open doors **Russian Scholarship Project Association "Global Universities"**

PROGRAM: ENGINEERING & TECHNOLOGIES

This document outlines the scope of themes, which may be included in the Olympiad tests. The themes are grouped by areas and are followed by the list of recommended references in the Russian and English languages.

Olympiad winner's skill set by subject
The winner of the Olympiad in the field of Engineering and Technologies must have the following competencies and skills.

Analytical competencies and skills
1. Analysis of mechanical systems. The ability to understand the nature of the movement of a mechanical system by its appearance, and the nature of the loading of a structure according to its drawing.
2. Analysis of electrical circuits. Understanding the structure of an electrical circuit from its image.
3. Reading drawings. The ability to understand the appearance of a part by looking at its drawing.
4. Analyzing system stability. To own methods of analyzing the system stability and dynamics performance.

Project-oriented competencies and skills
1. Execution of drawings. Ability to draw parts and assembly drawings of varying complexity.
2. Synthesis of automatic control systems. To own methods of synthesis of automatic control systems.

Research competencies and skills
1. Calculation of mechanical systems. The ability to calculate the parameters of movement of material points and parts of mechanisms, as well as loads in static structures.
2. Calculation of electrical circuits. Ability to calculate the parameters of electrical circuits and electronic devices.
3. Transformation of control systems models. To be able to perform the analysis of mathematical models of control systems.

Content
Section 1. Theoretical mechanics
1. The 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. Differential equations of motion of a material point.
5. General theorems of the dynamics of a material point and a mechanical system, applications to the dynamics of a rigid body.

Section 2. Engineering graphics and basics of designing
1. Basic terms of engineering graphics. Coordinate system. Projections. Views. Sectional views. Sections. Unwrap.
2. Drawings. Lines of drawings. Different types of lines.
3. Mechanical engineering drawing. Classification of nodes and parts in mechanical engineering drawing.
4. Joints of parts. Detachable joints. Non-detachable joints.
5. Development of drawings. Designations on the drawings. Projections. Sectional views. Sections.

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6. Basics of digital manufacturing. Programming of CNC machines. G-CODE language. Technology commands. Tool positioning commands.

Section 3. Mechanics of a deformable solid body

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. Displacements and deformations. Tensor of small deformations.
3. Stressed state. Stress tensor. Differential equilibrium equation.
4. Theory of elasticity. Hooke's law. Statement of the problem in the theory of elasticity. Flat tasks.
5. Thermodynamics of continuous media. The energy of elastic deformation. Generalized Hooke's law.
6. Elements of resistance of materials. Bending and twisting of rods. Statistically determined and statically indeterminate rod systems. Theorem of Castigliano.
7. Elements of the theory of viscoelasticity. Linear creep. Elementary models (Maxwell body, Voigt body, standard body).
8. Elements of the theory of plasticity. Ideal ductility and ductility with hardening. Deformation theory, theory of plastic flow. Associated law of plastic flow. The von Mises principle (the principle of maximum dissipation).
9. Elements of the theory of destruction. Stress concentration. Griffith's theory of brittle fracture.

Section 4. Fluid and Gas Mechanics

1. Analysis of dimensions. Basic and derived units of measurement. Systems of units of measurement. Class of systems of units of measurement. Dimensionality of a physical quantity. Dependent and independent dimensions. P-theorem. Solution of problems with the help of the P-theorem.

2 Theory of motion of an ideal fluid. Kinematics of liquid medium. Basic equations of the ideal fluid. Hydrostatics. Flat vortex-free steady-state flows of an ideal incompressible fluid. Vortex motions of an ideal fluid.

3. Theory of viscous fluid motion. Basic equations of motion of viscous fluid. Exact solutions of the equations of motion of viscous fluid. Approximate solutions of the equations of motion of viscous fluid in the case of small and large Reynolds numbers.

4. Theory of motion of compressible fluid. Riemann invariants. Method of characteristics. Hydraulic jumps. Theory of shallow water.

Section 5. Automatic Control Theory

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. The Bellman principle. The Pontryagin's maximum principle.

Section 6. Electrical Engineering

1. Calculation of resistive R-circuits
2. Transient processes in linear circuits
3. Steady-state sinusoidal mode
4. Three-phase circuits.

Section 7. Electronics

1. The main active components of electronics (diodes, transistors and operational amplifiers).
2. Principles of construction of electronic devices (on the example of designing simple devices).
3. Information signal generation devices (sensors, sensors).
4. Signal processing (amplifiers, converters).
5. Components and display devices (indicators, displays).

