

Документ подписан простой электронной подписью
Информация о владельце:
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Должность: Ректор
Дата подписания: 24.04.2014 10:36:57
Уникальный программный ключ:
ca953a0120d891083f939673078ef1a989dae18a

**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

COURSE DESCRIPTION

13.04.03 Power Engineering

speciality code and title

Mechanical Engineering

higher education programme profile / specialisation title

Disciplines are studied as part of the curriculum hire educational program « Mechanical Engineering » in the field of training 13.04.03 Power Engineering

Course Title	"Russian language (as a foreign language)inprofessionalactivityииностранный) в профессиональной деятельности"
Course Workload, credits / academic hours	6 / 216
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 1. Introductory Phonetic and Grammatical course	Topic 1.1. Pronunciation and Spelling
	Topic 1.2. Introductory listening and Speaking
	course Topic 1.3. Formation of plural nouns. Request expression
Section 2. Elementary level	Topic 2.1. Gender of nouns. Possessive pronouns.
	Topic 2.2. Expression of time in a simple sentence
	Topic 2.3. The concept of the Russian verb. The creative case of nouns.
	Topic 2.4 Creative case of nouns. The verb TO WANT.
	Topic 2.5. Model of past tense formation from verbs with constant stress based
	on Topic 2.6. Model of past tense formation from verbs with variable stress.
	Topic 2.7. Constructions <i>need + infinitive, can + infinitive, What you need (can) + infinitive</i>
	Topic 2.8. Complex future tense of verbs.
	Topic 2.9. The verb <i>to learn</i> in the present, past and future tense.
	Topic 2.10. The verb <i>to speak</i> in the present, past and future tensesand. An imperative.
	Topic 2.11. The verb <i>to teach</i> in the present, past and future tensesand..
	Topic 2.12. Expression of the absence of the subject (<i>it is not</i> present). Phone conversation etiquette.
	Topic 2.13. Constructions <i>I have (was, will be)</i> and <i>I do not (did not, will not)</i> .
	Topic 2.14. Конструкция <i>I like the design</i> . Comparison of typical contexts of using the verbs <i>love</i> and <i>like</i> .
	Topic 2.15. Prepositional case of place.
	Topic 2.16. Expression of time in a simple sentence. Prepositional verbs.
	Topic 2.17. Phone conversation etiquette. Formation of a simple comparative degree of adverbs
	Topic 2.18. Creative case in the sense of joint action
	Topic 2.19. General idea of verbs of movement. Accusative case to indicate the direction of movement.
	Topic 2.20. Verbs of the group <i>go</i> and <i>walk</i> in the future and past tensesand..
Section 3. Basic level	3.1. Case classification. Prepositional case and its meanings. Prepositional places and position verbs (<i>lie, sit, stand, hang</i>). Prepositional case in the meaning of the object of thought (<i>about whom? about what?</i>).
	3.2. The genitive case and its meanings. Genitive case with prepositions <i>for, without, from, about, from, y, with, around, past</i>
	3.3. Types of verbs. The use of NSV and SV in the past tense, in the infinitive and imperative. The accusative case and its meanings. Accusative case of the object. Transitive verbs <i>read-read, write-write,</i>

	look-see, see-see, ask-ask, wait-wait, hear-hear, invite-invite, eat-eat, drink-drink, buy-buy, receive-receive, search-find, take-take
	3.4. Accusative case of direction. The verbs go-go, come-come, enter-enter, exit-exit, leave - leave, come - come.
	3.5. The dative case and its meanings. Dative case of the addressee of the action (to whom?). Verbs give - give, send-send, pay-pay, answer-answer, help – help. Dative case in impersonal constructions (I'm cold, etc.). Predicative adverbs denoting a person's feelings and state.
	3.6. The creative case and its meanings. Creative case in the meaning of an instrument of action (writing with a pen). Creative case with prepositions with, next to, over, under, near, before, between. Verbs meet – meet.

Course Title	«Philosophical issues of technical knowledge / Философские вопросы технических знаний»
Course Workload, credits / academic hours	3 / 108
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 1. Scientific and technical knowledge in the socio-cultural dimension.	Traditional culture and technogenic civilization: problems of development and interaction. Place and role of science and technology in the culture of technogenic civilization. Global crises and the problem of the value of scientific and technological progress.
Section 2. Philosophy of technology: problems, tasks and role in culture.	Philosophy of technology as a modern non-classical philosophical discipline. Object and subject of the philosophy of technology. The main problems and tasks of the philosophy of technology. The main Course Module Title of the philosophy of technology. Specifics of the philosophy of technology.
Section 3. Scientific and technical knowledge of the ancient world and antiquity.	Technical knowledge of the Ancient world and Antiquity. Religious and mythological understanding of practical activities in ancient cultures (Egypt and Mesopotamia). The distinction between "techne" and "episteme" in antiquity.
Section 4. Scientific and technical knowledge in the Middle Ages	Christian worldview and features of science and technology in the Middle Ages. Labor as a form of service to God. The role of universities in bringing practical orientation to the field of intellectual activity. Influence of Arabic sources and techniques of the medieval East.
Section 5. The emergence of interrelations between science and technology. Technical knowledge of the Renaissance	Changing attitudes to invention. Personalized synthesis of scientific and technical knowledge: artists and engineers, universal scientists of the Renaissance: Leon Batista Alberti, Leonardo da Vinci, Albrecht Durer, etc.
Section 6. Changing the socio-cultural paradigm of technology and science development in modern times.	The Scientific Revolution of the 17th century: the formation of the experimental method and the mathematization of natural science as prerequisites for the application of results in technology. Francis Bacon's "Arts and Sciences" reunion program.
Section 7. Science as a factor of technogenic civilization.	Organizational design of science. Universities and academies as communities of experimental scientists: academies in Italy, Royal Society of London, Paris Academy of Sciences, St. Petersburg Academy of Sciences. The beginning of the convergence of science and various spheres of human practice-crafts, military affairs, navigation. The Industrial Revolution of China in the 18th and 19th centuries.

