Subject Code: IFJM M009

Title of the study subject in Lithuanian: Biodegalų inžinerija
Title of the study subject in English: Biofuels Engineering

Credit value: 6 ECTS credits, 160 hours, contact 72 hours, student independent work 88 hours.

Types of students' work and workload:

<table>
<thead>
<tr>
<th>Types of contact work</th>
<th>Hours</th>
<th>Types of independent work</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures</td>
<td>52</td>
<td>Preparation for laboratory works and their defence</td>
<td>12</td>
</tr>
<tr>
<td>Laboratory works</td>
<td>16</td>
<td>Individual work</td>
<td>24</td>
</tr>
<tr>
<td>Consultations</td>
<td>2</td>
<td>Control work</td>
<td>12</td>
</tr>
<tr>
<td>Examine</td>
<td>2</td>
<td>Preparation for examine</td>
<td>40</td>
</tr>
</tbody>
</table>

Subject status:

<table>
<thead>
<tr>
<th>Cycle of studies</th>
<th>Study program</th>
<th>Type of subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second</td>
<td>Engineering of biofuels</td>
<td>Main subject</td>
</tr>
</tbody>
</table>

Aim of the study subject: To provide the students with knowledge about biofuel production technologies, biofuel and biogas chemical and physical properties, using in the internal combustion engines, classification, construction, operation and management, to develop skills to select and evaluate power, economical and emission parameters of the exhaust.

Prerequisites for the study subject: postgraduate students should have completed the studies of the general university study subjects, i.e. mechanic or energetic engineering bachelors studies and to know general engineering subjects.

Outcomes of the study subject:

Knowledge and understanding:
- student should to know technical features and properties of the biofuels and various fuel blends;
- student should to know the fuelling systems of engines fuelled with biofuels;
- student should to know the preparation of combustible mixture and combustion peculiarities;
- student should to know the influence of various performance modes on the performance parameters fuelled with biofuels;
- student should to know the ways and methods of how to reduce emissions of the exhaust appearing from the engine fuelled with biofuels.

Abilities and skills:
- ability to analyse and evaluate properties of biofuels and various fuel blends;
- ability to analyse and evaluate the fuelling systems adapted for the biofuels usage;
- ability to adapt common fuelling systems for a work on biofuels
- ability to analyse and evaluate economical parameters of the engines running on biofuels;
- ability to choose methods allowing to reduce emissions of the exhaust when running on biofuels;
Value-based provisions:
- to achieve rational use of natural, human, technical and technological factors combined;
- to develop responsibility for a healthy environment;
- to be responsible for professional activity results;
- to be self-confident, self-respect and respect to other colleagues.

Assessment criteria for the outcomes of the study subject:
- the subject of study the basic concepts, terminology understanding and consumption;
- the absorption of the knowledge of study results.
- the application of the knowledge of study results into practice in different situation.
- performance quality of independent work, formulation of conclusions and generalizations.

Contents of the study subject:

Lectures – Contact hours (L-52 val., Kr -12 val., E -40 val.):

1. Production technologies of the biofuels (RME, bioethanol, biobutanol, bio ETBE and etc.). Production technologies of a second generation biofuels and their improvement. Production of liquid biofuels from synthetic gases (syngas) and production of alcohols from cellulose materials (L 2, Kr 3, E 1).


3. Types of biofuels, structure, main technical properties, determination methods and their influence on performance of the fuelling system, performance parameters of the engine and emissions of the exhaust (L 4, Kr 3, E 3).

4. Biofuels and chemical reactions of the combustion process, heat release, harmful for the environment components of the exhaust, the EU requirements and norms of the exhausts toxicity permissible by the EU standards (L 4, Kr 3, E 3).

5. Peculiarities of the biofuel using in the internal combustion engines. The influence of the biofuel technical properties on performance of the fuelling system, fuel supply pumps, fuel injection characteristics, penetration of the fuel spray tips into in-cylinder compressed air environment, atomisation of the fuel droplets and quality of combustible mixture (L 6, E 6).

6. The influence of biofuel properties, engine performance mods and control factors on the combustion process, engine effective parameters, noise and the composition of toxic components (L 4, E 3).

7. The properties of bioethanol and methanol and methods of using these fuels in the internal combustion engines, peculiarities, means and practice. Analyses of performance and emissions parameters of the engine exhaust when operating on alcoholic fuels (L 6, E 4).

8. Vegetable derived oils and the influence of their properties on effective parameters of diesel engines and emissions composition of the exhaust. Performance peculiarities of the fuelling system and the fuel filters, problems related to the carbons build up on the injectors and the combustion chamber internal surfaces and their solution methods (L 4, E 5).

9. Vegetable oil derived esters, the influence of esters and their blends with diesel fuel on engine performance parameters and emission of the exhaust. Experience in using of RME and other vegetable derived oil esters in the diesel engines (L 6, E 6).


11. Other alternative fuels and aviation jet fuels, their properties and using in the internal combustion engines possibilities (L 4, E 2).
12. Economical and ecological aspects of using of biological oils and lubricants in transport and power machines (L 2, E 2).

**Laboratory works (L - 16 val., Pl – 12 val.):**

1. Research of parameters of biodiesel fuel and its blends with diesel fuel (L 4, Pl 3).
2. Research of technical properties of petrol and alcohol fuel blends (L 4, Pl 3).
3. Research of performance and emission parameters of diesel engines fuelled with biofuels and their blends with diesel fuel (L 4, Pl 3).
4. Research of performance and emission parameters of Otto engines when operating on various petrol and alcohol fuel blends (L 4, Pl 3).

**Practical work and/or seminars:** unexpected

**Training practice:** unexpected, however for solving of special questions possible are excursions to biofuel production plants and biofuels using transport enterprises are available (individual work).