Recommended literature

Section 1. Theoretical mechanics

Sources	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 Access regime: limited	4. Differential equations of motion of a material point. 5. 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. 5th edition Imperial College Press. 2011. 478 p. https://www.amazon.com/Classical-Mechanics-5th-Tom-Kibble/dp/1860944353 Access regime: limited	4. Differential equations of motion of a material point. 5. General theorems of the dynamics of a material point and a mechanical system, applications to the dynamics of a rigid body.
3. McLean W.G., et al. Engineering Mechanics, Statics and Dynamics, McGrawHill (1962). https://archive.org/details/schaumsoutlineof0000mcle Access regime: limited	1. Equilibrium of a rigid body under the conditions of a convergent, flat or spatial system of forces; friction. 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. Differential equations of motion of a material point.
4. 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 Access regime: limited	1. Equilibrium of a rigid body under the conditions of a convergent, flat or spatial system of forces; friction.
5. Polyakhov N.N., Yushkov M.P., Zegzhda S.A. Rational and Applied Mechanics, Springer Cham. 2021. 520p https://link.springer.com/book/10.1007/978-3-030-64061-3 Access regime: limited	1.Equilibrium of a rigid body under the conditions of a convergent, flat or spatial system of forces; friction. 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.Differential equations of motion of a material point.
6. 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 Access regime: free	1. Equilibrium of a rigid body under the conditions of a convergent, flat or spatial system of forces; friction. 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. Differential equations of motion of a material point. 5. General theorems of the dynamics of a material point and a mechanical system, applications to the dynamics of a rigid body.
7. 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 Access regime: free	1. Equilibrium of a rigid body under the conditions of a convergent, flat or spatial system of forces; friction. 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. Differential equations of motion of a material point. 5. General theorems of the dynamics of a material point and a mechanical system, applications to the dynamics of a rigid body.
8. Гантмахер Ф.Р. Лекции по аналитической механике. Изд. 3е. М.: ФИЗМАТЛИТ, 2001, 264 с. https://e.lanbook.com/book/47536 Access regime: free	1. Equilibrium of a rigid body under the conditions of a convergent, flat or spatial system of forces; friction. 4. Differential equations of motion of a material point. 5. General theorems of the dynamics of a material point and a mechanical system, applications to the dynamics of a rigid body.
9. 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 Access regime: free	1. Equilibrium of a rigid body under the conditions of a convergent, flat or spatial system of forces; friction. 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. Differential equations of motion of a material point. 5. General theorems of the dynamics of a material point and a mechanical system, applications to the dynamics of a rigid body.
10. 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. 2. https://lib-bkm.ru/load/114-1-0-3053 Access regime: free	1. Equilibrium of a rigid body under the conditions of a convergent, flat or spatial system of forces; friction. 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. Differential equations of motion of a material point. 5. General theorems of the dynamics of a material point and a mechanical system, applications to the dynamics of a rigid body.

11. Пятницкий Е.С., Трухан Н.М., Ханукаев Ю.И., Яковенко Г.Н., Сборник задач по аналитической механике, Учебное пособие для ВУЗов, 3-е изд., перераб. и доп., М. ФИЗМАТЛИТ, 2002, 400с. https://chembaby.ru/materialy/piatnitskii-e-s-trukhan-n-m-khanukaev-iu-i-iakovenko-g-n-sbornik-zadach-po-analiticheskoi-mekhanike Access regime: free	1. Equilibrium of a rigid body under the conditions of a convergent, flat or spatial system of forces; friction. 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. Differential equations of motion of a material point. 5. General theorems of the dynamics of a material point and a mechanical system, applications to the dynamics of a rigid body.
12. Тарг С.М. Краткий курс теоретической механики: Учеб. для втузов/С.М.Тарг.-12-е изд., стер. - М.: Высш. шк., 2010.-415 с. http://mechanicsrgsu.narod.ru/Targ.pdf Access regime: free	1. Equilibrium of a rigid body under the conditions of a convergent, flat or spatial system of forces; friction. 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. Differential equations of motion of a material point. 5. General theorems of the dynamics of a material point and a mechanical system, applications to the dynamics of a rigid body.
13. Яблонский А.А., В.М.Никифорова Курс теоретической механики. В 2х частях. (Часть I. Статика. Кинематика., Часть II Динамика). Учеб.пособие для вузов: 3-е изд., исправл. - М.: Высшая школа, 1966. https://dwg.ru/dnl/7904 Access regime: free	1. Equilibrium of a rigid body under the conditions of a convergent, flat or spatial system of forces; friction. 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. Differential equations of motion of a material point. 5. General theorems of the dynamics of a material point and a mechanical system, applications to the dynamics of a rigid body.

