



MECHANICAL ENGINEERING

MASTER'S PROGRAMME DEGREE



PROGRAM ADVANTAGES

- ✓ The program is based on the idea of highly professional training of specialists in the field of mechanical engineering and the need to use mathematical apparatus and software in practical research.
- ✓ Classes are held using modern formats and interactive training methods: cases, trainings, master classes, business games, discussions, brainstorming.
- ✓ The practice-oriented program has been built and is annually updated taking into account the demands of the industry for the level of training of masters in the field of creation, research, modeling, production, operation of internal combustion engines and power plants with internal combustion engines, energy conversion processes in internal combustion engines and combined internal combustion engines and their elements.
- ✓ In the process of training, masters communicate with heads of specialized departments of industrial enterprises and government structures, graduates of related programs both in the framework of scientific and methodological seminars and open classes, and practices.
- ✓ It is possible to compare the features of engine operation both in different countries and in different climatic conditions.
- ✓ A large number of hours are allocated for scientific research and practice.
- ✓ The opportunity to participate in the student exchange program with partner universities.



STUDYING PROCESS

120 credits.

Lectures, practical exercises and independent work
several types of practice.



MATHEMATICAL MODELING OF THERMAL PROCESSES

- The principles of mathematical modeling.
- Simulation concepts in mechanics.
- Elementary mathematical models.
- Getting models from the fundamental laws of nature.
- Conservation of the mass of the substance.
- Energy saving.
- Conservation of the number of particles.
- Joint application of several fundamental laws.
- The concepts of gas dynamics.
- Equations of gas dynamics in Lagrangian coordinates.
- The study of mathematical models.
- Application of similarity methods.
- Application of dimensional analysis to the construction of exact particular solutions to problems of mathematical physics.
- Dimension analysis and transformation groups.



COGENERATION PLANTS BASED ON HEAT ENGINES

- Cogeneration, trigeneration.
- Secondary Energy Resources.
- Classification.
- Thermal balance of engines.
- Cogeneration plants based on steam turbine plants.
- Cogeneration plants based on gas turbine units.
- Cogeneration plants based on internal combustion engines (ICE).
- Accounting and regulation of energy consumption.
- Heat pump installations.
- Organization and stimulation of energy saving.
- Economic incentive.
- Cogeneration in Russia and abroad.



- Energy planning, energy audit.
- Renewable energy production.
- Hydropower Wind power.
- Solar energy.
- Bioresources.
- Geothermal energy.
- Classification of heat pump units (HPU).
- Characterization of low-grade heat sources.
- Theoretical foundations of steam compression heat pump units.
- Ways to improve the efficiency.
- Working agents.
- Problems of using freons.
- Montreal Protocol, Kyoto Agreement and the Paris Climate Agreement.
- The characteristic of the secondary resources of a heat engine.



ICE TEST METHODS

- Types of experimental studies, planning concepts and experimental design, screening and extreme experiments, reduction in the number of variables.
- Probability theory in experimental practice, distribution function of random variables.
- Variational series, statistical characteristics, variance, errors. Dispersion analysis, factor analysis, correlation analysis, regression analysis.
- Planned experiment, checking the adequacy of mathematical models.
- Comparison, documentation and presentation of experimental data.
- Test methods for ICE.
- Theory of measurements and instrumentation.
- Electrical measuring systems.
- Determination of engine power.
- Speed measurement Pressure measurement.
- Temperature measurement.
- Cost measurement.
- Gas analysis.
- Determination of engine toxicity.
- Indication of engines.
- Determination of noise and vibration of the internal combustion engine.
- Determination of the characteristics of the internal combustion engine.



PATENTING

- International and regional patent systems.
- Legal acts relating to invention.
- Technical creativity.
- Stages of creating new technology.
- The Five Commandments of the Inventor.
- The concept of the invention.
- Patentability criteria.
- Types of objects of inventions.
- Claim.
- Patent for an invention.
- The relationship 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.
- The unity of invention.
- The definition of the object of the invention.
- Analog and prototype.
- Information Search.
- Drafting search rules.
- Search for a prototype Identification of the criterion of “Novelty.”
- Identification of the criterion of “Inventive step”.
- Identification of the criterion of “Industrial applicability”.
- Application for invention.
- Description of the invention.
- Formal and patent examination.
- Chamber of Patent Disputes, types of fees, publication of information about the application, issuance of a title of protection.
- The concept of a utility model.
- Registration and examination of an application for a utility model.
- Ergonomic and aesthetic requirements for products.
- Industrial design (definition, purpose and examination).
- Trademark (definition and purpose and examination).
- Rationalization proposal.
- Making an application for a rationalization proposal.
- Rationalizer Rights.



