

Postgraduate track Program: Engineering and Technologies

1. Olympiad winner's skill set

To win the Olympiad, you should have a firm grasp of engineering and technology concepts, namely:

- basics of theoretical mechanics,
- engineering graphics,
- fundamentals of design,
- continuum mechanics,
- automatic control,
- electrical and electronic engineering.

You should also have a solid command of the following skills:

- analyzing mechanical systems, motion of mechanical systems, stresses in structures, calculating parameters of motion of material points and parts of mechanisms, as well as loads;
- analyzing electrical circuits, describing the devices of an electrical circuit by its image, calculating the parameters of electrical circuits and electronic devices;
- reading mechanical engineering drawings; creating solid-state models and assemblies, developing design documentation for products;
- mastering Finite Element Analysis, technological preparation of production for CNC machines and additive installations;
- analyzing the stability of systems, mastering the methods of analyzing the stability of systems and the quality of their dynamics.

2. List of degree programs covered by the subject area

2.1. List of master's programs

- 11.04.02 Infocommunication Technologies and Communication Systems
- 13.04.02 Electric power and electrical engineering
- 14.04.01 Nuclear power and thermal physics
- 15.04.03 Applied Mechanics
- 15.04.06 Mechatronics and Robotics
- 22.04.01 Materials science and technology
- 27.04.04 Management in Engineering Systems

2.2. List of doctoral programs

- 2.2.14 Antennas, microwave devices and technologies
- 2.2.15 Telecommunication systems, networks and equipment
- 2.3.3 Process and production automation systems
- 2.3.4 Organizational management systems
- 2.4.1 Theoretical and applied electrical engineering
- 2.4.3 Electric engineering

- 2.4.4 Electrotechnology and electrophysics
- 2.4.9 Nuclear installation, fuel cycle, radiation safety
- 2.5.4 Robots, mechatronics and robotic systems
- 2.5.6 Mechanical engineering technology
- 2.6.17 Materials science

3. Content

General mechanical engineering

1. The conditions of equilibrium of a mechanical system.
2. Kinematics of a point; translational and rotational motion of a rigid body.
3. Velocity and acceleration at points of a rigid body and with complex motion.
4. Basic terms of engineering graphics. Coordinate system. Projections. Views. Sectional views. Sections. Developed view.
5. Drawings. Lines of drawings. Using different types of lines.
6. Mechanical engineering drawing. Classification of nodes and parts in mechanical engineering drawing.
7. Joints of parts. Detachable joints. Non-detachable joints.
8. Solid modelling of parts and assembly units. Parametric Modelling.
9. Fundamentals of Finite Element Analysis.
10. Tolerances and fits. Tolerances and fits of smooth joints. Tolerances and tolerances of typical joints. Basis and theory of dimensional chains.
11. Methods of metalworking. Machining, welding, metal pressure treatment, heat treatment, foundry technologies, powder metallurgy, additive technologies.
12. Displacements and deformations. Stressed state.
13. Theory of elasticity. Hooke's law. Statement of the problem in the theory of elasticity. Flat tasks.
14. Elements of resistance of materials. Bending and twisting of rods.
15. Statistically determinate and statically indeterminate rod systems.
16. Calculation of resistive R-circuits.
17. Steady-state sinusoidal mode.

Robotics

1. Differential equations of motion of a material point.
2. General theorems of the dynamics of a material point and a mechanical system, applications to the dynamics of a rigid body.
3. Basics of digital manufacturing: additive technologies.
4. Basics of digital manufacturing. Programming of CNC machines. G-CODE language. Technology commands. Tool positioning commands.

Automation & control systems

1. Differential equations, transfer functions and frequency response functions of linear continuous systems.

2. Performance measures of linear system dynamics in time-, frequency- and root domains.
3. Equivalent transformations of linear system block diagrams.
4. Mathematical models of dynamic systems in the form of state variables.
5. Routh-Hurwitz stability criterion (or Hurwitz stability criterion).
6. Nyquist stability criterion.
7. State feedback system design: Modal control (pole assignment).
8. System state reconstruction using state observers.
9. Equilibrium states of linear and nonlinear systems. Lyapunov's first and second methods in motion stability analysis.
10. PID Controllers. Linear regulator control.
11. Optimal control problem formulation. Bellman principle. Pontryagin maximum principle.

Engineering, electrical & electronic

1. Calculation of resistive R-circuits.
2. Transient processes in linear circuits.
3. Steady-state sinusoidal mode.
4. Three-phase circuits.
5. The main active components of electronics (diodes, transistors and operational amplifiers).
6. Principles of construction of electronic devices (on the example of designing simple devices).
7. Information signal generation devices (gauges, sensors).
8. Signal processing (amplifiers, converters).
9. Components and display devices (indicators, displays).

Materials science, characterization & testing

1. Tensor of the second rank. Symmetric and antisymmetric tensors of the second rank. Principal axes and principal components of a symmetric tensor of the second rank. Invariants.
2. Tensor of small deformations.
3. Stressed state. Stress tensor. Differential equilibrium equation.
4. Thermodynamics of continuous media. Energy of elastic deformation. Generalized Hooke's law.
5. Elements of the theory of viscoelasticity. Linear creep. Elementary models (Maxwell body, Voigt body, standard body).
6. Elements of the theory of plasticity. Ideal ductility and ductility with hardening. Deformation theory, theory of plastic flow. Associated law of plastic flow. Mises principle (principle of maximum dissipation).
7. Elements of the theory of destruction. Stress concentration. Griffith's theory of brittle fracture.
8. Theory of heat treatment. Types of heat treatment. Physico-chemical processes of heat treatment.

9. State diagrams. State diagrams of double, ternary systems. Typical diagrams of the state of common alloys (Fe-C, Cu-Sn, Cu-Zn, Al-Cu).
10. Tests of mechanical properties of metals and alloys. Static, dynamic, cyclic, technological testing of properties. Non-destructive control of properties.

Telecommunications

1. Transient processes in linear circuits.
2. Three-phase circuits.
3. The main active components of electronics (diodes, transistors and operational amplifiers).
4. Principles of construction of electronic devices (on the example of designing simple devices).
5. Information signal generation devices (gauges, sensors).
6. Signal processing (amplifiers, converters).
7. Components and display devices (indicators, displays).

Nuclear science & technology

1. Wave properties of particles, Louis de Broglie hypothesis.
2. Schrödinger equation.
3. Quantization of energy and orbital momentum, spin, rule of momentum momentum addition.
4. Dispersion of electrons into energy levels in the atom, Pauli's principle, shells and subshells, electron configuration of the atom, Mendeleev's periodic system of elements.
5. X-ray spectra, the width of spectral lines.
6. Basics of atomic nucleus physics. Composition of an atomic nucleus. Atomic number and mass number. Isotopes. Dimensions of an atomic nucleus.
7. Mass and binding energy. Defect of mass. Radioactivity. Types of radioactive processes. Law of decay.
8. Nuclear reactions. Nuclear fission. Synthesis of nuclei.
9. Elements of elementary particle physics. Types of interaction and classes of elementary particles. Particles and antiparticles.

4. Recommended references

4.1. Reading list

General mechanical engineering

Sources in English	Topic
1. Nimal Rajapakse, et al. Engineering Mechanics 1: Statics, Springer Berlin Heidelberg. 2009. 296 p. https://link.springer.com/book/10.1007/978-3-540-89937-2 Limited access	Equilibrium of a rigid body under the conditions of a convergent, flat or spatial system of forces; friction.