Section 2. Engineering graphics and basics of designing

Sources	Topic
1. G & M Code REFERENCE MANUAL https://machmotion.com/downloads/GCode/Mach4-G-and-M-Code-Reference-Manual.pdf Access regime: free	6. Basics of digital manufacturing. Programming of CNC machines. G-CODE language. Technology commands. Tool positioning commands.
2. S.P. Burkova, G.F.Vinokurova, R.G. Dolotova. Engineering Graphics. Textbook. – Tomsk: TPU Press, 2014, 174 pp. https://portal.tpu.ru/SHARED/d/DOLOTOVA/in_st/archiv_1/1.pdf Access regime: free	1. Basic terms of engineering graphics. Coordinate system. Projections. Views. Sectional views. Sections. Unwrap. 2. Drawings. Lines of drawings. Using different types of lines. 4. Joints of parts. Detachable joints. Non-detachable joints. 5.Development of drawings. Designations on the drawings. Projections. Sectional views. Sections.
3. 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/sozdanie-trehmernyh-modelej-i-konstruktorskoj-dokumentatsii-v-sisteme-kompas-3d-praktikum/ Access regime: limited	1. Basic terms of engineering graphics. Coordinate system. Projections. Views. Sectional views. Sections. Unwrap. 2. Drawings. Lines of drawings. Using different types of lines.
4. 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 Access regime: free	1. Basic terms of engineering graphics. Coordinate system. Projections. Views. Sectional views. Sections. Unwrap. 2. Drawings. Lines of drawings. Using different types of lines. 3. Mechanical engineering drawing. Classification of nodes and parts in mechanical engineering drawing. 4. Joints of parts. Detachable joints. Non-detachable joints. 5.Development of drawings. Designations on the drawings. Projections. Sectional views. Sections.
5. Инженерная и компьютерная графика: электрон. учеб. - метод. пособие к практ. занятиям и самост. работе студентов/ Р. А. Сакаев, Ю. В. Павлова, Б. М. Перлов, А. И. Лысков — СПб. : Изд-во СПбГЭТУ "ЛЭТИ", 2017.	1. Basic terms of engineering graphics. Coordinate system. Projections. Views. Sectional views. Sections. Unwrap. 2. Drawings. Lines of drawings. Using different types of lines.

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http://library.etu.ru/jirbis2/index.php?option=com_irbis&view=irbis&Itemid=108&task=set_static_req&bl_id_string=1&req_irb=%3c.%3eI=%D0%96%2011/%D0%9B88-352808%3c.%3e Access regime: limited	
6. 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 Access regime: free	3. Mechanical engineering drawing. Classification of nodes and parts in mechanical engineering drawing. 4. Joints of parts. Detachable joints. Non-detachable joints.
7. 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 Access regime: free	3. Mechanical engineering drawing. Classification of nodes and parts in mechanical engineering drawing. 4. Joints of parts. Detachable joints. Non-detachable joints.

Section 3. Mechanics of a deformable solid body

Sources	Topic
1. Fridtjov Irgen, Continuum Mechanics, Springer, 2008, 661 p. https://link.springer.com/book/10.1007/978-3-540-74298-2?utm_medium=referral&utm_source=google_books&utm_campaign=3_pier05_buy_print&utm_content=en_08082017 Access regime: free	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. Displacements and deformations. Tensor of small deformations. 3. Stressed state. Stress tensor. Differential equilibrium equation. 4. Theory of elasticity. Hooke's law. Statement of the problem in the theory of elasticity. Flat tasks. 5. Thermodynamics of continuous media. The energy of elastic deformation. Generalized Hooke's law. 6. Elements of resistance of materials. Bending and twisting of rods. Statistically determined and statically indeterminate rod systems. Theorem of Castigliano. 7. Elements of the theory of viscoelasticity. Linear creep. Elementary models (Maxwell body, Voigt body, standard body).
2. Teodor M. Atanackovic, Ardeshir Guran, Theory of Elasticity for Scientists and Engineers. Birkhauaser, 2000, 374 p. https://link.springer.com/book/10.1007/978-1-4612-1330-7?utm_medium=referral&utm_source=google_books&utm_campaign=3_pier05_buy_print&utm_content=en_08082017 Access regime: limited	
3. Theory and Problems of Continuum Mechanics / George E. Mase. 229 p.	

