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Federal State Autonomous Educational Institution of Higher Education
PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA NAMED AFTER PATRICE
LUMUMBA
RUDN University

Academy of Engineering

educational division (faculty/institute/academy) as higher education programme developer

COURSE SYLLABUS

Reduction of internal combustion engine pollution issues

course title

Recommended by the Didactic Council for the Education Field of:

13.04.03. POWER ENGINEERING

field of studies / speciality code and title

The course instruction is implemented within the professional education programme of higher education:

Mechanical Engineering

higher education programme profile/specialisation title

1. The COURSE GOAL

The discipline "Reduction of internal combustion engine pollution issues" is included in the master's degree program "Mechanical Engineering" in the direction of 13.04.03 "Energy Engineering" and is studied in the 3rd semester of the 2nd year. The discipline is implemented by the Basic Department of Energy Engineering. The discipline consists of 13 sections and 13 topics and is aimed at studying the composition of exhaust gases of internal combustion engines and reducing their impact on the environment.

The purpose of mastering the discipline is to form students' knowledge about the nature of the impact of exhaust gases of internal combustion engines on the environment and methods for improving the environmental characteristics of reciprocating engines. To achieve this goal, the following tasks are solved in the course of teaching: - the analysis of the effect of harmful substances contained in the combustion products of fuel in the internal combustion engine on the environment is carried out; - methods and means of standardized tests of internal combustion engines on toxicity parameters are studied; - physico-chemical mechanisms of formation of harmful substances in the combustion chamber of the internal combustion engine are considered; - mathematical models of the formation of toxic components during combustion of fuel in an internal combustion engine are considered; - ways to reduce the toxicity and smokiness of exhaust gases of an internal combustion engine due to the impact on the workflow are analyzed; - ways to improve the environmental characteristics of an internal combustion engine by additional treatment of exhaust gases are studied; - organizational measures to reduce emissions of harmful substances from exhaust gases of an internal combustion engine are studied.

2. REQUIREMENTS FOR LEARNING OUTCOMES:

The following competences are formed in the study process.

Table 2.1. List of competences that students acquire during the course

| Competence code | Competence descriptor | Competence formation indicators |
|-----------------|--|---|
| GC-7 | Ability to search for the necessary sources of information and data, perceive, analyze, memorize and transmit information using digital means, as well as using algorithms when working with data obtained from various sources in order to effectively use the information received to solve problems; evaluate information, its reliability, build logical conclusions based on incoming information and data. | GC-7.1. To know the methods of collecting and processing information using digital means, as well as current Russian and foreign sources of information in the field of professional activity, principles, methods and means of solving standard tasks of professional activity using digital means and taking into account the basic requirements of information security; GC-7.2. Be able to apply methods of searching, collecting and processing information; using digital means, carry out critical analysis and synthesis of information obtained from various sources, and solve standard tasks of professional activity using digital means and taking into account the basic requirements of information security; GC-7.3. Possess methods of searching, collecting and processing, critical analysis and synthesis of information using digital tools to solve tasks, skills in preparing reviews, annotations, abstracts, scientific reports, publications and bibliographies on research work using digital tools and taking into account information security requirements. |

3. COURSE IN HIGHER EDUCATION PROGRAMME STRUCTURE

The subject refers to the variable component of (B1) block of the higher educational pro-

gramme curriculum.

Within the higher education programme students also master other disciplines and internships that contribute to the achievement of the expected learning outcomes as results of the subject mastery

Table 3.1. The list of the higher education programme components that contribute to the achievement of the expected learning outcomes as the course results

| Com- petence code | Competence descriptor | Previous courses/modules, internships* | Subsequent courses/modules, internships* |
|-------------------------|--|---|--|
| GC-7 | Ability to search for the necessary sources of information and data, perceive, analyze, memorize and transmit information using digital means, as well as using algorithms when working with data obtained from various sources in order to effectively use the information received to solve problems; evaluate information, its reliability, build logical conclusions based on incoming information and data. | Modern computer communication services; Geoinformation Systems and Applications; | |

* - in accordance with the matrix of competencies and the SUP EP VO

4. WORKLOAD OF THE COURSE AND FORMS OF STUDY WORK

General workload of the course 6 credits, 216 hours. Table 4.1. Form of study work of EP HE

| Type of academic activities | Total academic hours | Semester(s) | | | |
|--|----------------------|-------------|-----|--|--|
| | | 1 | | | |
| Contact academic hours | 54 | 54 | | | |
| including: | | | | | |
| Lectures (LC) | 18 | 18 | | | |
| Lab works (LW) | 18 | 18 | | | |
| Seminars (workshops / tutorials) (S) | 18 | 18 | | | |
| Self-studies academic hours | 90 | 90 | | | |
| Evaluation and assessment academic hours | 36 | 36 | | | |
| Course work / project, credits | 36 | 36 | | | |
| Course workload | academic hours | 216 | 216 | | |
| | credits | 6 | 6 | | |