Course Title	«Philosophical issues of technical knowledge / Философские вопросы технических знаний»
Course Workload, credits / academic hours	3 / 108
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 8. Science and technology as socio-cultural phenomena.	Multifunctionality of science. Basic concepts of scientific means of "knowledge production" - theories, methods, technical equipment of scientific research. Science and technology from interaction to integration. Science as an integral part of the modern market
Section 9. Science and technology in the culture of the future.	The danger of alienating science and technology, their goals and results from people. Will science remain a knowledge factory that serves the various needs of a man-made civilization? Science and technology and global problems. "Philosophy of optimism" before a new challenge of history. Culture at the turn of the millennium in search of new spiritual landmarks.

Course Title	«Modern energy technology / Современные энергетические технологии»
Course Workload, credits / academic hours	4/ 144
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 1. Introduction	Basic concepts and definitions. Ensuring energy security. The main provisions of the law of the Russian Federation. Modern problems of ecology and resource conservation, applied to internal combustion engines
Section 2. VER	Review of ways to improve the efficiency of using fuel and energy resources. Secondary energy resources (SER). Energy saving in buildings and structures. Accounting and regulation of energy consumption. Heat pump installations.
Section 3. Energy saving	Organization and promotion of energy saving. Economic incentives. Energy saving in Russia and abroad. Energy planning, energy audit.
Section 4. Renewable energy	Production of energy based on renewable sources. Hydroelectric power industry. Wind power industry. Secondary energy. Bioresources. Geothermal energy.
Section 5. TNU	Classification of heat pump installations (HPI). Characteristics of low-potential heat sources.
Section 6. Secondary resources of the heat engine	Heat balance. Characteristics of secondary resources of a heat engine. Application of high-pressure fuel assemblies to increase the use of heat engines in the SER.
Section 7. Modern	internal combustion engines with adaptive workflow. Engines with controlled valve timing. Modern methods of joint management of fuel supply and air supply. Modern fuel systems.
Section 8 Ecology and energy saving	Environmental problems of power engineering. Energy saving by industry sector.

Course Title	«Modern issues of power engineering science and manufacture / Современные проблемы науки и производства в энергетическом машиностроении»
Course Workload, credits / academic hours	4 / 144
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 1. Current state of the world and Russian thermal power industry and its prospects	Main generating capacities of Russia and their technical level. Distribution of generating capacities, their age, ability to provide guaranteed electricity supply. Power system load graphs and problems of their coverage. Prospects for the development of global and Russian energy. Prospects for the development of gas-turbine and combined-cycle gas technologies.
Section 2. Problems of improving the efficiency and reliability of internal combustion engines and combined installations	Modern internal combustion engines: their design, parameters, applications. Examples of the best foreign internal combustion engines. The main problems of creating competitive internal combustion engines in Russia. Scientific problems of developing engine systems, improving the combustion process, and reducing toxic emissions. Maintenance issues. Scientific and practical problems of reliability of internal combustion engines.
Section 3. Energy saving	Organization and promotion of energy saving. Economic incentives. Energy saving in Russia and abroad. Energy planning, energy audit.
Section 4. Prospects for the development of hydroelectric	power engineering General information about current problems of science and technology of power engineering in the profile of training. The achieved level of excellence and unresolved problems of the power plant equipment and the working process of the hydro turbine. Energy pumps – problems and ways to solve them. Modern scientific and applied problems in the field of volumetric hydraulic machines, hydraulic-, and pneumatic systems and aggregates.
Section 5. Advanced materials in thermal and hydro power engineering and engine	building Structural materials in thermal and hydro power engineering. Structural materials used in engine building. Requirements for structural materials in the heat and hydro power industry. Promising materials in engine building.
Section 6. Modern liquid fuels for internal combustion engines	Liquid hydrocarbon fuels. Analysis of quality indicators of liquid hydrocarbon fuels with the aim of their influence on the working process of internal combustion engines. Advantages of light fuel injection.
Section 7. Alternative fuels	Types of alternative fuels their physical and chemical properties. Promising fuels for internal combustion engines. Analysis of the use of alternative fuels in internal combustion engines.