https://dokumen.tips/documents/mase-theory-and-problems-of-continuum-mechanicspdf.html?page=218 Access regime: free	8. Elements of the theory of plasticity. Ideal ductility and ductility with hardening. Deformation theory, theory of plastic flow. Associated law of plastic flow. The von Mises principle (the principle of maximum dissipation).
4. Извеков О.Я. Элементы механики деформируемого твердого тела. - М.: МФТИ, 2019. - 248 с. http://books.mipt.ru/book/301238 Access regime: free	
5. Мейз, Дж. Теория и задачи механики сплошных сред пер. с англ. Е. И. Свешниковой ; под ред. и с предисл. М. Э. Эглит - Москва: МИР, 1974. - 318 с https://www.c-o-k.ru/library/document/12357 Access regime: free	
6. Работнов Ю.Н. Механика деформируемого твердого тела М.: Наука, 1988. – 712 с. https://studizba.com/files/show/djvu/2605-2-yu-n-rabotnov--mehanika-deformiruemogo.html Access regime: free	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. Displacements and deformations. Tensor of small deformations. 3. Stressed state. Stress tensor. Differential equilibrium equation. 4. Theory of elasticity. Hooke's law. Statement of the problem in the theory of elasticity. Flat tasks. 5. Thermodynamics of continuous media. The energy of elastic deformation. Generalized Hooke's law. 6. Elements of resistance of materials. Bending and twisting of rods. Statistically determined and statically indeterminate rod systems. Theorem of Castigliano. 7. Elements of the theory of viscoelasticity. Linear creep. Elementary models (Maxwell body, Voigt body, standard body). 8. Elements of the theory of plasticity. Ideal ductility and ductility with hardening. Deformation theory, theory of plastic flow. Associated law of plastic flow. The von Mises principle

	(the principle of maximum dissipation). 9. Elements of the theory of destruction. Stress concentration. Griffith's theory of brittle fracture.
7. Рыжак Е.И. Бескординатное исчисление для механики сплошных сред. - М.: МФТИ, 2011. https://www.researchgate.net/publication/295852176_BESKOORDINATNOE_TENZORNOE_ISCISLENIE_DLA_MEHANIKI_SPLOSNYH_SRED Access regime: free	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.
8. Феодосьев В.И. Сопротивление материалов: Учебник для студ-ов высш.техн.учеб.зав. – 10-е изд., перераб. и доп. – М.: Изд-во МГТУ им. Н.Э. Баумана, 1999. – 592 с. https://pnu.edu.ru/media/filer_public/2013/04/10/2-12_fedosev_sopromat_1999.pdf Access regime: free	6. Elements of resistance of materials. Bending and twisting of rods. Statistically determined and statically indeterminate rod systems. Theorem of Castigliano.

Section 4. Fluid and Gas Mechanics

Sources	Topic
1. G.I. Barenblatt, Dimensional Analysis, CRC Press, 1987 .135 p https://books.google.co.uz/books?id=gHFQWEvTWBgC Access regime: limited	1. Analysis of dimensions
2. T.E. Faber. Fluid dynamics for physicists. Cambridge university press, 1995. 440 p. https://www.cambridge.org/core/search?q=T.E.Faber.+Fluid+dynamics+for+physicists. Access regime: limited	1.Analysis of dimensions 2.Theory of motion of an ideal fluid 3.Theory of viscous fluid motion
3. G.B. Whitham F.R.S. Linear and nonlinear waves., Jown Wiley&Sons, New York London, Sydney Toronto, 1974. 636 p.	4. Theory of motion of compressible fluid

