Federal State Autonomous Educational Institution for Higher Education
Peoples' Friendship University of Russia named after Patrice Lumumba
(RUDN University)
Engineering Academy

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

Base Department "Power Engineering"

(department realizing the PhD program)

COURSE SYLLABUS

Theory of working processes of heat engines (special chapters)

(course title)

Scientific specialty:

2.4.7 Turbomachines and Piston Engines

(scientific speciality code and title)

The course instruction is implemented within the PhD programmes:

Turbomachines and Piston Engines

(PhD program title)

2025

1. DISCIPLINE (MODULE) GOAL

The purpose of mastering the discipline "Theory of working processes of heat engines (special chapters)" is the preparation for the candidate's examinations, as well as the acquisition of knowledge, skills and experience in the research field, characterizing the stages of the formation of competencies and ensuring the achievement of the planned results of mastering the educational program.

The main objectives of the discipline are:

- teaching the basics of theoretical studies of thermal, gas-dynamic, hydraulic, mechanical, physico-chemical and information processes occurring in heat engines;
- formation of modern ideas about research related to power engineering;
- formation of ideas about the basic concepts, stages, logic of scientific research;
- explanation of the theoretical foundations of the strategy for conducting scientific research in the field of production, distribution of thermal energy, control of its flows and conversion of other types of energy into heat;

2. REQUIREMENTS TO PHD-STUDENTS ON FINISHING THE COURSE

Mastering the discipline " Theory of working processes of heat engines (special chapters) " is aimed at preparing for the candidate's examinations, as well as mastering the following competencies:

Know:

- basic schemes, classifications, principle of operation of turbomachines and piston engines;
- physical foundations of thermal physics occurring in the main units of heat engines;
- the main types of diagnostics of heat engines.

Be able to:

- apply the methods of differential and integral calculus, when solving problems of stationary and non-stationary heat and mass transfer;
- to make thermal calculation;
- calculate energy losses.

Own:

- methods of designing turbomachines and reciprocating engines;
- methods of analysis of heat and mass transfer in the technological process;
- methods for increasing the efficiency of heat engines;
- methodology for conducting the main types of diagnostics of heat engines.

Have an idea about:

- modern methods of operation of heat engines;
- difficult operating conditions;
- thermal processes in the main parts of thermal engines.

3. WORKLOAD OF THE DISCIPLINE AND TYPES OF ACTIVITIES

The total complexity of the discipline "Theory of working processes of heat engines (special chapters)" is 3 credit units.

Table 3.1. Types of educational work by periods of mastering the postgraduate program

Type of study work		**TOTAL**, acc.h.	**semester** **2**
Contact work, acc .		*18*	*18*
including:			
Lectures (**LK**)		thirty	thirty
Practical/seminar sessions (**SZ**)		thirty	thirty
Independent work of students, acc .		*48*	*48*
Control (test with assessment), acc .			
The total complexity of the discipline	ac.h.	**108**	**108**
	credit.ed.	**3**	**3**

4. CONTENT OF THE DISCIPLINE

Table 4.1. The content of the discipline (module) by type of educational work

Name of the discipline section	**Contents of the section (topic)**	**Type of study work**
Section 1 Thermodynamic cycles of reciprocating engines	Working process in piston engines. Carnot cycle. Generalized thermodynamic cycle of reciprocating and combined engines. Otto cycle. Diesel cycle. The Trinkler Cycle . Thermodynamic cycles of combined engines. Thermodynamic Stirling cycle. Thermodynamic cycle of rotary internal combustion engines. Miller cycle. Compression ignition (HCCI) process. The main characteristics of the internal combustion engine.	LK, SZ
Section 2. Thermodynamic parameters of the working fluid	Molecular masses, volumetric and mass fractions of components and thermophysical properties of the components of the working fluid (heat capacity, gas constant, lower calorific value). Theoretical required amount for combustion of 1 kg of fuel. Features of changing the parameters of the working body	LK, SZ
Section 3. Modeling the workflow in the internal combustion engine	The concept of a model. single zone model. Dual zone model. multizone model. Indicator and effective indicators of the engine. Thermal balance.	LK, SZ
Section 4. Injection and atomization of fuel in the internal combustion engine	Fuel injection in petrol and diesel engines. Fuel injection characteristics. Influence of multiple injection on the efficient and environmental performance of the workflow. The theory of liquid fuel jet decay.	LK, SZ
Section 5. Methods for calculating heat release in	The main types of heat release. One-time heat dissipation. Kinetic and diffusion phases of the	LK, SZ