Course Title	"Mathematical modeling of thermal processes / Математическое моделирование тепловых процессов"
Course Workload, credits / academic hours	3 / 108
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 1. Principles of mathematical modeling: concepts of modeling in mechanics; elementary	Aristotle's principle. Galileo's principle of relativity. Fundamental laws of nature. Variational principles. Using analogies to build models.

Course Title	"Mathematical modeling of thermal processes / Математическое моделирование тепловых процессов"
Course Workload, credits / academic hours	3 / 108
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
mathematical models	
Section 2. Obtaining models from the fundamental laws of nature: with the protection of the mass of matter; with the protection of energy; with the protection of the number of particles.	Hierarchical approach to getting models. Particle flow in the pipe. Basic assumptions about the gravitational regime of ground water flow. Mass balance in the ground element. Closure of the law of conservation of mass. On some properties of the Boussinesq equation.
Section 3. Joint application of several fundamental laws: comparative concepts of gas dynamics; the equalization of gas dynamics in Lagrangian coordinates.	Preliminary information about heat transfer processes. Derivation of Fourier's law from molecular-kinetic representations. Heat balance equation. Statement of typical boundary conditions for the heat conduction equation. Basic concepts of the theory of thermal radiation. Balance equation for the number of photons in a medium. Using the law of conservation of energy. Continuity equations for compressible media. Equations of gas motion. The energy equation. Boundary conditions for gas dynamics equations in Lagrangian coordinates. Some features of gas dynamics models.
Section 4. Models based on variational principles: Hamilton's variational principle; scalar string vibrations.	Simple waves in Lagrangian coordinates. Hamilton's principle as the foundation of mechanics. Derivation of an equation based on Hamilton's variational principle.
Section 5. Hierarchical chain of models: The Boltzmann equation for moments of the distribution function.	Description of a set of particles using the distribution function. Boltzmann equation for the distribution function. Maxwell's distribution and the H-theorem. Chain of hydrodynamic gas models.
Section 6. Research of mathematical models of Dimension.	Dimension – power monomial. Dimensional analysis. Proof of Buckingham's theorem. Illustrative examples. Dependence of the filling time of a vessel of a given volume on the pressure drop at the ends of the tube. The point explosion problem. Similarity. Examples of physical modeling. Strong heat waves. Strong blast waves. Auto-similarity. Intermediate asymptotics. Border layer on the plate. Rotation of the liquid in a cylindrical vessel.

Course Title	«Fuel heat engine co-generation plant / Когенерационные установки на базе тепловых двигателей»
Course Workload, credits / academic hours	4 / 144
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 1. Current state of energy	Basic concepts and definitions. Ensuring energy security. The main provisions of the Law of the Russian Federation "On Energy Saving". Cogeneration, trigeneration. Cogeneration in Russia and abroad.

Course Title	«Fuel heat engine co-generation plant / Когенерационные установки на базе тепловых двигателей»
Course Workload, credits / academic hours	4/ 144
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 2. International соглашения	The Montreal Protocol, the Kyoto Agreement and the Paris Agreements on Climate Protection.
Section 3. Secondary energy	Secondary energy resources (SER). Classification of SER.
Section 4. Regulatory framework for energy saving	Accounting and regulation of energy consumption. Organization and promotion of energy saving using SER. Economic incentives. Energy planning, energy audit.
Section 5. Energy production based on renewable sources	Hydropower. Wind power industry. Solar energy. Bioresources. Geothermal energy.
Section 6. Heat pump installations	Classification Heat pump installations Classification of heat pump installations. Characteristics of low-potential heat sources. Theoretical foundations of steam-compression heat pump installations (SCHPI). Ways to improve the efficiency of SCHPI. Working agents for SCHPI. Problems of using freons. Application of high-pressure fuel assemblies to improve the efficiency of using SER heat engines.
Section 7. Overview of types of cogeneration installations	Overview of ways to improve the efficiency of using fuel and energy resources. Cogeneration plants based on internal combustion engines. Cogeneration plants based on STP. Cogeneration plants based on GTU.

Course Title	«Modern computer communication services / Современные компьютерные коммуникационные технологии»
Course Workload, credits / academic hours	6/216
6/216 COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 1. The <i>MathCAD software product</i> .	Introduction. Defining variables and functions. Creating vectors and matrices. Calculations with arrays. Vector and matrix operators and functions. Programming: creating programs, conditional statements, loops. Solving linear and nonlinear equations. Data files. Data interpolation and approximation. Graphs: types and construction methods.
Section 2. Computer-aided design systems	The concept of computer-aided design systems (CAD). Modular principle of organization of automated calculation systems. Development of calculation schemes. Requirements for calculation schemes. Calculation of geometric parameters of flat shapes: area, static moments of inertia, coordinates of the center of gravity, moments of resistance, position of the main central axes. Build programs from modules. Export and import information to <i>MathCAD</i> .
Section 3. Development of application programs	The process of developing an application program: the stage of problem formulation, the stage of developing a calculation scheme, mathematical formulation of the problem (development of a mathematical model), development of numerical algorithms, programming.