https://eclass.uoa.gr/modules/document/file.php/PHYS289/Βιβλία/Whitham_Linear_and_Nonlinear_Waves.pdf Access regime: free	
4. Г.И.Баренблатт. Анализ размерностей. М.1987, 168 с. https://studizba.com/files/show/djvu/2986-1-g-i-barenblatt--analiz-razmernostey.html Access regime: free	1. Analysis of dimensions
5. С. В. Валландер. Лекции по гидроаэромеханике С.-Петерб. гос. ун-т .— 2-е изд. — СПб. : Изд-во С.-Петерб. ун-та, 2005 . 304 с. http://www.booksshare.net/books/physics/vallander-sv/1978/files/lexciipoaerogidromehanike1978.pdf?ysclid=lku2w1q7oc190818616 Access regime: free	2.Theory of motion of an ideal fluid
6. Н. Е. Кочин, И. А. Кибель, Н. В. Розе ; под ред. И. А. Кибеля .— 6-е изд., испр. и доп. — Теоретическая гидромеханика : 2 ч. Ч.1: учеб. пособие для вузов М : Физматгиз, 1963 .— 583 https://studizba.com/files/gidrogazodinamika-ggd/book/218683-n.e.-kochin-i.a.-kibel-n.v.-roze.html Access regime: free	2. Theory of motion of an ideal fluid
7. Н. Е. Кочин, И. А. Кибель, Н. В. Розе; под ред. И. А. Кибеля .— 4-е изд., перараб. и доп. Теоретическая гидромеханика: 2 ч. Ч. 2 : учеб. пособие для вузов, М : Физматлит, 1963 . 727 с. https://studizba.com/files/gidrogazodinamika-ggd/book/218684-n.e.-kochin-i.a.-kibel-n.v.-roze. Access regime: free	3. Theory of viscous fluid motion
8. Дж. Уизем ; пер. с англ. В. В. Жаринова ; под ред. А. Б. Шабата . Линейные и нелинейные волны. М. : Мир, 1977 .— 622 с. https://studizba.com/files/show/djvu/2719-1-dzh-uizem--lineynye-i-nelineynye-volny.html Access regime: free	4.Theory of motion of compressible fluid.

Section 5. Automatic Control Theory

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Source	Topics
1. Donald, E. Optimal control theory: an introduction. DOVER PUBNS, 2016. https://www.amazon.com/Optimal-Control-Theory-Introduction-Engineering/dp/0486434842 Access regime: limited	11. Optimal control problem formulation. Bellman principle. Pontryagin maximum principle.
2. Dorf R. C., Bishop R. H. Modern Control Systems. 10th edition. L.: Pearson Prentice Hall, 2005. https://powerunit-ju.com/wp-content/uploads/2016/11/Book-Modern_Control_Systems_11th_Edition.pdf Access regime: free	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 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
3. Gantmacher, Felix (1959), Theory of matrices, AMS Chelsea publishing https://www.maths.ed.ac.uk/~v1ranick/papers/gantmacher1.pdf Access regime: free	5.Routh-Hurwitz stability criterion (or Hurwitz stability criterion)
4. Hägglund T. Automatic Control. Lecture Notes. Lund, 2019. https://www.control.lth.se/fileadmin/control/Education/EngineeringProgram/FRTF05/engforel.pdf Access regime: free	7.State feedback system design: Modal control (pole assignment)
5. Khalil H. K. Nonlinear Systems. 3rd Edition. N. J.: Prentice Hall, 2002. https://www.lirmm.fr/~chemori/Temp/Ines/Khalil_Nonlinear_Systems.pdf Access regime: free	9.Equilibrium states of linear and nonlinear systems. Lyapunov's first and second methods in motion stability analysis
6. Kwakernaak H., Sivan R. Linear Optimal Control Systems. N. Y.: Wiley, 1972. https://yandex.ru/search/?text=kwakernaak+sivan&lr=2&clid=2296048&win=375&src=suggest_T	8.System state reconstruction using state observers

Access regime: free	
7. Modern Control. Engineering. Fifth Edition (2010). Katsuhiko Ogata. Prentice Hall. Boston Columbus Indianapolis New York San Francisco Upper Saddle River. http://docs.znu.ac.ir/members/pirmohamadi_ali/Control/Katsuhiko%20Ogata%20_%20Modern%20Control%20Engineering%205th%20Edition.pdf Access regime: free	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' analysis 10. PID Controllers. Linear regulator control.
8. Slotine Lectures on Nonlinear Systems https://web.mit.edu/nsl/www/videos/lectures.html Access regime: free	5. Routh-Hurwitz stability criterion (or Hurwitz stability criterion) 9. Equilibrium states of linear and nonlinear systems. Lyapunov's first and second methods in motion stability analysis
9. Wonham W. M. On Pole Assignment in Multivariable Linear Systems // IEEE Trans. on Automatic Control, Dec.1968, pp. 747–748. https://www.researchgate.net/publication/3025444_On_pole_assignment_in_multivariable_linear_systems/link/5488c9fa0cf268d28f08ff49/download Access regime: free	7. State feedback system design: Modal control (pole assignment)
10. Бесекерский В. А., Попов Е. П. Теория систем автоматического управления. М.: Профессия, 2003. https://studizba.com/files/show/pdf/3931-1-besekerskiy-v-a-popov-e-p--teoriya.html Access regime: free	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

