Prerequisites and purpose:
Senior students must learn courses of Internal Combustion Engines and pass through examinations. Senior students must also have basic knowledge in common disciplines, especially Physics, Mathematics, Heat technique, Theoretical mechanic and Resistance of materials. This lecture is prepared for students of agricultural technique of technological sciences (T000) and mechanical engineering (09T) branches.

Learning outcomes:
After completing the course post graduate students obtain knowledge in such areas: have understanding about thermodynamic, estimated and real cycles of the Internal Combustion Engines;

- they learn about how to select engine performance modes suitable for the research;
- how to obtain and analyse performance parameters of the engine and emission characteristics;
- have knowledge about indicating systems, indicator and effective parameters of the engine;
- evaluate quality of combustible mixture and its effect on combustion process, heat release and indicator parameters of the engine;
- have enough knowledge to perform the analysis of engine processes and evaluate effect of various factors on torque, power and fuel consumption;
- have good knowledge about the economical and ecological parameters of the engine;
- evaluate efectiveness of supercharging and select proper parameters of the fuel delivery systems;
- have good knowledge about main properties of biofuels and alternative fuels;
- evaluate performance stability, ecological and emission characteristics of the engine;
- have good knowledge concerning calculation of main engine systems and constructive parameters, have clear vision about engine development perspectives and tendencies.
Syllabus

- **Theory** (48 hours):


- **Practice classes** (16 hours)

  1. Testing of fuel injection systems, performance characteristics of Otto and Diesel engines, indicating of combustion processes (16 hours)

- **Private study** (96 hours)

  1. Individual home work  16 hours
  2. Auditorium works  14 hours
  3. Preparation for workshop  8 hours
  4. Work on course project  38 hours
  5. Examination  20 hours

**Course project:**
Themes of project can be taken from separate list according students request and subject contents. It should include description of the theme, selection of calculation performance modes, calculation of main engine parts and evaluation of normal, tangential, shearing, stressing, bending and compressing strains. Calculation of engine systems: fuelling, lubricating, cooling and starting. Evaluation of bearings load, oil pumps and oil filters capacity, oil pan capacity, air and water cooling systems, water pump and radiator capacity and other engine parts. Evaluation of starting systems of the engines. Conclusions and references. Size of project: 25-30 pages (format A4), font ≤ 13 pt with the pictures.

**Teaching and learning methods:**
Lectures, supported by PowerPoint presentation and slides.

**Registration for course:**
Two weeks before the beginning of the course.

**Methods and timing of assessment:**

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<th>The structure of achievements assessment</th>
<th>Importance coefficient</th>
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<td>Control works</td>
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<td>Course project</td>
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<td>Laboratories</td>
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<td>Examination</td>
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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 Lithuanian University of Agriculture

Study programme designed by
Prof. dr. Gvidonas Labeckas

Signature: ..........................

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ANNEX

CONTENT DESCRIPTION

Lessons (48 hours)

1. Thermodynamic cycles of Internal Combustion Engines (4 hours)
   - Effect of various factors on theoretical efficiency coefficient and mean cycle pressure.
   - Analysis of cycles when heat delivered at constant volume V = const., constant pressure p = const., in composite cycle at V = const and p = const.
   - Thermodynamic cycles of turbocharged engines.

2. Fuels, their properties and combustion reactions (4 hours)
   - Common knowledge about fuels structure, physical and chemical properties.
   - Biofuels, advantages and disadvantages.
   - Chemical combustion reactions, combustion products and heat release.

3. Theoretical and real cycles of Internal Combustion Engines (4 hours)
   - Two and four strokes engines performance cycles.
   - The effect of various constructive and performance mode factors on intake, compression, combustion – extension and exhausts parameters.

4. Analysis of indicated and effective engine parameters (4 hours)
   - The influence of combustible mixture quality, load, rotation speed and other factors on engine indicated and effective parameters, structure of the exhausts and smoke opacity.
   - Factors affecting internal friction forces, mechanical losses and engine effective parameters.
   - Methods used for boosting up the engines effective power output.