Course Title	«Modern computer communication services / Современные компьютерные коммуникационные технологии»
Course Workload, credits / academic hours	6/216
6/216 COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 4. Software blocks for profiling strong parts of blade machines	Software block for constructing a nozzle profile defined by the coordinate method. Software block for constructing the working profile of a turbine blade defined by conjugate arcs of circles. Program block for calculating the axial turbine stage. Innovative methods for profiling strong parts of shovel machines.

Course Title	"Internal Combustion Engine test methods / Методы испытаний двигателей внутреннего сгорания"
Course Workload, credits / academic hours	7/252
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 1. Analysis of types of experimental studies. Methods for planning experimental studies	Types of experimental studies, концепции planning concepts and experimental plan, screening and extreme experiments, reducing the number of variables.
Section 2. Application of methods of probability theory and mathematical statistics for processing and analysis of experimental research	Probability theory in experimental practice, distribution functions of random variables. Variational series, statistical characteristics, variance, and errors. Analysis of errors in recording and processing experimental data. Confidence interval and plotting experimental functions. Construction and analysis of the regression equation based on experimental data.
Section 3. Application of variance, factor correlation and regression analysis in experimental studies	Variance analysis, factor analysis, correlation analysis, regression analysis. Planned experiment, checking the adequacy of mathematical models. Compare, document, and present experimental data.
Section 4. Experimental planning method for village testing	Planning, processing and analysis of experimental data for testing turbines с using программы the "PLANEX" program. Methods of testing turbines. Measurement theory and instrumentation. Electrical measurement systems. Determination of engine power. Speed measurement. Pressure measurement. Temperature measurement. Cost measurement. Gas analysis. Determination of engine toxicity. Engine indexing. Determination of turbine noise and vibrations. Determination of turbine characteristics.
Section 5. Features of village testing	Application of the planned experiment method in village testing steam and gas turbines

Course Title	«Special chapters of the theory of heat engines / Спец главы теории тепловых двигателей»
Course Workload, credits / academic hours	4/144
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 1. Introduction to the theory of combined internal combustion	The concept of a supercharged engine; the concept of a combined internal combustion engine (CVDS). Supercharging of gasoline engines, supercharging of diesel engines. Compressors, superchargers, and turbochargers.

Course Title	«Special chapters of the theory of heat engines / Спец главы теории ТЕПЛОВЫХ ДВИГАТЕЛЕЙ»
Course Workload, credits / academic hours	4/144
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 2. Thermodynamic justification for the use of internal combustion engine boost	The air charge density p_k , the relationship with the valve timing phases of 2-stroke and 4-stroke internal combustion engines, the relationship between power and boost pressure, piston speed and rotation speed. Comparison of two engines of the same design with and without supercharged boost. <i>"Mechanical" supercharging</i> (from the drive supercharger).
Section 3. Compressors. Turbochargers	Types of superchargers (compressors). Volumetric (piston, plate or slide, bladed and multi-bladed or Root type, screw or Elliot type), their characteristics, their areas of application. Centrifugal pumps. Their characteristics, advantages and disadvantages. Wave exchangers (Comprex), operating principle, characteristics, области applications.). Comparison of weight and size parameters of different types of superchargers. (gas turbochargers – GTN). Gas turbine supercharging (supercharging from a free GTN). The principle of the device and operation. Regulation by discharge valves. Engine consumption characteristics. (ps. <i>Design and theory of compressors and turbines - in the courses " Supercharging units" and "Turbomachines"</i>). Alignment системы of the GTN system on engines. Placement of GTN on the engines of cars, marine installations, construction and road vehicles , т. etc . (ps. <i>Basic requirements for the installation and dismantling of gas turbine engines, diagnostic operations, repair and post-repair control - in the course "Technical operation and repair of internal combustion engines"</i>). <i>GTN for increasing power</i> : compression pressure and compression ratio, pistons and their cooling systems, combustion chambers, valves, thermal insulation of injectors, cylinder block, connecting rod bearings, gas exchange phase adjustments, fuel supply, cooling system , lubrication and filtration system. Starting the supercharged engine.
Section 4. Engine modification using gas turbine supercharging	Engine modification using supercharging: fuel supply, lubrication, cooling, gas exchange systems, combustion chambers; start-up problems. Advantages of supercharged engines: power, efficiency, durability, dimensions, environmental qualities, fuel resources, applicability in different markets consumers, in non-standard conditions.
Section 5. Start-up systems, intake and exhaust manifolds and intercooling of air	Intake and exhaust manifolds placement schemes: supercharging with a pulse turbine and a constant pressure turbine, schemes for changing pressure waves in exhaust manifolds, pulse converters, schemes for their inclusion in the diesel GTN system. Charge air coolers are water - air, air-to-air. <i>GTN to reduce the toxicity and smokiness</i> of emissions. Influence of exhaust gas neutralization systems on GTN operation. Historical background, boost diagrams, boost control, boost engine workflowom
control Section 6. Boost engines with forced ignition	Comparison of indicator diagrams for supercharged and non - supercharged engines: compression ratio, continued expansion, decrease in V_c , increase in λ , increase in L_t operation and thermal efficiency. of the $n-t$ cycle. Starting the supercharged engine.
Section 7. Special supercharging systems	Comparison of the speed characteristics of diesels with different supercharging systems: "Classic" GTN, supercharging controlled by discharge valves (Booster), with an additional supercharger, GTN driven

Course Title	«Special chapters of the theory of heat engines / Спец главы теории ТЕПЛОВЫХ ДВИГАТЕЛЕЙ»
Course Workload, credits / academic hours	4/144
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
	through a planetary gearbox (differential drive), Hyperbar system, adjustable supercharging and Maxidine system, dynamic supercharging, two-stage supercharging.