ONE CLICK TO OPEN ALL DOORS

	5. Routh-Hurwitz stability criterion (or Hurwitz stability criterion)
	6. Nyquist stability criterion
11. Бороденко В. А. Сборник задач по теории автоматического управления. Павлодар: Кереку, 2009. http://knigainformatika.com/rule/Borodenko_zadania_TAU.pdf Access regime: free	7. State feedback system design: Modal control (pole assignment) 8. System state reconstruction using state observers
12. Гантмахер Ф. Р. Теория матриц. — М.: Наука, 1967. http://mathscinet.ru/files/Gantmaher.pdf Access regime: free	5. Routh-Hurwitz stability criterion (or Hurwitz stability criterion)
13. Дорф Р., Бишоп Р. Современные системы управления. М.: Лаборатория Базовых Знаний, 2014. http://centrlit.com/Market/Book/Index/5149 Access regime: limited	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 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
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15. Ким Д. П., Дмитриева Н. Д. Сборник задач по теории автоматического управления. Линейные системы. М.: ФИЗМАТЛИТ, 2007. https://www.litres.ru/book/nikterne-dmitrieva-8/sbornik-zadach-po-teorii-avtomaticheskogo-upravleniya-16957671/ Access regime: limited	1.Differential equations, transfer functions and frequency response functions of linear continuous systems 3. Equivalent transformations of linear system block diagrams 5. Routh-Hurwitz stability criterion (or Hurwitz stability criterion)
16. Кузовков Н. Т. Модальное управление и наблюдающие устройства. М.: Машиностроение, 1976.	4. Mathematical models of dynamic systems in the form of state variables

https://www.studmed.ru/kuzovkov-nt-modalnoe-upravlenie-i-nablyudayuschie-ustroystva_ab682bb12fd.html Access regime: free	7.State feedback system design: Modal control (pole assignment) 8.System state reconstruction using state observers
17. Мирошник И . В. Теория автоматического управления. Линейные системы. СПб.: Питер, 2006. https://www.studmed.ru/view/miroshnik-iv-teoriya-avtomaticheskogo-upravleniya-lineynye-sistemy_ac833bdfa9f.html Access regime: free	9. Equilibrium states of linear and nonlinear systems. Lyapunov's first and second methods in motion stability analysis
18. Поляк Б.Т., Хлебников М.В., Рапопорт Л.Б. Математическая теория автоматического управления: учебное пособие. М.: ЛЕНАНД, 2019. 500 с https://urss.ru/cgi-bin/db.pl?lang=Ru&blang=ru&page=Book&id=249750 Access regime: limited	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. The Bellman principle. The Pontryagin's maximum principle.
19. Сю Д., Мейер А. Современная теория автоматического управления и ее применение. М.: Машиностроение, 1972. https://www.studmed.ru/syu-d-meyer-a-sovremennaya-teoriya-avtomaticheskogo-upravleniya-i-ee-primenenie_c02398a1ac9.html Access regime: free	4. Mathematical models of dynamic systems in the form of state variables 9. Equilibrium states of linear and nonlinear systems. Lyapunov's first and second methods in motion stability analysis

20. Филлипс Ч., Харбор Р. Системы управления с обратной связью. М.: Лаборатория Базовых Знаний, 2001. https://www.studmed.ru/fillips-ch-harbor-r-sistemy-upravleniya-s-obratnoy-svyazyu_8ae801e5eb2.html Access regime: free	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 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
21. Халил X. К. Нелинейные системы. 3-е изд. М.–Ижевск: НИЦ «Регулярная и хаотическая динамика», Институт компьютерных исследований, 2009. https://ru.ug1lib.org/book/2524855/134f6a Access regime: free	9. Equilibrium states of linear and nonlinear systems. Lyapunov's first and second methods in motion stability analysis