<p>2. McLean W.G., et al. Engineering Mechanics, Statics and Dynamics, McGraw-Hill (1962). https://archive.org/details/schaumsoutlineof0000mcle Limited access</p>	<p>Equilibrium of a rigid body under the conditions of a convergent, flat or spatial system of forces; friction. Kinematics of a point; translational and rotational motion of a rigid body. Velocity and acceleration at points of a rigid body and with complex motion.</p>
<p>3. Burkova S.P., Vinokurova G.F., Dolotova R.G. Engineering Graphics. Textbook. Tomsk: TPU Press, 2014, 174 p. https://portal.tpu.ru/SHARED/d/DOLOTOVA/in_st/archiv_1/1.pdf Free access</p>	<p>Basic terms of engineering graphics. Coordinate system. Projections. Views. Sectional views. Sections. Developed view. Drawings. Lines of drawings. Using different types of lines. Joints of parts. Detachable joints. Non-detachable joints. Development of drawings. Designations on the drawings. Projections. Sectional views. Sections.</p>
<p>4. Charles K. Alexander, Matthew N.O. Sadiku Fundamentals of Electric Circuits. 5th edition. — McGraw-Hill, 2012. 992 p. https://eruditor.io/file/1863997/ Limited access</p>	<p>Calculation of resistive R-circuits. steady sinusoidal mode.</p>
<p>5. Nilsson J.W., Riedel S. Electric Limited access Circuits. Peanon Prentice Hall, 2008. 855 p. https://eruditor.io/file/1101007/</p>	<p>Calculation of resistive R-circuits. steady sinusoidal mode.</p>
<p>6. Rizzoni Giorgio. Fundamentals of Electrical Engineering. New York: McGraw-Hill Education, 2009. 736 p. https://eruditor.io/file/1802751/ Limited access</p>	<p>Calculation of resistive R-circuits. steady sinusoidal mode.</p>
<p>7. N.V. RAGHAVENDRA, L. KRISHNAMURTHY ENGINEERING METROLOGY AND MEASUREMENTS, 2013, Oxford University Press. https://nitsri.ac.in/Department/Mechanical%20Engineering/MEC_405_Book_2_for_Unit_2B.pdf Free access</p>	<p>Tolerances and fits. Tolerances and fits of smooth joints. Tolerances of typical joints. Basic theory of dimensional chains.</p>

Sources in Russian	Topic
<p>1. Маркеев А.П. Теоретическая механика. Учебник для университетов. Москва: ЧеРо, 1999. 572 с.</p>	<p>Equilibrium of a rigid body under the conditions of a convergent, flat or spatial system of forces; friction.</p>

<p>2. https://coollib.com/b/525460-a-p-markeev-teoreticheskaya-mehanika-uchebnik-dlya-universitetov</p> <p>Free access</p>	<p>Kinematics of a point; translational and rotational motion of a rigid body. Velocity and acceleration at points of a rigid body and with complex motion.</p>
<p>3. Бать М.И и др. Теоретическая механика в примерах и задачах. Учеб. пособ. для вузов. В 2-х т./М.И.Бать, Г.Ю.Джанелидзе, А.С. Кельзон.-9-е изд., перераб. - М.: Наука, 2007.-670 с. https://lib-bkm.ru/load/114-1-0-2981</p> <p>Free access</p>	<p>Equilibrium of a rigid body under the conditions of a convergent, flat or spatial system of forces; friction. Kinematics of a point; translational and rotational motion of a rigid body. Velocity and acceleration at points of a rigid body and with complex motion.</p>
<p>4. Бутенин Н.В. и др. Курс теоретической механики: Учеб.пособие для студ-ов вузов по техн. спец.:В 2-х т./ Н.В.Бутенин, Я.Л.Лунц, Д.Р.Меркин. СПб.:Лань.-5-е изд., испр. 2008.-729 с. https://lib-bkm.ru/14968</p> <p>Free access</p>	<p>Equilibrium of a rigid body under the conditions of a convergent, flat or spatial system of forces; friction. Kinematics of a point; translational and rotational motion of a rigid body. Velocity and acceleration at points of a rigid body and with complex motion.</p>
<p>5. Мещерский И.В. Задачи по теоретической механике: Учеб. пособие для студ. вузов, обуч.по техн. спец./И.В.Мещерский; Под ред.В.А.Пальмова,Д.Д.Меркина.-45-е изд., стер.- СПб. и др.: Лань, 2009.-447 с. https://lib-bkm.ru/load/114-1-0-3053</p> <p>Free access</p>	<p>Equilibrium of a rigid body under the conditions of a convergent, flat or spatial system of forces; friction. Kinematics of a point; translational and rotational motion of a rigid body. Velocity and acceleration at points of a rigid body and with complex motion.</p>
<p>6. Виноградов В.Н., Василенко Е.А., Альхименок А.А. и др. Словарь-справочник по черчению: книга для учащихся. — М.: Просвещение, 1993. — 159 с. https://www.studmed.ru/vinogradov-v-n-vasilenko-e-a-alhimenok-a-a-i-dr-slovar-spravochnik-po-chercheniyu_5954cc862e5.html</p> <p>Free access</p>	<p>Basic terms of engineering graphics. Coordinate system. Projections. Views. Sectional views. Sections. Developed view. Drawings. Lines of drawings. Using different types of lines. Mechanical engineering drawing. Classification of nodes and parts in mechanical engineering drawing. Joints of parts. Detachable joints. Non-detachable joints. Development of drawings. Designations on the drawings. Projections. Sectional views. Sections.</p>
<p>7. Большаков В.П. Создание трехмерных моделей и конструкторской документации в системе КОМПАС-3D. Практикум. — СПб.: БХВ-Петербург,</p>	<p>Basic terms of engineering graphics. Coordinate system. Projections. Views. Sectional views. Sections. Developed view. Drawings. Lines of drawings. Using different types of lines.</p>

<p>2010. — 496 с.: ил. + DVD — (Учебное пособие) https://bhv.ru/product/sozдание-trehmernyh-modelej-i-konstruktorskoj-dokumentatsii-v-sisteme-kompas-3d-praktikum/ Limited access</p>	
<p>8. Машиностроительное черчение, Справочник, Попова Г.Н., Алексеев С.Ю., 2011 https://obuchalka.org/20180613101094/mashinostroitelnoe-cherchenie-spravochnik-popova-g-n-alekseev-s-u-2011.html Free access</p>	<p>Basic terms of engineering graphics. Coordinate system. Projections. Views. Sectional views. Sections. Developed view. Drawings. Lines of drawings. Using different types of lines.</p>
<p>9. Фролов С. А. Начертательная геометрия: учебник для ВТУЗов. – 2-е изд. – М.: Машиностроение, 1983. -240 с., ил. https://obuchalka.org/2017082195873/nachertatelnaya-geometriya-frolov-s-a-2010.html Free access</p>	<p>Mechanical engineering drawing. Classification of nodes and parts in mechanical engineering drawing. Joints of parts. Detachable joints. Non-detachable joints.</p>
<p>10. Мейз, Дж. Теория и задачи механики сплошных сред пер. с англ. Е. И. Свешниковой ; под ред. и с предисл. М. Э. Эглит https://divu.online/file/XF2oD05BIPQVD Limited access</p>	<p>Displacements and deformations. Stressed state. Theory of elasticity. Hooke's law. Statement of the problem in the theory of elasticity. Flat tasks. Elements of resistance of materials. Bending and twisting of rods. Statistically determined and statically indeterminate rod systems.</p>
<p>11. Работнов Ю.Н. Механика деформируемого твердого тела М.: Наука, 1988. – 712 с. https://divu.online/file/y5safQwUkHjJy Limited access</p>	<p>Displacements and deformations. Stressed state. Theory of elasticity. Hooke's law. Statement of the problem in the theory of elasticity. Flat tasks. Elements of resistance of materials. Bending and twisting of rods. Statistically determined and statically indeterminate rod systems.</p>
<p>12. Извеков О.Я. Элементы механики деформируемого твердого тела. - М.: МФТИ, 2019. - 248 с. http://books.mipt.ru/book/301238 Free access</p>	<p>Displacements and deformations. Stressed state. Theory of elasticity. Hooke's law. Statement of the problem in the theory of elasticity. Flat tasks. Elements of resistance of materials. Bending and twisting of rods.</p>

	Statistically determined and statically indeterminate rod systems.
13. Радкевич Я.М. - Метрология, стандартизация и сертификация. Учебник. 5-е изд., 2013. - 815 с https://vk.com/doc52147895_660511664 Free access	Tolerances and fits. Tolerances and fits of smooth joints. Tolerances and tolerances of typical joints. Basis and theory of dimensional chains.
14. Дальский А.М. и др. - Технология конструкционных материалов. МОСКВА, «МАШИНОСТРОЕНИЕ», 2004 https://lib-bkm.ru/12915 Free access	Methods of metalworking. Machining, welding, metal pressure treatment, heat treatment, foundry technologies, powder metallurgy, additive technologies.
15. Атабеков Г. И. Теоретические основы электротехники. Линейные электрические цепи. СПб.: Издательство «Лань», 2009. 592 с. http://eor.dgu.ru/lectures_f/ЛабТОЭгиперссылки/учебники/26331_72f3adc944e19929b2ba15787d758c01.pdf Free access	Calculation of resistive R-circuits, steady sinusoidal mode.
16. Бакалов В.П., Дмитриков В.Ф., Крук Б.Е. Основы теории цепей. М.: Радио и связь, 2000. 592 с. http://mts.edu.27.ru/biblio/ОТС/31325_bakalov_v_p_osnovy_teorii_cepuy_3_e_izdanie(2).pdf Free access	Calculation of resistive R-circuits, steady sinusoidal mode.