Course Title	«Reduction of internal combustion engine pollution issues / Проблемы снижения вредных выбросов ДВС»
Course Workload, credits / academic hours	6/216
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
<p>Topic 1. Operation of internal combustion engines and ecology.</p> <p>Topic 2. Harmful internal combustion engine emissions.</p> <p>Topic 3. Test cycles.</p> <p>Topic 4. Methods of reducing the toxicity of internal combustion engines.</p> <p>Topic 5. Mathematical modeling of internal combustion engines by Parameters toxicity parameters.</p> <p>Topic 6. Internal combustion engine maintenance.</p> <p>Topic 7. Application of alternative fuels in internal combustion engines.</p>	<p>Internal combustion engine operation and ecology. Toxicity of fuels and their combustion products in internal combustion engines. International and domestic legal and regulatory-technical documentation on the assessment of harmful substances and smoke emissions. Methods for estimating emissions of harmful substances from internal combustion engine exhaust gases. Equipment for measuring the content of harmful substances, soot and dispersed particles in the exhaust gases of internal combustion engines. Toxicity testing cycles.</p> <p>Physico-chemical processes of toxic components formation in internal combustion engines. Methods for reducing the toxicity of internal combustion engines by influencing the workflow. Influence of design and control factors on the emission of harmful substances from the exhaust gases of internal combustion engines. Methods of additional treatment of internal combustion engine exhaust gases.</p> <p>Mathematical modeling and computational optimization of internal combustion engines by toxicity parameters. Internal combustion engine maintenance and emissions of harmful substances. Application of alternative fuels and hybrid power plants to reduce harmful emissions</p> <p>Modeling of soot formation in the combustion chamber of internal combustion engines. Physico-chemical bases of toxic components formation in the process of fuel combustion in internal combustion engines. Test cycles of internal combustion engines and vehicles to assess their environmental parameters. Physical basis for measuring emissions of harmful substances from exhaust gases of internal combustion engines. Methods impact on the internal combustion engine workflow in order to reduce emissions of harmful substances from exhaust gases. Methods of oxidative and reductive neutralization of internal combustion engine exhaust gases. Application of particulate filters and their operating conditions.</p> <p>Influence of control parameters on emissions of harmful substances from internal combustion engine exhaust gases.</p>

Course Title	"Automatic heat engine control / Автоматическое регулирование тепловых двигателей"
Course Workload, credits / academic hours	5/180
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 1. Fundamentals of Automatic control Theory (ACT)	1. General principles of management in society, nature and technology.
	2. Fundamentals of the theory of technical systems management.
	3. Creation and development of ACT.
Section 2. Technical means of automatic control of machine-building equipment (MBE)	1. Technical means of automatic control of machine-building equipment.
	2. Linear analog self-propelled guns (continuous time). Description and main features.
	3. Elementary links of linear systems.
	4. Structural diagrams of self-propelled guns.
	5. Sample description of the tracking system.
	6. Quality of regulation and stability of linear self-propelled guns. Typical impacts.
	7. The concept of MBE stability and its forecasting criteria
	8. Classical approach to linear MBE design. Stages and principles of MBE design.
	9. Elements of analog self-propelled guns.
	10. Computer-aided design of linear self-propelled guns.
	11. Algorithmic and программное software CAD MBE.
Section 3. Internal combustion engine regulation	1. Internal combustion engine regulation Part 1
	2. Internal combustion engine regulation Part 2

Course Title	«Patenting / Патентование»
Course Workload, credits / academic hours	5/ 180
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 1. Introduction. The patent system. Technical creativity	Development history. Privileges. International and regional patent systems. Development of the national patent system. Legal acts concerning invention. Technical creativity. Stages of creating new equipment. The Five Commandments of the inventor. The concept of an invention.
Section 2. Legal protection of inventions	Patentability criteria. Types of objects of inventions. The formula of the invention. Patent for an invention. Relations between the author and the patent holder. Use of the invention. Patent infringement. Other rights of authors and patent holders, including copyright and related rights. Unity of invention.
Section 3. Utility model	The concept of a utility model. Registration and examination of an application for a utility model. Ergonomic and aesthetic requirements for products.
Section 4. Protection of artistic solutions in industry	Industrial design (definition, purpose and expertise). Товарный Trademark (definition, purpose, and expertise).
Section 5. Rationalization and other intellectual property objects	Rationalization proposal. Making an application for an innovation proposal. Rights of innovators.

Course Title	«Patenting / Патентование»
Course Workload, credits / academic hours	5/ 180
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 6. Elements of inventive creativity. Technology and techniques for activating the search for solutions to inventive problems	Definition of the object of invention. Analog and prototype. Information search. Drawing up search rules. Search for a prototype and identify the "Novelty" criterion. Identification of the "Inventive level" criterion. Identification of the "Industrial applicability" criterion. Application for an invention. Description of the invention. Formal and patent examination.

