technologies: electro-sparking welding, electro-impulsive alloying, laser processing, non-abrasive anti-frictional surface finishing.