Robotics

Sources in English	Topic
1. Hand L.N.; Finch J.D. (). Analytical Mechanics. Cambridge University Press, 1998. 576 p. https://www.amazon.com/Analytical-Mechanics-Louis-N-Hand/dp/0521575729 Limited access	Differential equations of motion of a material point. General theorems of the dynamics of a material point and a mechanical system, applications to the dynamics of a rigid body.
2. Kibble T. W.; Berkshire, F. H. (2004). Classical Mechanics. 5 th edition Imperial College Press. 2011. 478 p. https://www.amazon.com/Classical-Mechanics-5th-Tom-Kibble/dp/1860944353	Differential equations of motion of a material point. General theorems of the dynamics of a material point and a mechanical system, applications to the dynamics of a rigid body.

Limited access	
Sources in Russian	Topic
<p>1. Маркеев А.П. Теоретическая механика. Учебник для университетов. Москва: ЧеРо, 1999. 572 с. https://coollib.com/b/525460-a-p-markeev-teoreticheskaya-mehanika-uchebnik-dlya-universitetov</p> <p>Free access</p>	<p>Differential equations of motion of a material point. General theorems of the dynamics of a material point and a mechanical system, applications to the dynamics of a rigid body.</p>
<p>2. Гантмахер Ф.Р. Лекции по аналитической механике. Изд. 2е. М.: ФИЗМАТЛИТ, 1998. https://divu.online/file/locG1FqRWofji</p> <p>Limited access</p>	<p>Differential equations of motion of a material point. General theorems of the dynamics of a material point and a mechanical system, applications to the dynamics of a rigid body.</p>
<p>3. Мещерский И.В. Задачи по теоретической механике: Учеб. пособие для студ. вузов, обуч. по техн. спец./И.В.Мещерский; Под ред. В.А.Пальмова, Д.Д.Меркина. -45-е изд., стер.- СПб. и др.: Лань, 2009.-447 с. https://lib-bkm.ru/load/114-1-0-3053</p> <p>Free access</p>	<p>Differential equations of motion of a material point. General theorems of the dynamics of a material point and a mechanical system, applications to the dynamics of a rigid body.</p>
<p>4. Бутенин Н.В. и др. Курс теоретической механики: Учеб. пособие для студ-ов вузов по техн. спец.: В 2-х т./ Н.В.Бутенин, Я.Л.Лунц, Д.Р.Меркин. СПб.: Лань.-5-е изд., испр. 2008.-729 с. https://lib-bkm.ru/14968</p> <p>Free access</p>	<p>Differential equations of motion of a material point. General theorems of the dynamics of a material point and a mechanical system, applications to the dynamics of a rigid body.</p>
<p>5. Большаков В.П. Создание трехмерных моделей и конструкторской документации в системе КОМПАС-3D. Практикум. — СПб.: БХВ-Петербург, 2010. — 496 с.: ил. + DVD — (Учебное пособие) https://bhv.ru/product/sozдание-trehmernyh-modelej-i-konstruktorskoj-dokumentatsii-v-sisteme-kompas-3d-praktikum/</p> <p>Режим доступа: ограниченный</p>	<p>Basics of digital manufacturing: additive technologies. Basics of digital manufacturing. Programming of CNC machines. G-CODE language. Technology commands. Tool positioning commands.</p>

Automation & control systems

Sources in English	Topic
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<p>1. Modern Control. Engineering. Fifth Edition (2010). Katsuhiko Ogata. Prentice Hall. Boston Columbus Indianapolis New York San Francisco Upper Saddle River.</p> <p>http://docs.znu.ac.ir/members/pirmohamadi_ali/Control/Katsuhiko%20Ogata%20 %20Moder n%20Control%20Engineering%205th%20Editi on.pdf</p> <p>Free access</p>	<p>Differential equations, transfer functions and frequency response functions of linear continuous systems.</p> <p>Performance measures of linear system dynamics in time-, frequency- and root domains</p> <p>Equivalent transformations of linear system block diagrams.</p> <p>Mathematical models of dynamic systems in the form of state variables.</p> <p>Routh-Hurwitz stability criterion (or Hurwitz stability criterion).</p> <p>Nyquist stability criterion.</p> <p>State feedback system design: Modal control (pole assignment).</p> <p>System state reconstruction using state observers analysis.</p> <p>PID Controllers. Linear regulator control.</p>
<p>2. Dorf R. C., Bishop R. H. Modern Control Systems. 10th edition. L.: Pearson Prentice Hall, 2005.</p> <p>https://powerunit-ju.com/wp-content/uploads/2016/11/Book-Modern_Control_Systems_11th_Edition.pdf</p> <p>Free access</p>	<p>Differential equations, transfer functions and frequency response functions of linear continuous systems.</p> <p>Performance measures of linear system dynamics in time-, frequency- and root domains.</p> <p>Mathematical models of dynamic systems in the form of state variables</p> <p>Routh-Hurwitz stability criterion (or Hurwitz stability criterion).</p> <p>Nyquist stability criterion.</p>
<p>3. Donald, E. Optimal control theory: an introduction. DOVER PUBNS, 2016.</p> <p>https://www.amazon.com/Optimal-Control-Theory-Introduction-Engineering/dp/0486434842</p> <p>Limited access</p>	<p>Optimal control problem formulation. Bellman principle. Pontryagin maximum principle.</p>
<p>4. Slotine Lectures on Nonlinear Systems</p> <p>https://web.mit.edu/ns1/www/videos/lectures.html</p> <p>Free access</p>	<p>Equilibrium states of linear and nonlinear systems. Lyapunov's first and second methods in motion stability analysis.</p> <p>Routh-Hurwitz stability criterion (or Hurwitz stability criterion).</p>
<p>5. Gantmacher, Felix (1959), Theory of matrices, AMS Chelsea Publishing</p> <p>https://pdfcoffee.com/the-theory-of-matrices-vol-2-gantmacher-pdf-pdf-free.html</p> <p>Free access</p>	<p>Routh-Hurwitz stability criterion (or Hurwitz stability criterion).</p>

<p>6. Hägglund T. Automatic Control. Lecture Notes. Lund, 2019. https://www.control.lth.se/fileadmin/control/Education/EngineeringProgram/FRTF05/engforel.pdf Free access</p>	<p>State feedback system design: Modal control (pole assignment).</p>
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Sources in Russian	Topic
<p>1. Поляк Б.Т., Хлебников М.В., Рапопорт Л.Б. Математическая теория автоматического управления: учебное пособие. М.: ЛЕНАНД, 2019. 500 с. https://www.ipu.ru/sites/default/files/page_file/T1.%20Б.Т.%20Поляк%20М.В.%20Хлебников%20Л.Б.%20Рапопорт.%20Математическая%20теория%20автоматического%20управления.pdf Free access</p>	<p>Differential equations, transfer functions and frequency response functions of linear continuous systems. Performance measures of linear system dynamics in time-, frequency- and root domains. Equivalent transformations of linear system block diagrams. Mathematical models of dynamic systems in the form of state variables. Routh-Hurwitz stability criterion (or Hurwitz stability criterion). Nyquist stability criterion. State feedback system design: Modal control (pole assignment). System state reconstruction using state observers. Equilibrium states of linear and nonlinear systems. Lyapunov's first and second methods in motion stability analysis. PID Controllers. Linear regulator control. Optimal control problem formulation. Bellman principle. Pontryagin maximum principle.</p>
<p>2. Бесекерский В. А., Попов Е. П. Теория систем автоматического управления. М.: Профессия, 2003. https://booksee.org/book/635481 Free access</p>	<p>Differential equations, transfer functions and frequency response functions of linear continuous systems. Performance measures of linear system dynamics in time-, frequency- and root domains. Equivalent transformations of linear system block diagrams. Routh-Hurwitz stability criterion (or Hurwitz stability criterion). Nyquist stability criterion.</p>
<p>3. Бороденко В. А. Сборник задач по теории автоматического управления. Павлодар: Кереку, 2009.</p>	<p>State feedback system design: Modal control (pole assignment). System state reconstruction using state observers.</p>

<p>http://knigainformatika.com/rule/Borodenk_o_zadania_TAU.pdf</p> <p>Free access</p>	
<p>4. Гантмахер Ф. Р. Теория матриц. — М.: Наука, 1967.</p> <p>https://booksee.org/book/569100</p> <p>Free access</p>	Routh-Hurwitz stability criterion (or Hurwitz stability criterion).
<p>5. Дорф Р., Бишоп Р. Современные системы управления. М.: Лаборатория Базовых Знаний, 2002.</p> <p>https://booksee.org/book/561484</p> <p>Free access</p>	<p>Differential equations, transfer functions and frequency response functions of linear continuous systems.</p> <p>Performance measures of linear system dynamics in time-, frequency- and root domains.</p> <p>Mathematical models of dynamic systems in the form of state variables.</p> <p>Routh-Hurwitz stability criterion (or Hurwitz stability criterion).</p> <p>Nyquist stability criterion.</p>
<p>6. Квакернаак Х., Сиван Р. Линейные оптимальные системы управления. М.: Мир, 1977.</p> <p>https://booksee.org/book/445855</p> <p>Free access</p>	System state reconstruction using state observers.
<p>7. Ким Д. П., Дмитриева Н. Д. Сборник задач по теории автоматического управления. Линейные системы. М.: ФИЗМАТЛИТ, 2007.</p> <p>https://eruditor.io/file/1035189/</p> <p>Limited access</p>	<p>Differential equations, transfer functions and frequency response functions of linear continuous systems.</p> <p>Equivalent transformations of linear system block diagrams.</p> <p>Routh-Hurwitz stability criterion (or Hurwitz stability criterion).</p>
<p>8. Кузовков Н. Т. Модальное управление и наблюдающие устройства. М.: Машиностроение, 1976.</p> <p>https://booksee.org/book/532491</p> <p>Free access</p>	<p>Mathematical models of dynamic systems in the form of state variables.</p> <p>State feedback system design: Modal control (pole assignment).</p> <p>System state reconstruction using state observers.</p>
<p>9. Мирошник И. В. Теория автоматического управления. Линейные системы. СПб.: Питер, 2006.</p> <p>https://booksee.org/book/482940</p> <p>Free access</p>	Equilibrium states of linear and nonlinear systems. Lyapunov's first and second methods in motion stability analysis.