Course Title	«Geoinformation Systems and Applications / Геоинформационные системы и их применение»
Course Workload, credits / academic hours	3/108
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 1. Fundamental concepts of geoinformatics	1.1. Geographical information system: overview, software and data, spatial and attribute data, vector and raster data, layers, networks and webclients. 1.2. Open and Commercial GIS. Thematic GIS applications.
Section 2. Geographic information systems and spatial data	2.1. Data sources for GIS. Data entry issues. Remote sensing as a data source. 2.2. Geographical reference and map projections in GIS.
Section 3. Thematic mapping, surfaces and Digital Terrain Model (DEM)	3.1. Drawing up thematic maps, Types of digital terrain models, algorithms for working with DEM, creating 3D terrain models. 3.2. Integrated use of remote sensing data and geoinformation technologies in industry management.
Section 4. Analytical functions of GIS	4.1. Typical queries. The overlay. 4.2. Spatial queries in GIS.
Section 5. Creating a project style	Creating a map layout

Course Title	«Alternative Energy Sources / Альтернативные источники энергии»
Course Workload, credits / academic hours	4/144
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 1. Traditional and alternative energy sources.	State strategy in the field of energy saving. Secondary energy resources and energy conservation.
Section 2. Renewable energy	Solar energy. Wind power. Energy of water flows. Biofuels. Geothermal energy.
Section 3. Energy storage and conservation.	Energy storage devices. Energy transfer and conservation.

Course Title	«Systems of fuel supply for ICE / Системы топливоподачи»
Course Workload, credits / academic hours	3 / 108
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 1 Introduction	Functions of fuel systems and their requirements. Classification of fuel systems.
Section 2. Diesel fuel systems. General provisions.	2.1 Classification of diesel fuel systems. 2.2 Fundamentals of injection processes. 2.3 Cylinder filling systems with air. Regulation of the mixture composition in diesel engines. 2.4 Features of the combustion process in diesel engines. Basic methods of mixing.
Section 3. Design of diesel fuel systems.	3.1 Split injection systems. Inline fuel pumps. 3.2 Distribution type fuel pump with axial and radial plunger movement and control solenoid valves. 3.3 Individual fuel pumps. 3.4 Pump-injectors. Design, operating modes. 3.5 The Common Rail system. Features of the work. Basic elements. High pressure pump. High-pressure battery (Rail). 3.6 The Common Rail system. High pressure pump. High-pressure battery (Rail). Injectors. 3.7 Composition and diagrams of the low pressure line of fuel systems. 3.8 Electronic fuel supply control and regulation systems. 3.9 Control unit. Sensors. 3.10 Electronic diagnostic system. 3.11 Examples of bringing diesel engine parameters in line with the requirements of a vehicle with specified performance characteristics.
Section 4. Power systems for gasoline engines. General provisions.	4.1 Composition of the mixture. Dosing and mixing. The most advantageous characteristic of the carburetor. 4.2 Fuel supply methods. Injection and mixing. The process of atomization and evaporation of fuel. 4.3 Cylinder filling control systems. 4.4 Overview of fuel injection systems.
Section 5. Design of gasoline engine power systems.	5.1 Central injection. Advantages and disadvantages. 5.2 Petrol injection systems in the intake pipe. Advantages and development prospects. 5.3 Petrol injection systems in the intake pipe. Designs of pumps, injectors, and other actuators. 5.4 Systems for direct injection of gasoline into the cylinder. Advantages and development prospects. Operating modes of the direct injection system in the cylinder. 5.5 Systems for direct injection of gasoline into the cylinder. Quantitative and qualitative methods of direct injection power control. Constructive solutions. 5.6 Combined injection system. 5.7 Electronic fuel supply control and regulation systems. 5.8 Control unit. Sensors. 5.9 Electronic diagnostic system.
Section 6. Power systems for gas-powered engines.	6.1 Classification of gas-powered power systems. Gas equipment of motor vehicles Internal combustion engines with forced ignition, pre-chamber-flare ignition.

Course Title	«Systems of fuel supply for ICE / Системы топливоподачи»
Course Workload, credits / academic hours	3 / 108
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
	6.2 Composition of systems and control methods for natural gas engines. Constructions of the main elements. 6.3 Composition of systems and control methods for engines running on liquefied gas. Basic element designs