Name of the discipline section	Contents of the section (topic)	Type of study work
internal combustion engines	combustion process. Double heat dissipation. Calculation of heat release based on a bimolecular reaction. Calculation of heat release based on the theory of chain reactions. Wiebe's law . An indicator of the nature of combustion.	
Section 6. Heat transfer in internal combustion engines.	Evolution of the doctrine of heat transfer in internal combustion engines. Nusselt formula. Voshni formula .	LK, SZ
Section 7. Thermal insulation of parts and its effect on the working process of the internal combustion engine	Thermal insulation of the combustion chamber. "Adiabatic" engine. Engine with low thermal losses. Natural thermal insulation of the combustion chamber. Non-stationary temperature and heat flux on the surface of the soot layer. Determination of the local thickness of the soot layer. Artificial thermal insulation of the combustion chamber and its effect on fuel consumption. Vushni effect . Features of the working process at high temperatures of the surface of the combustion chamber. Improvement of the working process of a diesel engine with artificial thermal insulation of the combustion chamber.	LK, SZ

5. EQUIPMENT AND TECHNOLOGY SUPPORT REQUIREMENTS

Table 5.1. Logistics of discipline

Audience type	Audience equipment	Specialized educational / laboratory equipment, software and materials for mastering the discipline (if necessary)
Lecture	An auditorium for lecture-type classes, equipped with a set of specialized furniture; board (screen) and technical means of multimedia presentations.	projector, screen, computer, chalkboard
Seminar	An auditorium for conducting seminar-type classes , group and individual consultations, current control and intermediate certification, equipped with a set of specialized furniture and technical means for multimedia presentations.	projector, screen, computer, chalkboard
For independent work of students	An 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.	projector, screen, computer, chalkboard

* - the audience for independent work of students is required!

6. METHODOLOGICAL SUPPORT AND LEARNING MATERIALS

Main literature:

1. Kavtaradze R.Z. Theory of piston engines. Textbook for universities. - M.: Publishing house of MSTU im. N.E. Bauman, 2016.-720 p. http://ebooks.bmstu.press/catalog/198/book1502.html

2. Kavtaradze R.Z. Local heat transfer in reciprocating engines . - 3rd ed. revised . and additional - M .: Publishing house of MSTU im. N.E. Bauman, 2016.-520 p. https://www.studmed.ru/kavtaradze-rz-lokalnyy-teploobmen-v-porshnevyh-dvigatelyah_3824853ec7c.html

3. Patrakhaltsev N. N. Characteristics of internal combustion engines [Text / electronic resource]: Textbook / - Electronic text data. - M. : Publishing House of RUDN University, 2012. - 153 p. : ill. - ISBN 978-5-209-04247-1: 86.66. http://lib.rudn.ru/MegaPro2/Web/SearchResult/ToPage/1

Additional literature:

1. Combined internal combustion engines: A textbook for university students. / N. D. Chainov , N. A. Ivashchenko, A. N. Krasnokutsky , L. L. Myagkov; Ed. N. D. Chainova .- M .: Mashinostroenie, 2008. - 496 p. https://www.twirpx.com/file/346021/

2. Patrakhaltsev N. N. Improving the economic and environmental qualities of internal combustion engines based on the use of alternative fuels [Text / electronic resource]: Textbook / - M.: Publishing house of RUDN University, 2008. - 267 p. : ill. - (Priority national project "Education": A complex of export-oriented innovative educational programs in priority areas of science and technology). - Application: CD ROM (Electrical resource). - 94.64. http://lib.rudn.ru/MegaPro2/Web/SearchResult/ToPage/1

3. Patrakhaltsev N. N. Supercharging of internal combustion engines [Text]: Textbook / - M.: Publishing house of RUDN University, 2003, 2006. - 319 p. - ISBN 5-209-01501-7 : 125.00. http://lib.rudn.ru/MegaPro2/Web/SearchResult/ToPage/1

Resources of the information and telecommunications network "Internet":

1. RUDN ELS and third-party ELS, to which university students have access on the basis of concluded agreements:

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

2. Databases and search engines:

- electronic fund of legal and normative-technical documentation http://docs.cntd.ru/
- Yandex search engine https:// www .yandex.ru/

Google search engine https://www.google.ru/

- abstract database SCOPUS http:// www .elsevierscience.ru/ products / scopus /

Educational and methodological materials for independent work of students in the development of the discipline/module:*

1. A course of lectures on the discipline "Methodology of scientific research".
2. Guidelines for self-study

* - all educational and methodological materials for independent work of students are placed in accordance with the current procedure on the page of the discipline in TUIS!

7. ASSESSMENT TOOLKIT AND GRADING SYSTEM FOR MIDTERM ATTESTATION OF STUDENTS IN THE DISCIPLINE (MODULE)

Assessment toolkit and a grading system to evaluate the level of competences (competences in part) formation as the course results are specified on the TUIS platform.

DEVELOPERS:

Associate Professor of the Department of Power Engineering		Smirnov S.V.
Position, BUP	Signature	Surname I.O.

HEAD OF BUP:

Department of Power Engineering		Radin Yu.A.
Name of BUP	Signature	Surname I.O.