Engineering, electrical & electronic

Sources in English	Topic
1. Charles K. Alexander, Matthew N.O. Sadiku	Calculation of resistive R-circuits,

<p>Fundamentals of Electric Circuits. 5th edition. — McGraw-Hill, 2012. 992 p. https://eruditor.io/file/1863997/ Limited access</p>	<p>Transient processes in linear circuits, steady sinusoidal mode, three-phase circuits.</p>
<p>2. Nilsson J.W., Riedel S. Electric Circuits. Peanon Prentice Hall, 2008. 855 p. https://eruditor.io/file/1101007/ Limited access</p>	<p>Transient processes in linear circuits.</p>
<p>3. Rizzoni Giorgio. Fundamentals of Electrical Engineering. New York: McGraw-Hill Education, 2009. 736 p. https://eruditor.io/file/1802751/ Limited access</p>	<p>Transient processes in linear circuits.</p>
<p>4. Wadhwa C.L. Basic Electrical Engineering. New Delhi, New Age International (P) Ltd., Publishers, 2007. 422 p. https://eruditor.io/file/1802694/ Limited access</p>	<p>Three-phase circuits.</p>
<p>5. Martin Hartley Jones. A Practical Introduction to Electronic Circuits. Cambridge University Press, 1995. https://books.google.ru/books?id=EEcemA_BAU44C&sitesec=buy&hl=ru&source=gbs_atb Free access</p>	<p>The main active components of electronics (diodes, transistors and operational amplifiers). Principles of construction of electronic devices (on the example of designing simple devices). Information signal generation devices (sensors, sensors). Signal processing (amplifiers, converters).</p>
<p>6. S.S. Bhatti, Rahul Malhotra. A Textbook of Digital Electronics, nov, 2011. eBook - Amazon.com. https://www.amazon.com/Textbook-Digital-Electronics-Bhatti-Malhotra-ebook/dp/B01IGUSY80/ref=sr_1_9?crd=1WAY1Q51Y5MS9&keywords=electronics+books&qid=1688757983&s=books&prefix=electronics%2Cstripbooks-intl-ship%2C177&sr=1-9 Limited access</p>	<p>The main active components of electronics (diodes, transistors and operational amplifiers). Principles of construction of electronic devices (on the example of designing simple devices). Information signal generation devices (sensors, sensors). Signal processing (amplifiers, converters).</p>
<p>7. Robert Erickson. Fundamentals of Power Electronics. 3rd ed. 2020. https://www.amazon.com/Fundamentals-Power-Electronics-Robert-Erickson/dp/3030438791/ref=sr_1_14?crd=1WAY1Q51Y5MS9&keywords=electroni cs+books&qid=1688757983&s=books&spr</p>	<p>The main active components of electronics (diodes, transistors and operational amplifiers). Principles of construction of electronic devices (on the example of designing simple devices). Information signal generation devices (sensors, sensors). Signal processing (amplifiers, converters).</p>

<p>efix=electronics%2Cstripbooks-intl-ship%2C177&sr=1-14</p> <p>Limited access</p>	
<p>8. READING SCHEMATICS 101: A step-by-step guidebook on the basics of understanding how to read schematics for beginners. 2023.</p> <p>https://www.amazon.com/s/ref=dp_byline_sr_book_1?ie=UTF8&field-author=CALVIN+BRENNAN&text=CALVIN+BRENNAN&sort=relevancerank&search-alias=books</p> <p>Limited access</p>	<p>The main active components of electronics (diodes, transistors and operational amplifiers). Principles of construction of electronic devices (on the example of designing simple devices). Information signal generation devices (sensors, sensors). Signal processing (amplifiers, converters).</p>
<p>9. Windell Oskay and Eric Schlaepfer. 2022. Open Circuits: The Inner Beauty of Electronic Components.</p> <p>https://www.amazon.com/Open-Circuits-Beauty-Electronic-Components/dp/1718502346/ref=sr_1_2?crid=1WAY1Q51Y5MS9&keywords=electronics+books&qid=1688763786&s=books&prefix=electronics%2Cstripbooks-intl-ship%2C177&sr=1-2</p> <p>Limited access</p>	<p>The main active components of electronics (diodes, transistors and operational amplifiers). Principles of construction of electronic devices (on the example of designing simple devices). Information signal generation devices (sensors, sensors). Signal processing (amplifiers, converters).</p>
<p>10. Easy Electronics (Make: Handbook). by Charles Platt. 2017.</p> <p>https://www.amazon.com/s?k=electronics+books&i=stripbooks-intl-ship&crid=1WAY1Q51Y5MS9&s=electronics%2Cstripbooks-intl-ship%2C177&ref=nb_sb_ss_ts-doa-p_3_11</p> <p>Limited access</p>	<p>The main active components of electronics (diodes, transistors and operational amplifiers). Principles of construction of electronic devices (on the example of designing simple devices). Information signal generation devices (sensors, sensors). Signal processing (amplifiers, converters).</p>

Sources in Russian	Topic
<p>1. Аполлонский С.М., Виноградов А.Л. Теоретические основы электротехники. М.: КНОРУС, 2016. 250 с.</p> <p>https://divu.online/file/Utg66gpk99v09</p> <p>Free access</p>	<p>Transient processes in linear circuits, three-phase circuits</p>
<p>2. Атабеков Г. И. Теоретические основы электротехники. Линейные электрические цепи. СПб.: Издательство «Лань», 2009. 592 с.</p>	<p>Transient processes in linear circuits, three-phase circuits</p>

<p>http://eor.dgu.ru/lectures_f/ЛабТОЭгиперссылки/учебники/26331_72f3adc944e19929b2ba15787d758c01.pdf</p> <p>Free access</p>	
<p>3. Демирчян К.С., Нейман Л.Р., Коровкин Н.В. Теоретические основы электротехники. Том 1. – 4-е изд. СПб.: Питер, 2003. 463 с.</p> <p>https://www.elec.ru/viewer?url=/files/2020/01/30/nejman_teo_osn_eltex_t1.pdf</p> <p>Free access</p>	<p>Transient processes in linear circuits, three-phase circuits</p>
<p>4. Иванов И.И., Соловьев Г.И., Фролов В.Я. Электротехника и основы электроники. СПб.: Издательство «Лань», 2021. 736 с.</p> <p>https://www.rulit.me/data/programs/resources/pdf/Ivanov_Elektrotehnika-i-osnovy-elektroniki_RuLit_Me_689668.pdf</p> <p>Free access</p>	<p>Transient processes in linear circuits, three-phase circuits</p>
<p>5. Джонс М.Х. Электроника – практический курс. Перевод выполнен на кафедре радиотехники МФТИ. – М.: Постмаркет. 1999. – 528 с.</p> <p>https://divu.online/file/ofVs9igzD5fjP</p> <p>Free access</p>	<p>The main active components of electronics (diodes, transistors and operational amplifiers). Principles of construction of electronic devices (on the example of designing simple devices). Information signal generation devices (sensors, sensors). Signal processing (amplifiers, converters).</p>
<p>6. Манаев Е.И. Основы радиоэлектроники / Е.И. Манаев. - М.: КД Либроком, 2019. - 512 с.</p> <p>https://www.elec.ru/library/nauchnaya-i-tehnicheskayaliteratura/manaev-osnovy-radioelektroniki/</p> <p>Free access</p>	<p>The main active components of electronics (diodes, transistors and operational amplifiers). Principles of construction of electronic devices (on the example of designing simple devices). Information signal generation devices (sensors, sensors). Signal processing (amplifiers, converters).</p>
<p>7. Марченко А. Л. Основы электроники. Учебное пособие для вузов / А. Л. Марченко. — М : ДМК Пресс, 2008. — 296 с.</p> <p>https://agrarniy.volgattech.net/studentu/orga_nizatsiya-dosuga/Марченко%20Основы%20электроники%20Учебное%20пособие%20для%20вузов.pdf</p> <p>Free access</p>	<p>The main active components of electronics (diodes, transistors and operational amplifiers). Principles of construction of electronic devices (on the example of designing simple devices). Information signal generation devices (sensors, sensors). Signal processing (amplifiers, converters).</p>