Course Title	«Prospects for the use of alternative fuels in diesel engines / Перспективы применения альтернативных топлив в дизелях»
Course Workload, credits / academic hours	3/108
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Topic 1. Current trends in resource conservation	With the structure of the fuel and energy balance in our country and the world. Current trends in resource conservation and fuel and energy security. Forecasts for the extraction of fossil energy resources. Justification of the need to use alternative fuels in the power industry and, in particular, in internal combustion engines – diesel engines. Carbon dioxide cycling in the use of fuels from renewable sources. Thermal pollution of the environment. Greenhouse gases and internal combustion engines. The Kyoto Agreement.
Topic 2. Types of alternative fuels	In alternative fuel IDs. Alternative fuels from fossil sources, as a temporary measure to reduce the consumption of traditional motor fuels of petroleum origin. General characteristics of fuels obtained from renewable sources and problems of using alcoholic fuels and esters, fuels obtained from vegetable oils, gaseous fuels, etc. as motor fuels.
Topic 3. Features of renewable resources	Technological, economic and environmental aspects of the production of alternative fuels from their renewable sources. Features of renewable resources, environmental friendliness of production, adaptability to transportation and storage, adaptability to modern infrastructure of gas stations. Modern technologies for the production of alcoholic fuels and esters, fuels derived from vegetable oils, and gaseous fuels.
Topic 4. On the uncertainties of using alternative fuels from renewable sources in diesel engines.	On the limitations of using alternative fuels from renewable sources in the full life cycle of mechanical energy production in diesel engines. The role of full life product assessment in planning the production and operation of machines and mechanisms. Methods for evaluating the full life cycle. Features of the complete life cycle of a power plant, and diesel, in particular.
Topic 5. Features of physico-chemical and thermophysical characteristics of alternative fuels	Features of physico-chemical and thermophysical characteristics of alternative fuels and, in particular, those obtained from renewable sources; Chemical composition, density, viscosity, surface tension coefficient, lowest calorific value, cetane number, auto-ignition temperature, turbidity and solidification temperature, heat of evaporation, saturated vapor pressure, sulfur content, coking ability, etc.
Topic 6. Fuel supply, injection, atomization and mixing processes in diesel engines when using alternative fuels	The influence of the properties of alternative fuels on the processes of fuel supply, injection, spraying and mixing in diesels. Features of fuel supply in diesels, types of fuel supply equipment, trends in its development and features of its design taking into account the characteristics of alternative fuels. The fuel torch, its structure,

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COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
	interaction with the air charge and the influence of the characteristics of alternative fuels on the quality of preparation of the fuel-air mixture. Typical solutions for the organization of fuel supply of alternative fuels.
Topic 7. On the prevalence of auto-ignition and combustion of alternative fuels in diesel engines.	Requirements for the auto-flammability of fuels from the organization of the working process in diesel engines. Influence of the ignition delay period on the power, fuel-economic and environmental characteristics of diesel engines. Kinetic and diffusion stages of fuel combustion in diesel engines. Features of the organization of the combustion process of alternative fuels in diesel engines with open, полуразделенными semi-separated combustion chambers, as well as when using vortex combustion chambers and pre-chambers. Application of special designs of combustion chambers, on the example Эльсбет of the Elsbet-motor diesel engine, when using alternative fuels obtained from renewable sources.
Topic 8. Diesel exhaust gas emissions during their operation on alternative fuels	With equal characteristics of diesel toxicity during operation on traditional and alternative fuels. Different requirements for the content of harmful substances in diesel exhaust gases. Requirements from the State Standards of the Russian Federation, the International Organization for Standardization (ISO), the United Nations Economic Commission for Europe (UNECE) and other organizations for certification of manufactured internal combustion engines according to environmental parameters, including when working on alternative fuels. Control of emissions of harmful substances during the operation of installations with internal combustion engines. Characteristics of diesel engine toxicity.
Topic 9. Mechanisms of formation of incomplete fuel combustion products in diesel engines.	Analysis of the characteristics of alternative fuels for the formation of normalized toxic components of exhaust gases: nitrogen and carbon oxides, incompletely burned hydrocarbons and soot (dispersed particles). Mechanisms of formation of incomplete fuel combustion products in diesel engines. Mechanism of formation of nitrogen oxides during fuel combustion in a piston engine. Mechanisms of soot and particulate matter formation in diesel engines. Principles of operation, design and features of subsequent treatment of diesel exhaust gases in neutralizers and filters when using alternative fuels.
Topic 10. Methods for adapting diesels and changing their design to run on alternative fuels.	Use of devices that reduce the viscosity of alternative fuels. Changes in the design and adjustments of fuel supply equipment with reduced calorific value of alternative fuels. Ways to reduce auto-flammability requirements alternative fuels from the workflow side. Methods of reducing the sensitivity of the structure to increased ash content, coking ability, varnish formation, reduced evaporation, aggregate state, etc. of alternative fuels.
Topic 11. Influence of control parameters on the characteristics of diesel engines when using alternative fuels	Influence of control parameters on the power, fuel-economic and environmental characteristics of diesel engines when using alternative fuels obtained from renewable sources. Operation of diesel engines on alternative fuels without significant redesign of the design. Removing