**Topic for the individual work:** The biofuel preparation and processing from biomass. Biofuel production technologies, properties of biofuels and peculiarities in using in the internal combustion engines. Specific term of the task is taken with regard to requests of student, his term of final work and the research activities.

**Methods of studying:** lectures, laboratory works, individual task, control work and examination. For the study visual (slides) means are and programme arrangement are used, textbooks, learning books, methodical guidance, computer equipment, models, the fuel injection pumps and engines units, cross-sections of various mechanisms and other means, explanation, discussion, problematic learning and analyses of situations. The students perform specific tasks at the laboratory works, fuel supply apparatus, petrol and diesel engine bench test stands are used and laboratory equipment. Defence is performed with each student individually. Specific task is performed by themselves and is defended publically in front of the auditorium, evaluated by mark.

**Structure and methods of cumulative assessment of student learning outcomes:** A ten-point criteria-based scale is applied for the assessment.

<table>
<thead>
<tr>
<th>Form of assignment</th>
<th>Weight score</th>
<th>Dates of assessment</th>
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</thead>
<tbody>
<tr>
<td>Laboratory works</td>
<td>0,15</td>
<td>prior to examination session</td>
</tr>
<tr>
<td>Individual task</td>
<td>0,20</td>
<td>3-1 week before examination session</td>
</tr>
<tr>
<td>Control work</td>
<td>0,15</td>
<td>after 1/3 of semester</td>
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<tr>
<td>Examine</td>
<td>0,50</td>
<td>during examination session</td>
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</table>

Every laboratory work and practical assignment are defended and assessed by a mark; only the laboratory work or practical assignment, which receives positive evaluation, are considered to be defended. The individual paper work is defended and assessed by a mark; only the work, which receives positive evaluation, is considered to be defended. Examination can be taken provided laboratory work, practical assignments and individual work all receive positive evaluations. Examination includes all the materials of the study subject and is taken in the written form; the final assessment is calculated provided the examination receives positive evaluation.
Interaction between study programme learning outcomes and study methods and methods of student learning outcomes assessment:

<table>
<thead>
<tr>
<th>Types of the outcomes of the study program</th>
<th>Outcomes of the study programme</th>
<th>Study subjects</th>
<th>Assessment methods of student learning outcomes</th>
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</thead>
<tbody>
<tr>
<td>Deeper knowledge of biomass production and conversion technologies and technological processes as well as theoretical understanding of operation principles</td>
<td>To know how to evaluate quality parameters of biofuels heat energy conversion in ICI and determining methods</td>
<td>Lectures and laboratory tests of fuel pumps and engines, case studies, visual means, analyses of changes occurring in the performance and emission parameters, discussions, individual paper work</td>
<td>Presentation of a laboratory work, practical, answering questions, discussion. A ten-point scale is applied for the assessment.</td>
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<tr>
<td></td>
<td>A student understands biofuel injection characteristics, heat-mass exchange processes and engine performance on biofuels theoretical rules</td>
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<td></td>
<td>A student is able to solve engineering questions, coordinating technical, qualitative, economical, and ecological aspects</td>
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<td></td>
<td>Investigation, analysis and evaluation of biomass properties, possibilities of its use, conversion technologies and technological processes in energetic and other branches of economy.</td>
<td>A student knows equipment used for biofuel production, their purpose and performance, chemical and physical properties of the biofuels, possible influence on the performance of the fuel supply apparatus and an engine work</td>
<td>Lectures and laboratory tests of fuel pumps and engines, case studies, analyses of changes occurring in the performance and emission parameters, discussions, individual paper work</td>
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<td>A student knows how to analyse the fuel injection characteristics, their effect on preparation of combustible mixture, engine performance parameters and emissions of the exhaust</td>
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<td>A student is able to evaluate and improve the bioenergy conversion efficiency in the internal combustion engine, predict performance parameters of the engine and changes occurring in the exhaust emissions</td>
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<td></td>
<td>Analysis and evaluation of energy consumption in companies of biomass production and processing for the improvement of technological processes and determination of the indicators of product lifecycle.</td>
<td>A student knows equipment used for biofuel production, their purpose and performance, chemical and physical biofuel properties, possible influence on the fuel injection apparatus and engine performance</td>
<td>Laboratory tests, case studies, analyses of situations, discussions, mind exchange</td>
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<td>A student knows how to analyse and evaluate chemical and physical properties of biofuels, how to select suitable biofuels for engines</td>
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<td>A student is able to compile and use the obtained knowledge for other studies programmes subjects, especially related to biofuels using in the automotive engine.</td>
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<tr>
<td>Ability to conduct analysis of biomass resources, as well as the study of the possibilities of implementing bioenergy projects and their impact on the environment.</td>
<td>A student is able to analyse and evaluate the influence of biofuels on the fuel injection and atomisation characteristics, preparation of combustible mixture and combustion processes in the engine cylinder.</td>
<td>Laborary tests of fuel pumps and engines, case studies, lectures, individual paper work analyses of changes occurring in the performance and emission parameters, discussions.</td>
<td>Presentation of a laboratory work, practical, answering questions, discussion. A ten-point scale is applied for the assessment.</td>
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<tr>
<td>A student is able to analyse and evaluate the influence of biofuels on effective parameters of Otto and Diesel engines and their emissions produced from the combustion of biofuels.</td>
<td>A student is self-confident and his intensities, responsible for professional activity’s results.</td>
<td>A student is able to evaluate himself, always ready to study the subject and improve his professional skill and competency.</td>
<td>A student with a good approach and respect to other colleagues.</td>
</tr>
</tbody>
</table>

**Main literature references for subject study:**

**Additional literature references for subject study:**