<p>8. Артемов Р.Г. Электроника: конспект лекций. – Омск: Изд-во Ом-ГТУ, 2010. – 88 с. https://www.studmed.ru/artemov-ad-elektronika-konspekt-lekciy_4c1a2502a3a.html Free access</p>	<p>The main active components of electronics (diodes, transistors and operational amplifiers). Principles of construction of electronic devices (on the example of designing simple devices). Information signal generation devices (sensors, sensors). Signal processing (amplifiers, converters).</p>
<p>9. Прянишников В.А. Электроника: полный курс лекций. 4-е изд. - СПб: 2004. - 416 с. https://www.studmed.ru/pryanishnikov-va-elektronika-polnyy-kurs-lekciy_a5e31f8251d.html Free access</p>	<p>The main active components of electronics (diodes, transistors and operational amplifiers). Principles of construction of electronic devices (on the example of designing simple devices). Information signal generation devices (sensors, sensors). Signal processing (amplifiers, converters).</p>
<p>10. Джексон Р.Г. Новейшие датчики. – М. Техносфера. 2007. с. https://djvu.online/file/NMpd8NDLxa6bC#p=1 Free access</p>	<p>Components and display devices (indicators, displays).</p>

Materials science, characterization & testing

Sources in English	Topic
<p>1. George E. Mase. MASE-SCHAUMS THEORY AND PROBLEMS OF CONTINUUM MECHANICS, 1970, McGraw-Hill, https://www.academia.edu/36693361/Mase_Schaums_Theory_And_Problems_Of_Continuum_Mechanics</p>	<p>Tensor of the second rank. Symmetric and antisymmetric tensors of the second rank. Principal axes and principal components of a symmetric tensor of the second rank. Invariants. Tensor of small deformations. Stressed state. Stress tensor. Differential equilibrium equation. Thermodynamics of continuous media. Energy of elastic deformation. Generalized Hooke's law. Elements of the theory of viscoelasticity. Linear creep. Elementary models (Maxwell body, Voigt body, standard body). Elements of the theory of plasticity. Ideal ductility and ductility with hardening. Deformation theory, theory of plastic flow. Associated law of plastic flow. Mises principle (principle of maximum dissipation). Elements of the theory of destruction. Stress concentration. Griffith's theory of brittle fracture.</p>

<p>2. R.K. Rajput Manufacturing Technology. 2007. LAXMI Publications LTD, New Delhi. https://books.google.ru/books?id=6wFuwbwufTMC&printsec=frontcover&hl=ru#v=onepage&q&f=false Free access</p>	<p>Theory of heat treatment. Types of heat treatment. Physico-chemical processes of heat treatment. State diagrams. State diagrams of double, ternary systems. Typical diagrams of the state of common alloys (Fe-C, Cu-Sn, Cu-Zn, Al-Cu). Tests of mechanical properties of metals and alloys. Static, dynamic, cyclic, technological testing of properties. Non-destructive control of properties.</p>
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Sources in Russian	Topic
<p>1. Мейз, Дж. Теория и задачи механики сплошных сред; пер. с англ. Е. И. Свешниковой ; под ред. и с предисл. М. Э. Эглит - Изд. 3-е. - Москва: Книжный дом "ЛИБРОКОМ", 2010. - 318 с. https://studizba.com/files/mehanika-sploshnyh-sred-mss/book/274263-mejz-dzh-1974-teoriya-i-zadachi-mehaniki.html Limited access</p>	<p>Tensor of the second rank. Symmetric and antisymmetric tensors of the second rank. Principal axes and principal components of a symmetric tensor of the second rank. Invariants. Tensor of small deformations. Stressed state. Stress tensor. Differential equilibrium equation. Thermodynamics of continuous media. Energy of elastic deformation. Generalized Hooke's law. Elements of the theory of viscoelasticity. Linear creep. Elementary models (Maxwell body, Voigt body, standard body). Elements of the theory of plasticity. Ideal ductility and ductility with hardening. Deformation theory, theory of plastic flow. Associated law of plastic flow. Mises principle (principle of maximum dissipation).</p>
<p>2. Работнов Ю.Н. Механика деформируемого твердого тела М.: Наука, 1988. – 712 с. https://lib-bkm.ru/12714 Limited access</p>	<p>Displacements and deformations. Stressed state. Theory of elasticity. Hooke's law. Statement of the problem in the theory of elasticity. Flat tasks. Elements of resistance of materials. Bending and twisting of rods. Statistically determined and statically indeterminate rod systems.</p>
<p>3. Извеков О.Я. Элементы механики деформируемого твердого тела. - М.: МФТИ, 2019. - 248 с. http://books.mipt.ru/book/301238 Free access</p>	<p>Tensor of the second rank. Symmetric and antisymmetric tensors of the second rank. Principal axes and principal components of a symmetric tensor of the second rank. Invariants. Tensor of small deformations. Stressed state. Stress tensor. Differential equilibrium equation.</p>

	<p>Thermodynamics of continuous media. Energy of elastic deformation. Generalized Hooke's law.</p> <p>Elements of the theory of viscoelasticity. Linear creep. Elementary models (Maxwell body, Voigt body, standard body).</p> <p>Elements of the theory of plasticity. Ideal ductility and ductility with hardening. Deformation theory, theory of plastic flow. Associated law of plastic flow. Mises principle (principle of maximum dissipation).</p> <p>Elements of the theory of destruction. Stress concentration. Griffith's theory of brittle fracture.</p>
<p>4. Гуляев А.П. <i>Металловедение: учебник для вузов</i>. 6-е изд. М.: <i>Металлургия</i>, 1986. - 544 с. https://nizrp.narod.ru/metallvediterm.pdf Free access</p>	<p>Theory of heat treatment. Types of heat treatment. Physico-chemical processes of heat treatment.</p> <p>State diagrams. State diagrams of double, ternary systems. Typical diagrams of the state of common alloys (Fe-C, Cu-Sn, Cu-Zn, Al-Cu).</p>
<p>5. <i>Механические свойства металлов: Учебник для вузов / Золоторевский В.С.</i> - М.: <i>Металлургия</i>, 1983. - 352 с. http://www.materialscience.ru/subjects/materialovedenie/knigi/mehanicheskie_svoystva_metallov_uchebnik_dlya_vuzov_zolotorrevskiy_vs_m_metallurgiya_1983_352_s_24_01_2010/ Free access</p>	<p>Tests of mechanical properties of metals and alloys. Static, dynamic, cyclic, technological testing of properties. Non-destructive control of properties.</p>

Telecommunications

Sources in English	Topic
<p>1. Martin Hartley Jones. <i>A Practical Introduction to Electronic Circuits</i>. Cambridge University Press, 1995. https://books.google.ru/books?id=EEcemABAU44C&sitesec=buy&hl=ru&source=gbs_atb Free access</p>	<p>The main active components of electronics (diodes, transistors and operational amplifiers).</p> <p>Principles of construction of electronic devices (on the example of designing simple devices).</p> <p>Information signal generation devices (gauges, sensors).</p> <p>Signal processing (amplifiers, converters).</p>
<p>2. S.S. Bhatti, Rahul Malhotra. <i>A Textbook of Digital Electronics</i>, nov, 2011. eBook - Amazon.com. https://www.amazon.com/Textbook-Digital-Electronics-Bhatti-Malhotra-</p>	<p>The main active components of electronics (diodes, transistors and operational amplifiers).</p> <p>Principles of construction of electronic devices (on the example of designing simple devices).</p>