PROBLEMS OF REDUCING HARMFUL EMISSIONS FROM INTERNAL COMBUSTION ENGINES

- ICE operation and ecology.
- Toxicity of fuels and their combustion products in internal combustion engines.
- International and domestic legal and regulatory technical documentation for the assessment of emissions of harmful substances and smoke.
- Methods for estimating emissions of harmful substances from the internal combustion engine exhaust gases.
- Equipment for measuring the content of harmful substances, soot and dispersed particles in the exhaust gases of the internal combustion engine.
- Toxicity test cycles.
- Physico-chemical processes of the formation of toxic components in internal combustion engines.
- Methods of reducing the toxicity of internal combustion engines by affecting the work process.
- The influence of design and regulatory factors on the emission of harmful substances from the exhaust gases of the internal combustion engine.
- Methods of additional exhaust gas treatment for internal combustion engines.
- Mathematical modeling and design optimization of ICE according to toxicity parameters.
- ICE maintenance and emissions.
- The use of alternative fuels and hybrid power plants to reduce emissions.



ICE FUEL SUPPLY SYSTEMS

- Light fuel injection systems, their classification and features.
- Central and distributed injection, advantages and disadvantages, basic design schemes.
- The impact of electronic fuel management on the performance of gasoline ICEs.
- The basic principle of engine management.
- Analysis of the command parameters of the fuel metering.
- Pressure measuring instruments, air and fuel flow meters for gasoline internal combustion engines and diesel engines.
- Contact and proximity sensors.
- Direct injection of light fuel into the engine cylinder.
- Effects on effective and toxic engine performance.
- Diesel fuel system. Direct fuel equipment.
- Methods for regulating the cyclic fuel supply.



- Individual and block fuel pumps of a high pressure.
- Injection pump distribution type.
- Features of regulation of cyclic feed.
- Pump - nozzles.
- Diesel nozzles. Battery-powered fuel systems.
- Feed management.
- Injection pump and injectors for battery systems.
- Optimization of fuel supply equipment.
- General issues of the development of diesel control systems. The capabilities of these systems in solving the problem of creating economical and environmentally friendly diesel engines.
- The principles of construction and classification of control systems.
- Evaluation of fuel equipment of various types from the point of view of the organization of fuel supply process control.
- Systems of electronic diagnostics of modern fuel supply equipment.
- Study of the design of modern fuel supply systems for gasoline ICE.
- Sensors and air flow meters, λ probes.
- Fuel supply pumps and nozzles, pressure regulators.



SPECIAL CHAPTERS OF THEORY OF HEAT ENGINES

- Thermodynamic justification for the use of ICE pressurization.
- Compressors Turbochargers Modification of the engine using gas turbine boost.
- Starting systems.
- Intake and exhaust manifolds and intercooler.
- Supercharged engine with positive ignition.
- Special boost systems.



SPECIAL CHAPTERS OF THEORY AND DESIGN OF INTERNAL COMBUSTION ENGINES

- Principles of calculation and design of internal combustion engines.
- New materials in engine building.
- Kinematics and dynamics of ICE.
- The balancing of the internal combustion engine.
- The design of the main parts of the internal combustion engine.
- Calculation of ICE elements.
- Optimization of ICE work processes.
- Strength analysis of ICE elements.



HEAD OF THE PROGRAMME

IGOR KEVORKOVICH DANILOV



Doctor of Technical Sciences,
Professor at the Department of Mechanical
Engineering and Instrument Engineering,
Head of the Operation of Transport
and Technological Machines and Complexes
Department.

FIELDS OF SCIENTIFIC INTERESTS:

Research in the field of reliability of vehicles,
Work processes in internal combustion engines (ICE),
ICE fuel equipment, Alternative fuels, Automotive
technical expertise.

Author of scientific articles in peer-reviewed Russian and foreign scientific
journals (Higher Attestation Commission, SCOPUS, Web of Science).

Regularly makes presentations at Russian and international conferences on
the operation of motor vehicles, energy and heat engines.