5. CONTENT OF THE COURSE

Table 5.1. Content of the course

| The title of the section of the discipline | Content of the section (topic) | Types of educational work* |
|--|---|----------------------------|
| Section 1 Internal combustion engine operation and ecology. | Calculation of specific explosive emissions during internal combustion engine tests in accordance with the UNECE Regulations. | LC, SM, AW |

| | | |
|--|--|------------------------|
| Section 2 The toxicity of fuels and their combustion products in the internal combustion engine Gorenje. | Formation of an external velocity characteristic from the condition of smoke limitation. Determination of the UWT characteristic, optimal in terms of NO _x emissions and exhaust smoke. Complex effects on emissions of nitrogen oxides and soot. | LC, LR SM, AW |
| Section 3 International and domestic legal and regulatory technical documentation on the assessment of emissions of harmful substances and smokiness. | Legislation of Russia and foreign countries in the field of limiting harmful emissions of internal combustion engines. Test cycles. Regulated harmful substances in diesel exhaust gases and modern methods of reducing toxicity. | LC, SM, AW |
| Section 4 Methods for estimating emissions of harmful substances from exhaust gases of internal combustion engines. | The role of dispersed particles in the total toxicity of diesel exhaust gases, methods of their control and ways to reduce emissions. | LC, LR SM, AW |
| Section 5 Equipment for measuring the content of harmful substances, soot and dispersed particles in exhaust gases of internal combustion engines. | Gas analyzers. Smoke meters. The physical basis for measuring emissions of harmful substances from exhaust gases of internal combustion engines. | LC, SM, AW |
| Section 6 Toxicity test cycles. | Test cycles of internal combustion engines and vehicles to assess their environmental parameters. | LC, SM, AW |
| Section 7 Physico-chemical processes of formation of toxic components in internal combustion engines. | The physico-chemical basis of the formation of toxic components during the combustion of fuel in the internal combustion engine. | LC, LR SM, AW |
| Section 8 Methods of reducing the toxicity of internal combustion engines by influencing the workflow. | The use of particulate filters and their operating conditions. | LC, SM, AW |
| Section 9 The influence of design and regulatory factors on the emission of harmful substances with exhaust gases of the internal combustion engine. | The influence of regulatory parameters on emissions of harmful substances from exhaust gases of the internal combustion engine. | LC, LR SM, AW |
| Section 10 Methods of additional treatment of exhaust gases of internal combustion engines. | Methods of influencing the internal combustion engine workflow in order to reduce emissions of harmful substances from exhaust gases. Methods of oxidative and reductive neutralization of exhaust gases of internal combustion engines. | LC, SM, AW |
| Section 11 Mathematical modeling and computational optimization of internal combustion engines in terms of toxicity parameters. | Modeling the formation of nitrogen oxides in the combustion chamber of an internal combustion engine. Modeling the formation of carbon monoxide in the combustion chamber of an internal combustion engine. Modeling the formation of unburned and not completely burned hydrocarbons in the combustion chamber of an internal combustion engine. Modeling of soot formation in the combustion chamber of an internal combustion engine. | LC, SM, AW |
| Section 12 Internal combustion engine maintenance and emissions of harmful substances. | The impact of the frequency and quality of maintenance on internal combustion engine emissions. The change in the content of harmful emissions depending on the modes of operation of the internal combustion engine. The quality of the operational materials used. | LC, SM, AW |

| | | |
|---|---|------------------|
| Section 13 The use of alternative fuels and hybrid power plants to reduce harmful emissions. | Reducing the amount and composition of harmful emissions of internal combustion engines when using alternative fuels. Hybrid power plants. | LC, SM, AW |
|---|---|------------------|