<p>ebook/dp/B01IGUSY80/ref=sr_1_9?crd=1WAY1Q51Y5MS9&keywords=electronics+books&qid=1688757983&s=books&sprefix=electronics%2Cstripbooks-intl-ship%2C177&sr=1-9</p> <p>Limited access</p>	<p>Information signal generation devices (gauges, sensors).</p> <p>Signal processing (amplifiers, converters).</p>
<p>3. Robert Erickson. Fundamentals of Power Electronics. 3rd ed. 2020. https://www.amazon.com/Fundamentals-Power-Electronics-Robert-Erickson/dp/3030438791/ref=sr_1_14?crd=1WAY1Q51Y5MS9&keywords=electronics+books&qid=1688757983&s=books&sprefix=electronics%2Cstripbooks-intl-ship%2C177&sr=1-14</p> <p>Limited access</p>	<p>The main active components of electronics (diodes, transistors and operational amplifiers). Principles of construction of electronic devices (on the example of designing simple devices).</p>
<p>4. Windell Oskay and Eric Schlaepfer. 2022. Open Circuits: The Inner Beauty of Electronic Components. https://www.amazon.com/Open-Circuits-Beauty-Electronic-Components/dp/1718502346/ref=sr_1_2?crd=1WAY1Q51Y5MS9&keywords=electronics+books&qid=1688763786&s=books&sprefix=electronics%2Cstripbooks-intl-ship%2C177&sr=1-2</p> <p>Limited access</p>	<p>The main active components of electronics (diodes, transistors and operational amplifiers). Principles of construction of electronic devices (on the example of designing simple devices). Information signal generation devices (gauges, sensors). Signal processing (amplifiers, converters). Components and display devices (indicators, displays).</p>
<p>5. Easy Electronics (Make: Handbook). by Charles Platt. 2017. https://www.amazon.com/s?k=electronics+books&i=stripbooks-intl-ship&crd=1WAY1Q51Y5MS9&sprefix=electronics%2Cstripbooks-intl-ship%2C177&ref=nb_sb_ss_ts-doa-p_3_11</p> <p>Limited access</p>	<p>The main active components of electronics (diodes, transistors and operational amplifiers). Principles of construction of electronic devices (on the example of designing simple devices). Information signal generation devices (gauges, sensors). Signal processing (amplifiers, converters).</p>

Sources in Russian	Topic
<p>1. Джонс М.Х. Электроника – практический курс. Перевод выполнен на кафедре радиотехники МФТИ. – М.: Техносфера. 2006. – 512 с. ISBN 5-94836-086-5. https://elib.pstu.ru/Record/RUPSTUbooks110421/Description</p>	<p>The main active components of electronics (diodes, transistors and operational amplifiers). Principles of construction of electronic devices (on the example of designing simple devices). Information signal generation devices (gauges, sensors).</p>

Free access	Signal processing (amplifiers, converters).
2. Манаев Е.И. Основы радиоэлектроники / Е.И. Манаев. - М.: КД Либроком, 2019. - 512 с. https://www.elec.ru/library/nauchnaya-i-tehnicheskayaliteratura/manaev-osnovy-radioelektroniki/	The main active components of electronics (diodes, transistors and operational amplifiers). Principles of construction of electronic devices (on the example of designing simple devices). Information signal generation devices (gauges, sensors).
Free access	Signal processing (amplifiers, converters).
3. Марченко А. Л. Основы электроники. Учебное пособие для вузов / А. Л. Марченко. — М : ДМК Пресс, 2008. — 296 с. https://agrarniy.volgatech.net/studentu/orga_nizatsiya-dosuga/%D0%9C%D0%B0%D1%80%D1%87%D0%B5%D0%BD%D0%BA%D0%BE%20%D0%9E%D1%81%D0%BD%D0%BE%D0%B2%D1%8B%20%D1%8D%D0%BB%D0%B5%D0%BA%D1%82%D1%80%D0%BE%D0%BD%D0%B8%D0%BA%D0%B8%20%D0%A3%D1%87%D0%B5%D0%B1%D0%BD%D0%BE%D0%B5%20%D0%BF%D0%BE%D1%81%D0%BE%D0%B1%D0%B8%D0%B5%20%D0%B4%D0%BB%D1%8F%20%D0%B2%D1%83%D0%B7%D0%BE%D0%B2.pdf	The main active components of electronics (diodes, transistors and operational amplifiers). Principles of construction of electronic devices (on the example of designing simple devices). Information signal generation devices (gauges, sensors). Signal processing (amplifiers, converters). Components and display devices (indicators, displays).
Free access	
4. Артемов Р.Г. Электроника: конспект лекций. – Омск: Изд-во Ом-ГТУ, 2010. – 88 с. https://www.studmed.ru/artemov-ad-elektronika-konspekt-lekciy_4c1a2502a3a.html	The main active components of electronics (diodes, transistors and operational amplifiers). Principles of construction of electronic devices (on the example of designing simple devices). Information signal generation devices (gauges, sensors).
Free access	Signal processing (amplifiers, converters). Components and display devices (indicators, displays).
5. Прянишников В.А. Электроника: полный курс лекций. 4-е изд. - СПб: 2004. - 416 с. https://www.studmed.ru/pryanishnikov-va-elektronika-polnyy-kurs-lekciy_a5e31f8251d.html	The main active components of electronics (diodes, transistors and operational amplifiers). Principles of construction of electronic devices (on the example of designing simple devices). Information signal generation devices (gauges, sensors).
Free access	Signal processing (amplifiers, converters).

	Components and display devices (indicators, displays).
6. <u>Джексон Р.Г.</u> Новейшие датчики. – М. Техносфера. 2007. https://djvu.online/file/NMpd8NDLха6bC#p=1 Free access	Components and display devices (indicators, displays).

Nuclear science & technology

Sources in English	Topic
1. Martin, B. R. (Brian Robert), Nuclear and particle physics/B. R. Martin, by Thomson Press (India) Limited, John Wiley & Sons, 2006 – 415 p. https://fisica.net/nuclear/Martin%20-%20Nuclear%20and%20Particle%20Physics%20-%20An%20Introduction.pdf Free access	Mass and binding energy. Defect of mass. Radioactivity. Types of radioactive processes. Law of decay. Nuclear reactions. Nuclear fission. Synthesis of nuclei. Basics of elementary particle physics. Types of interaction and classes of elementary particles. Particles and antiparticles.
2. Samuel S.M. WONG, Introductory Nuclear Physics/ Wiley-VCH Verlag GmbH & Co. KGaA, 2004 – 475 p. https://faculty.washington.edu/bulgac/560_2014/ Free access	Wave properties of particles, Louis de Broglie hypothesis. Schrödinger equation. Quantization of energy and orbital momentum, spin, rule of momentum momentum addition. Dispersion of electrons into energy levels in the atom, Pauli's principle, shells and subshells, electron configuration of the atom, Mendeleev's periodic system of elements. Basics of atomic nucleus physics. Basics of elementary particle physics. Types of interaction and classes of elementary particles. Particles and antiparticles.

Sources in Russian	Topic
1. И.В. Савельев. Курс общей физики Кн.5 Квантовая оптика. Атомная физика. Физика твердого тела. Физика атомного ядра и элементарных частиц, СПб.: Издательство «Лань», 2021. — 384 с. http://publ.lib.ru/ARCHIVES/U/ Free access	Wave properties of particles, Louis de Broglie hypothesis. Schrödinger equation. Quantization of energy and orbital momentum, spin, rule of momentum momentum addition. Dispersion of electrons into energy levels in the atom, Pauli's principle, shells and subshells, electron configuration of the atom, Mendeleev's periodic system of elements. X-ray spectra, the width of spectral lines. Basics of atomic nucleus physics. Composition of an atomic nucleus. Atomic number and mass

	<p>number. Isotopes. Dimensions of an atomic nucleus.</p> <p>Mass and binding energy. Defect of mass. Radioactivity. Types of radioactive processes. Law of decay.</p> <p>Nuclear reactions. Nuclear fission. Synthesis of nuclei.</p> <p>Principles of elementary particle physics. Types of interaction and classes of elementary particles. Particles and antiparticles.</p>
<p>2. И.Е. Иродов. Задачи по общей физике: учебное пособие для вузов, Москва: Бином. Лаборатория знаний, 2012 – 431 с.</p> <p>3. https://kaf19.mephi.ru/content/public Free access</p>	<p>Wave properties of particles, Louis de Broglie hypothesis.</p> <p>Schrödinger equation.</p> <p>Quantization of energy and orbital momentum, spin, rule of momentum momentum addition.</p> <p>Dispersion of electrons into energy levels in the atom, Pauli's principle, shells and subshells, electron configuration of the atom, Mendeleev's periodic system of elements.</p> <p>X-ray spectra, the width of spectral lines.</p> <p>elements of atomic nucleus physics.</p> <p>Composition of an atomic nucleus. Atomic number and mass number. Isotopes. Dimensions of an atomic nucleus.</p> <p>Mass and binding energy. Defect of mass. Radioactivity. Types of radioactive processes. Law of decay.</p> <p>Nuclear reactions. Nuclear fission. Synthesis of nuclei.</p> <p>Principles of elementary particle physics. Types of interaction and classes of elementary particles. Particles and antiparticles.</p>

4.2. Recommended online courses

General mechanical engineering

Online courses in English	Link	Summary
Introduction to Engineering Mechanics (Coursera 1	https://coursera.org/learn/engineering-mechanics-statics	This course is an introduction to the study and application of the principles necessary to solve engineering mechanics problems. This course will apply concepts from previous courses you have taken in basic math and physics. The course covers modelling and analysis of static equilibrium problems with an emphasis on real engineering applications and problem solving.