5. Ecological parameters of the engine (4 hours)
   - Formation mechanisms of toxic species in the exhausts.
   - Toxicity of the exhausts and smoke reduction methods for petroleum and diesel fuelled engines.
   - Improvement of performance processes of the engines and noise reduction.

6. Characteristics of the engines and performance modes (4 hours)
   - Load, speed, governor and regulatory characteristics.
   - Analysis of exhaust emissions and smoke characteristics.
   - Special and multi-functional characteristics of the engine, purpose, formation methods and analysis of their parameters.

7. Performance stability of the engines and air charging methods (4 hours):
   - Torque, its formation and torque reserves.
   - Performance unevenness of the engines, inertia torque and calculation of flywheel parameters.
   - Air charging methods and general requirements.
   - Air charging systems. Analysis of turbochargers characteristics. Coordination
of turbochargers and engines characteristics.
• Calculation of basic parameters of turbochargers.
• Performance characteristics of supercharged engines, their formation and analysis.

8. Heat balance of the engines (4 hours):
• The effect of engine load and speed on heat energy distribution and its effective utilisation.
• Heat strains of main engine parts.
• Heat strains reduction methods and selection of materials for parts production.

9. Combustible mixture preparation in Otto and Diesel engines (4 hours):
• Petroleum injection systems.
• Requirements for Diesel engine fuel delivery systems.
• Fuel injection, droplets atomisation processes and affecting common criteria.
• Injection pumps performance characteristics correction methods.
• Selection of basic parameters of injection systems.
• Effect of various factors on the combustible mixture quality.

10. Preparation of combustible mixture in diesel engines (4 hours):
• Effect of fuel injection and droplets atomisation characteristics on combustible mixture quality.
• Optimisation of fuel injection and atomisation processes.
• Formation of fuel spray patterns, calculation of their initial spreading angle and total surface area.

11. Combustion and heat release processes in diesel engines (4 hours):
• Duration of autoignition delay and affecting factors.
• Kinetic and diffusion combustion phases.
• The influence of fuel injection and combustible mixture quality on combustion process.
• Effect of fuel physical, chemical properties and machines exploitation factors on combustion process and engine performance efficiency.
• The effect of fuel injection timing advance, needle valve lifting pressure, load and speed modes on combustion process and engine indicator parameters.

12. Calculation of main parameters of the engine and its systems (4 hours):
• Calculation modes of the engine. Calculation peculiarities in Otto and Diesel engines.
• Normal, tangential, shearing, stressing, bending and compression stresses of the engine parts.
• Calculation of main engine parts (body, oil pan, cylinder head, crankshaft mechanism, piston, connecting rod, compression and lubricating rings, timing gears and etc.), improvement of their production technologies and selection of constructive materials.
• Turning and bending torques in crankshaft mechanisms, strains in main and connecting road bearings, formation theoretical wear diagrams.
• Calculation of engine systems – fuelling, lubricating, cooling and starting.

Practical laboratory works (16 hours)

1. Load characteristic of Diesel engine and analysis of its parameters (4 hours)
• Determining of hourly fuel consumption changes, volumetric efficiency, air to
fuel equivalence ratio, brake specific fuel consumption and temperature of the exhausts versus engine load (bmeP) and/or power developed (kW).

- Determining of engine performance modes those suggest minimum brake specific fuel consumption.

2. Load characteristic of Otto engine and analysis of its parameters (4 hours)
- Determining of hourly fuel consumption changes, volumetric efficiency, air to fuel equivalence ratio, brake specific fuel consumption and temperature of the exhausts versus engine load (bmeP) and/or power developed (kW).
- Determining of engine performance modes those suggest minimum brake specific fuel consumption.

3. Regulator characteristic of Otto engine according ignition advance angle and analysis of its parameters (4 hours)
- Determining of optimum ignition advance angle that suggests minimum specific fuel consumption for various loading conditions and constant speed.

4. Indicating procedures in order to determine main parameters of the engine (4 hours)
- Introduction to engine indicating systems and apparatus used.
- Taking of indicator diagram and determining of main performance parameters of the engine.