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Course Workload, credits / academic hours	3/108
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
	adjustment characteristics. Influence of the fuel injection advance angle on diesel engine performance.
Topic 12. Methods of diagnostics of the technical condition of diesel engines in the process of operation	About the safety of operation of diesel engines on alternative fuels, including those obtained from renewable sources. Non-disassembly methods for diagnosing the technical condition of diesel engines during operation. Decomposing mixed fuels and methods for improving their stability. Compression, cleaning, and dehumidification of biogas. Reduced sulfur content. Increasing the specific calorific value of low-calorie gases from renewable sources. Methods for cleaning injectors from deposits without disassembling the diesel engine. The effect of alternative fuels on engine oil.
Topic 13. Solid fuel gasification	For the construction of systems for converting raw materials and obtaining motor fuel on board a vehicle. Fundamentals of organic solid fuel gasification. Gas generators and gas purification and cooling systems. Engines for running on generator gas. Mixing devices, power enhancement methods, engine wear. Features of maintenance, efficiency of operation of gas-generating vehicles
Topic 14. Two-component fuel supply systems.	Analysis of ways to convert liquid fuel engines into gas-powered engines, including biogas or generator gas. Two-component fuel supply systems. Analysis of structures. Features of operation and characteristics of diesel engines on the example of the gas-diesel process. Application of the gas-diesel process on supercharged diesel engines. Management problems and ways to automate the management of the gas-diesel process with the provision of its rational adjustments. Prospects for improving technologies for using alternative fuels from renewable sources in diesel engines.

Course Title	«Special chapters of construction theory / Специальные главы теории и конструирования двигателей внутреннего сгорания»
Course Workload, credits / academic hours	3/108
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 1. Fundamentals Design basics двигателей of internal combustion engine design	General principles of machine design. Main provisions and definitions. The main tasks of ad designers. Taking into account the economic effect when designing: factors, their influence on the functional purpose of machines. Features of internal combustion engine design. Market needs. Methodology and methods (succession, inversion, subsequent development of machines) design process.
Section 2. Internal combustion engine type.	Main provisions and definitions. Methods for developing the internal combustion engine type. Time frame of the type. Reasons for creating a new type (creating a new base model). Tasks that marketers and analysts solve when creating a type.
Section 3. Balancing procedure	General balancing procedure for V, VR, and W-shaped engines with a crank mechanism having a connecting rod neck common to two adjacent cylinders.

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Course Workload, credits / academic hours	3/108
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Section 4. Direction of improvement of automotive engines	Engines with an adjustable compression ratio. Regulation of engine operating modes by disconnecting the cylinders. General provisions. Workflow. Schemes of converting mechanisms of internal combustion engines with variable compression ratio and working volume. Cylinder shutdown schemes. Stirling engine.
Section 5. Rotary-piston engines.	General provisions. Workflow. Advantages and disadvantages. Kinematics of rotary-piston engines
Section 6. Dynamics of rotary-piston engines.	Building an indicator chart. Forces acting on the rotor and eccentric neck. Rotor inertia forces. Forces acting on the shaft support necks. Balancing.
Section 7. Gas distribution mechanism.	General provisions. Profiling and kinematics of the impact-free cam of the Kurtsa. Polydynamic cams (polydine). Diagram of valve actuators. Determination of the maximum valve lift. Determination of the flow section of the valve slot.

Course Title	«Improving of economical and ecological ICE characteristics / Повышение экономических и экологических качеств двигателей внутреннего сгорания»
Course Workload, credits / academic hours	3/108
COURSE CONTENTS	
Course Module Title	Brief Description of the Module Content
Alternative fuels and their motor properties	Fuel and energy balance. Renewable and non-renewable traditional and non-traditional resources, alternative fuels. Main types of alternative fuels, physical, chemical and motor properties of such fuels. Determination of the amount of air required for complete combustion of 1 kg of fuel $C + H + O = 1,000$. Determination of the calorific value of fuels and fuel mixtures. Gas-engine fuels. Natural gas. Liquefied petroleum gas. Liquid synthetic hydrocarbons. Dimethylether. Biofuels. Alcohols. Highly flammable liquids. The use of hydrogen as a fuel. Mixed fuels. Working fluids based on alternative fuels. Solid fuels.
Power supply systems and organization of work processes for internal combustion engines using alternative fuels	That use alternative fuels. Separate alternative and traditional fuel supply systems. Mixed fuel supply systems – alternative fuel mixed with the main fuel. Fuel supply systems that provide the ability to regulate diesel by changing the physicochemical properties of fuel. The need to adjust or regulate the consumption of the additive. Control of engines that implement the method of physico-chemical regulation based on alternative fuels.
Regulation of internal combustion engines by changing the physico-chemical properties of fuel	"Physico-chemical" regulation of diesel engines. "Physico-chemical" regulation of spark -ignition engines. Applicability of the method of "physico-chemical" regulation.
Examples of the implementation of the method of "physico-chemical" regulation of the internal combustion	Reduction of exhaust gas smoke. Reduction of emission toxicity. Improved fuel efficiency. Economy of traditional petroleum fuel replaced by alternative fuel. Long-term power boost of the engine. Short-term power boost – "fast and furious". Increase the efficiency of diesel start-up in special conditions. Improve engine performance in high-altitude environments. Improving the motor properties of fuel. Disposal of various combustible waste. Improve the efficiency of maintenance. Extending the service life of a diesel engine. Improving the efficiency of the system for neutralizing harmful emissions. Improving the efficiency of unsteady diesel operation modes.

HEAD
OF EDUCATIONAL DEPARTMENT

Head of the Department of Power
Engineering

position

signature

Radin Yu.A.

name and surname.