Particle Dynamics (Coursera)	https://www.coursera.org/learn/particle-dynamics	This course is a study of dynamics, one of the basic subjects of mechanics in mechanical engineering. Students will be able to systematize their knowledge of force and motion, work energy, and momentum-momentum, taking into account Newton's 2nd law and its integration over time and displacement. Engineering dynamics consists of two parts: particle dynamics and solid dynamics.
Engineering Graphics and Design (ClassCentral)	https://www.classcentral.com/course/swayam-engineering-graphics-and-design-43589	This course develops essential visualization skills for engineers, focusing on both traditional paper-based drawing and digital representations. It equips students with the ability to communicate ideas clearly through visual means, interpreting and creating technical drawings effectively. The course is relevant to all undergraduate engineering students and anyone interested in graphics design and visualization. No prior knowledge is required.
Online courses in Russian	Link	Summary
Краткий курс теории по сопротивлению материалов	https://isopromat.ru/sopromat/obzornyj-kurs-teorii	This short course provides a fundamental introduction to the theory of strength of materials, covering essential definitions, formulas, and sign conventions. It explores strength and stiffness conditions for different loading types, illustrated with examples and problem-solving techniques.
Теоретическая механика	https://mpei.ru/Structure/Universe	This course explores the fundamental principles of classical mechanics, encompassing kinematics, statics, and dynamics of point masses, rigid bodies, and mechanical systems. It delves into analytical mechanics, oscillation theory, and impact theory, and introduces the dynamics of variable-mass bodies and celestial mechanics. Practical examples of problem-solving are included.
Инженерная графика для технических специальностей	https://openedu.ru/course/mephi/mephi_igdts/	This online Engineering Graphics course provides the foundational knowledge and skills essential for engineers to create and interpret technical drawings, enabling them to confidently develop designs and technical documentation. The course focuses on mastering standard drawing methods and conventions, ensuring students can effectively communicate and understand technical information through visual representations.

Динамика частиц	https://www.coursera.org/learn/particle-dynamics	This course is a study of dynamics, one of the basic subjects of mechanics in mechanical engineering. Students will be able to systematize their knowledge of force and motion, work energy, and momentum-momentum, taking into account Newton's 2nd law and its integration over time and displacement. Engineering dynamics consists of two parts: particle dynamics and solid dynamics.
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Robotics

Online courses in English	Link	Summary
Engineering Graphics/Drawin g (MyGreatLearnin g)	https://www.mygreatlearning.com/academy/learn-for-free/courses/engineering-graphics-drawing	This course provides a comprehensive overview of Engineering Drawing/Graphics concepts typically covered in first-year engineering curricula. Designed to enhance understanding and problem-solving skills, it aids students in mastering key concepts and preparing for internal exams and assessments.
Engineering Graphics and Design	https://archive.nptel.ac.in/courses/112/102/112102304/	This course aims to develop your visual communication skills through drawing. You'll learn to observe your surroundings, translate those observations into sketches, and express ideas pictorially.
Engineering drawing and computer graphics	https://archive.nptel.ac.in/courses/112/105/112105294/	This course introduces the fundamental principles of engineering drawing and design, essential for expressing ideas graphically in all phases of product manufacturing. Students will learn the basics of technical drawing, gain proficiency in computer-aided design (CAD) for 3D object creation, and develop an understanding of the visual elements of technical drawings used in industries.
Online courses in Russian	Link	Summary
Детали машин	https://stepik.org/course/66036/promo	This course explores the principles, calculations, and design considerations for machine elements and assemblies within the broader field of mechanical engineering. It focuses on applying scientific knowledge and engineering experience to create reliable and robust structures, components, and assemblies for a wide range of applications.
Аддитивные технологии (3D-)	https://openedu.ru/course/spbstu/ADT ECH/	The purpose of this online course is to provide students with an understanding of the principles of 3D printing, and the capabilities and limitations of

печать). Вводный курс		additive technologies, and to show real-world examples of the application of these technologies in industry and educational activities.
Технологии цифровой промышленности и	https://openedu.ru/course/spbstu/DIGTECH/	This general education course provides an overview of modern digital technologies driving the digital transformation of industry, a key sector in the global economy.

Automation & control systems

Online courses in English	Link	Summary
Classical Control Theory (Brian Douglas).	https://www.youtube.com/playlist?list=PLUMWjy5jgHK1NC52DXXrriwihVrYZKqjk	This course is a set of lectures on the main topics of technical systems control theory
Principles of Automatic Control (MIT Open Courseware).	https://ocw.mit.edu/courses/16-06-principles-of-automatic-control-fall-2012/pages/lecture-notes/	This course introduces the design of feedback control systems as applied to a variety of air and spacecraft systems. Topics include the properties and advantages of feedback systems, time-domain and frequency-domain performance measures, stability and degree of stability, the Root locus method, the Nyquist criterion, frequency-domain design, and state space methods.
Control Systems. (ClassCentral)	https://www.classcentral.com/course/youtube-control-systems-48209/classroom	The course outlines the fundamentals of control theory: Principles of modelling; block diagram manipulation, Mason's rule; the dynamic response of closed-loop systems; time domain characteristics; the influence of zeros; Root's criterion; the influence of noise, steady-state errors; PID control; root locus method; root locus rules; root locus rules, advance compensation; lag compensation; zero degree root locus, etc.
Online courses in Russian	Link	Summary
Теория автоматического управления. Нелинейные системы автоматического управления	https://openedu.ru/course/misis/TAU/	This course equips students with practical skills in analyzing nonlinear automatic control systems. Students will gain expertise in understanding the topological properties of system phase portraits, stability analysis (in small, large, and general), and absolute stability of closed-loop systems. They will also learn to identify conditions for the emergence of periodic processes in these systems. The course emphasizes developing proficiency in constructing

		mathematical models of nonlinear systems, analyzing their topological properties and characteristics, and mastering methods of linear representation for these models.
Основы теории автоматического управления	https://stepik.org/course/115666/promo	The course "Automatic Control System" is devoted to the basic concepts, methods and laws of control of technical objects. The structure of the course includes: the basics of mathematical models, methods of research of stability of control objects, approaches to synthesis and correction of automatic control systems, optimization methods, and study of the peculiarities of the influence of nonlinear elements in the system structure. The class of linear, nonlinear, deterministic and stochastic systems, continuous and discrete systems is studied.
Теория автоматического управления. 3	https://www.youtube.com/watch?v=h9OALKuSLaU	The course "Theory of Automatic Control" is devoted to the basic concepts, methods and laws of control of technical objects. The course includes: the basics of compiling mathematical models, methods of studying the stability of control objects, approaches to the synthesis and correction of automatic control systems, optimization methods, and the study of the peculiarities of the influence of nonlinear elements in the structure of the system. The class of linear, nonlinear, deterministic and stochastic systems, continuous and discrete systems are studied.

Engineering, electrical & electronic

Online courses in English	Link	Summary
Circuits and Electronics 1: Basic Circuit Analysis (EdX)	https://www.edx.org/course/circuits-and-electronics-1-basic-circuit-analysi-2	This course will provide you with the tools and skills necessary to design and analyze electrical circuits. You will learn to apply fundamental circuit analysis techniques such as the node method, superposition, and Thevenin's theorem. You will also gain an understanding of lumped circuit models, abstraction techniques, and intuition-based circuit solving. The course includes the construction of simple digital gates using MOSFET transistors, along with instruction on using virtual lab tools such as oscilloscopes, multimeters, and signal generators.

Basic Electrical Circuits (ClassCentral)	https://www.classcentral.com/course/swayam-basic-electrical-circuits-618	This course explores the fundamental principles of electrical circuits, from the tiny circuits found in mobile phones to the large-scale power grids that power our homes. You'll gain an understanding of key electrical quantities, basic circuit elements (resistors, inductors, capacitors, and controlled sources), and various circuit analysis techniques applicable to complex circuits. The course also covers circuit theorems and the basics of negative feedback using operational amplifiers.
Semiconductor Fundamentals (EdX)	https://www.edx.org/course/semiconductor-fundamentals	This course lays the foundation for understanding the operation of semiconductor devices, including transistors, diodes, solar cells, and light-emitting devices. It's designed for electrical engineering students interested in applying these devices to circuits and systems.
Online courses in Russian	Link	Summary
Введение в цифровую электронику	https://intuit.ru/studies/courses/588/444/info	This course explores the principles, structure, and applications of digital electronic devices. It covers the key types of digital equipment, their operational algorithms, and typical circuit designs, with a focus on emerging trends in microprocessor systems.
Практический курс по ТОЭ. Первая часть	https://stepik.org/course/96348/promo	This course explores the fundamental principles and analysis methods of electrical circuits, focusing on resistive and dynamic circuits, as well as classical and modern filter theory. It covers electrical signal analysis (constant, periodic, and non-periodic), their Laplace and Fourier representations, linear circuit characteristics, circuit analysis techniques in time, frequency, and Laplace domains, spectral analysis, and methods for calculating three-phase and inductively coupled circuits.
Общая электротехника	https://oiledu.ru/courses/ugntu/obshchaya-elektrotehnika.html	The course familiarizes students with basic concepts and laws of electrical engineering, such as electric current, resistance, voltage, frequency, Ohm's law, Kirchhoff's law, and electromagnetic induction, with types and elements of electric circuits, methods of their calculation and analysis, with electric machines of direct and alternating current, transformers, rectifiers and inverters, with devices for measuring power and electricity, as well as with schemes of their inclusion.