* - LC – lecture, LR – laboratory work, SM – seminars; AW – Autonomous work

6. INTERNSHIP EQUIPMENT AND TECHNOLOGY SUPPORT REQUIREMENTS

Table 6.1. Technical Support Requirements

| A type of aclassroom | Technical Support Requirements | Special equipment, software |
|----------------------|---|---|
| For lectures | An auditorium for lecture-type classes, equipped with a set of specialized furniture; board (screen) and technical means of multimedia presentations | Technical means: projector Epson EH- TW5300 (LCD, 1080p 1920 x 1080, 2200Lm, 35000:1, 2 x HDMI, MHL, экран Draper Bar-onet NTSC (3:4) 244/96(8) 152*203 MW |
| For seminars | Auditorium for seminar-type classes, group and individual consultations, current control and intermediate certification, equipped with a set of specialized furniture and technical means of multimedia presentations | Computer class; technical equipment: personal computers, projection screen, multimedia projector, NEC NP-V302XG, Internet access. Software: Microsoft products (OS, office suite, incl. MS Office/Office 365, Teams, Skype), |
| For autonomous work | Auditorium for independent work of students (can be used for seminars and consultations), equipped with a set of specialized furniture and computers with access to the EIOS | Computer class; technical equipment: personal computers, projection screen, multimedia projector, NEC NP-V302XG, Internet access. Software: Microsoft products (OS, office suite, including. MS Office/Office 365, Teams, Skype) |

7. RESOURCES RECOMMENDED FOR THE COURSE:

Main literature:

1. Гусаков С.В. Физико-химические основы процессов смесеобразования и сгорания в ДВС. Основы теории горения: Учебн. пособие. М.: Изд-во РУДН, 2001. 134 с.
2. Горбунов В.В., Патрахальцев Н.Н. Токсичность двигателей внутреннего сгорания. М.: Изд-во РУДН, 1998. 214 с.
3. Кульчицкий А.Р. Токсичность автомобильных и тракторных двигателей: Учеб. пос. для высшей школы. 2-е изд., испр. и доп. М.: Академический проспект, 2004. 400 с.
4. Марков В.А., Баширов Р.М., Габитов И.И. Токсичность отработавших газов дизелей. 2-е изд., перераб. и доп. М.: Изд-во МГТУ им. Н.Э. Баумана, 2002. 376 с.
5. Гусаков С.В. Методика многопараметрической оптимизации дизеля по токсичности и топливной экономичности.- Вестник РУДН: Серия «Инженерные исследования». – М.: Изд-во РУДН. №1(8), 2004, С.9-11.

Additional readings:

1. Зельдович Я.Б., Садовников П.Я., Франк–Каменецкий Д.А. Окисление азота при горении. – М.: Изд-во АН СССР, 1947. –147с.
2. Звонов В.А. Токсичность двигателей внутреннего сгорания. М.: Машиностроение, 1981. 160 с.
3. Звонов А.В, Корнилов Г.С., Козлов А.В., Симонова Е.А. Оценка и контроль выбросов дисперсных частиц с отработавшими газами дизелей. М.: Прима-Пресс-М, 2005. 312 с.
4. Кинетика образования и разложения загрязняющих веществ при горении. К.Т. Боумен (Калифорнийский ун-т, Беркли, США/ Образование и разложение загрязняющих веществ в

пламени. – М.: Машиностроение, 1981. – С. 59–84.

5. Лиханов В.А., Сайкин А.М. Снижение токсичности автотракторных дизелей. М.: Колос, 1994. 224 с.

6. Морозов К.А. Токсичность автомобильных двигателей. М.: Легион-Автодата, 2000. 80 с.

7. Толшин В.И., Яқунчиков В.В. Режимы работы и токсичные выбросы ОГ судовых дизелей. М.: МГВАТ, 1999. 190 с.

Electronic library systems:

1. Electronic libraries (EL) of RUDN University and other institutions, to which university students have access on the basis of concluded agreements:

- RUDN Electronic Library System (RUDN ELS) <http://lib.rudn.ru/MegaPro/Web>
- EL "University Library Online" <http://www.biblioclub.ru>
- EL "Yurayt" <http://www.biblio-online.ru>
- EL "Student Consultant" www.studentlibrary.ru
- EL "Lan" <http://e.lanbook.com/>
- EL "Trinity Bridge"

2. Databases and search engines:

- electronic foundation of legal and normative-technical documentation <http://docs.cntd.ru/>
- Yandex search engine <https://www.yandex.ru/>
- Google search engine <https://www.google.ru/>
- Scopus abstract database <http://www.elsevierscience.ru/products/scopus/>

The training toolkit and guidelines for a student:

1. Collection of lectures on the course Reduction of internal combustion engine pollution issues.

* The training toolkit and guidelines for the course are placed on the internship page in the university telecommunication training and information system under the set procedure.

8. ASSESSMENT TOOLKIT AND GRADING SYSTEM* FOR EVALUATION OF STUDENTS' COMPETENCES LEVEL AS INTERNSHIP RESULTS

The assessment toolkit and the grading system* to evaluate the level of competences (competences in part) formation as the course Reduction of internal combustion engine pollution issues results are specified in the Appendix to the internship syllabus.

* The assessment toolkit and the grading system are formed on the basis of the requirements of the relevant local normative act of RUDN University (regulations / order).

DEVELOPERS:

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position, educational department

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