Materials science, characterization & testing

Online courses in English	Link	Summary
Strength of Materials	https://freevideocourses.com/course/96/strength-of-materials	This Strength of Materials course provides a foundational understanding of material behaviour essential for mechanical engineering students. It explores the concepts of load resultants, the effects of different loading types on various structural elements, and how different materials withstand these loads. The course utilizes clear and concise explanations to make the fundamental principles accessible to students.
Advanced Strength of Materials	https://freevideocourses.com/course/2356/advanced-strength-of-materials	This course delves into the analysis of stress and strain in three dimensions, covering topics such as stress vectors, planes of maximum shear stress, tensors, hydrostatic and deviatoric stress, displacement and rotation tensors, and equilibrium equations in polar coordinates. It explores practical applications of these concepts in areas like shrink fit stress, duplex cycle analysis, thin box section analysis, and pressure vessel design. The course also covers theories of failure, energy principles, and applications related to shear centres, bimetallic points, and discontinuities.
Mechanics of Materials IV: Deflections, Buckling, Combined Loading & Failure Theories (Coursera)	https://www.coursera.org/learn/materials-structures	This course covers the analysis and design of engineering structures considering deflection, buckling, combined loading and failure theories.
Online courses in Russian	Link	Summary
Механика материалов III: Изгиб балки	https://www.coursera.org/learn/beam-bending	This course focuses on the analysis and design of beam bending problems, building upon the fundamentals of stress, deformation, and axial loading covered in Mechanics of Materials I.
"Механика материалов I: Основы напряжений и деформаций и	https://www.coursera.org/learn/mechanics-1	This course explores the topic of solid objects subject to stress and strain. The methods taught in the course are used to predict the response of engineering structures to different types of loading and to analyze the vulnerability of these structures to

осевое напряжение"		different failure modes. The focus of this course is on axial loading.
Механика материалов IV: Прогибы, смятие, комбинированно е напряжение и теории разрушения	https://www.coursera.org/learn/materials-structures	This course covers the analysis and design of engineering structures considering deflection, buckling, combined loading and failure theories.

Telecommunications

Online courses in English	Link	Summary
CIRCUITS AND ELECTRONICS (MIT Open Courseware)	https://ocw.mit.edu/courses/6-002-circuits-and-electronics-spring-2007/	The course is designed to serve as a first course in an undergraduate electrical engineering (EE), or electrical engineering and computer science (EECS) curriculum. The course introduces the fundamentals of the lumped circuit abstraction. Topics covered include resistive elements and networks; independent and dependent sources; switches and MOS transistors; digital abstraction; amplifiers; energy storage elements; dynamics of first- and second-order networks; design in the time and frequency domains; and analogue and digital circuits and applications. Design and lab exercises are also significant components of the course.
Linear Circuits 2: AC Analysis (Coursera)	https://www.coursera.org/learn/linear-circuits-ac-analysis	This course explains how to analyze circuits that have alternating current (AC) voltage or current sources. Circuits with resistors, capacitors, and inductors are examined both analytically and experimentally. Some practical applications in sensors are demonstrated.
Introduction in Electronics	https://www.coursera.org/learn/electronics	This course introduces students to the basic components of electronics: diodes, transistors, and operational amplifiers. It covers basic principles of operation and some common applications.
Online courses in Russian	Link	Summary
Переходные процессы в линейных электрических	https://www.ups-info.ru/for_partners/library/teoreticheskie_osnove_elektrot	The course covers the basic methods of analyzing transients in linear circuits.

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Трехфазные цепи	https://www.youtube.com/watch?v=k_gX3mLh56Wg	The course covers the theory of three-phase electric circuits.
Основные активные компоненты электроники (диоды, транзисторы и операционные усилители)	https://stepik.org/course/115236/promo	This course explores the fundamental principles of analogue and digital electronics, covering the key functional units, their parameters, and characteristics. You'll learn calculation methods for device element parameters and solve test problems related to the course's core concepts.
Принципы построения электронных устройств (на примере проектирования простых устройств)	https://supereyes.ru/articles/other/top-sovetov-razrabotchiku-elektronnykh-ustroystv/	This course provides a practical guide for aspiring electronic device developers, covering essential steps from initial concept to final assembly. You'll learn about choosing a design direction, sketching circuits, debugging using electronic models, creating circuit diagrams and board layouts, soldering techniques, independent research, and general tips for success in the field.
Устройства формирования информационного сигнала (датчики, сенсоры)	https://portal.tpu.ru/SHARED/a/ARISTOV/Learning/Izmerit_preobr/Tab3/%D0%BF%D0%BE%D1%81%D0%BE%D0%B1%D0%B8%D0%B5%20%D0%BF%D0%BE%20%D0%B4%D0%B0%D1%82%D1%87%D0%B8%D0%BA%D0%B0%D0%BC.pdf	This course explores a wide range of sensors and detectors used to measure diverse physical quantities.
Обработка сигнала (усилители, преобразователи)	https://rtf.sfedu.ru/rpru/files/upos04.pdf	This course examines the design principles and fundamental circuitry of signal reception and processing devices, covering theoretical foundations and practical applications for professional and consumer radio-electronic systems.

Компоненты и устройства отображения (индикаторы, дисплеи)	https://dzen.ru/a/X70yJ26mXCSziCUw	This course provides an overview of the components and devices commonly used for standalone information display in various devices, including a brief explanation of their operational principles.
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Nuclear science & technology

Online courses in English	Link	Summary
Introduction To Applied Nuclear Physics	https://ocw.mit.edu/courses/22-02-introduction-to-applied-nuclear-physics-spring-2012/	The course introduces the fundamental principles that underline nuclear science and its engineering applications, as well as the mathematical tools needed to grasp these concepts. Applications to nuclear science and engineering will be used to illustrate these (often abstract) principles.
Engineering Of Nuclear Reactors	https://ocw.mit.edu/courses/22-312-engineering-of-nuclear-reactors-fall-2015/	This course explores the engineering principles behind nuclear reactors, with a focus on power reactors. It covers topics such as power plant thermodynamics, reactor heat generation and removal (including single-phase and two-phase coolant flow and heat transfer), structural mechanics, and design considerations for reactor engineering.
Applied Nuclear Physics	https://ocw.mit.edu/courses/22-101-applied-nuclear-physics-fall-2006/	This course explores elements of nuclear physics for engineering students. It covers basic properties of the nucleus and nuclear radiations; quantum mechanical calculations of deuteron bound-state wave function and energy; n-p scattering cross section; transition probability per unit time and barrier transmission probability. It also covers binding energy and nuclear stability; interactions of charged particles, neutrons, and gamma rays with matter; radioactive decay; and energetics and general cross-section behaviour in nuclear reactions.
Online courses in Russian	Link	Summary
Физика в опытах. Часть 5. Атомная физика	https://openedu.ru/course/mephi/ATP_HYS/	This course uses hands-on experiments to bring the principles of physics to life. You'll experience firsthand how "simple" physical questions can have surprising answers, depending on the experimental setup. Through these demonstrations, you'll gain a deeper understanding of the concepts often taught through theory and mathematical models.

Квантовая механика	https://www.coursera.org/learn/quantum-mechanics	The course provides an introduction to quantum mechanics at a level suitable for those with a background in mechanical or aerospace engineering. Using a postulate approach that describes the steps that follow, the Schrödinger wave equation is derived and simple solutions are obtained to illustrate the behaviour of atomic and molecular structures. More realistic behaviour is also discussed, as well as modern methods for the numerical solution of the wave equation in quantum chemistry.
Физика частиц: введение	https://www.coursera.org/learn/particle-physics	This course delves into the realm of subatomic physics, exploring nuclear and particle physics. You'll gain an understanding of fundamental concepts in particle physics, the properties and applications of atomic nuclei, particle acceleration and detection methods, insights from high-energy particle reactions and decays, and the principles of electromagnetic interactions.