Section 6. Electrical Engineering

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1. Charles K. Alexander, Matthew N.O. Sadiku Fundamentals of Electric Circuits. 5th edition. — McGraw-Hill, 2012. 992 p. https://lms.su.edu.pk/lesson/1793/fundamentals-of-electric-circuits-5th-edition-charles-k-alexander-matthew-n-o-sadiku Access regime: free	1. Calculation of resistive R-circuits 2. Transient processes in linear circuits 3. Steady sinusoidal mode 4. Three-phase circuits
2. Nilsson J.W., Riedel S. Electric Circuits. Peanon Prentice Hall, 2008. 855 p. https://mohamadramdhani.staff.telkomuniversity.ac.id/files/2016/08/James_W._Nilsson_Susan_Riedel_Electric_Circuits_RL-2015Book4You.pdf Access regime: free	1. Calculation of resistive R-circuits 2. Transient processes in linear circuits 3. Steady sinusoidal mode
3. Rizzoni Giorgio. Fundamentals of Electrical Engineering. New York: McGraw-Hill Education, 2009. 736 p.	1. Calculation of resistive R-circuits 2. Transient processes in linear circuits 3. Steady sinusoidal mode

https://www.opentextbooks.org.hk/system/files/export/9/9648/pdf/Fundamentals_of_Electrical_Engineering_I_9648.pdf Access regime: limited	
4. Wadhwa C.L. Basic Electrical Engineering. New Delhi, New Age International (P) Ltd., Publishers, 2007. 422 p. https://sciarium.com/file/180796/ Access regime: limited	3.Steady sinusoidal mode 4.Three-phase circuits
5. Аполлонский С.М., Виноградов А.Л. Теоретические основы электротехники. М.: КНОРУС, 2016. 250 с. https://www.litres.ru/book/aleksandr-vinogradov-5991645/teoreticheskie-osnovy-elektrotehniki-22984016/ Access regime: limited	1. Calculation of resistive R-circuits 2. Transient processes in linear circuits 3. Steady sinusoidal mode 4. Three-phase circuits
6. 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 Access regime: free	2. Transient processes in linear circuits 3. Steady sinusoidal mode 4. Three-phase circuits
7. 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/OTC/31325_bakalov_v_p_osnovy_teorii_cepey_3_e_izdanie(2).pdf Access regime: free	1. Calculation of resistive R-circuits 3. Steady sinusoidal mode
8. Бессонов Л. А. Теоретические основы электротехники. Электрические цепи. М.: «Высшая школа», 1996. 638 с. http://publ.lib.ru/ARCHIVES/B/BESSONOV_Lev_Alekseevich/_Bessonov_L.A..html Access regime: free	1. Calculation of resistive R-circuits 3. Steady sinusoidal mode 4. Three-phase circuits

9. Бычков Ю.А., Золотницкий В.М., Чернышев Э.П., Белянин А.Н. Основы теоретической электротехники. СПб.: Издательство «Лань», 2008. 592 с. http://group8209.ru/Books/TOE/Bychkov_uchebnik.pdf Access regime: free	1. Calculation of resistive R-circuits 3. Steady sinusoidal mode 4. Three-phase circuits
10. Демирчян К.С., Нейман Л.Р., Коровкин Н.В. Теоретические основы электротехники. Том 1. – 4-е изд. СПб.: Питер, 2003. 463 с. https://www.elec.ru/viewer?url=/files/2020/01/30/nejman_teo_osn_eltex_t1.pdf Access regime: free	3.Steady sinusoidal mode 4.Three-phase circuits
11. Иванов И.И., Соловьев Г.И., Фролов В.Я. Электротехника и основы электроники. СПб.: Издательство «Лань», 2021. 736 с. https://www.rulit.me/data/programs/resources/pdf/Ivanov_Elektrotehnika-i-osnovy-elektroniki_RuLit_Me_689668.pdf Access regime: free	1. Calculation of resistive R-circuits 2. Transient processes in linear circuits 3. Steady sinusoidal mode 4. Three-phase circuits

Section 7. Electronics

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1. 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?crid=1WAY1Q51Y5MS9&keywords=electronics+books&qid=1688757983&s=books&sprefix=electronics%2Cstripbooks-intl-ship%2C177&sr=1-9 Access regime: limited	2. Principles of construction of electronic devices (on the example of designing simple devices). 3. Information signal generation devices (sensors, sensors). 4. Signal processing (amplifiers, converters).
2. Easy Electronics (Make: Handbook). by Charles Platt. 2017. https://www.amazon.com/Make-Electronics-hands-electronics-	1. The main active components of electronics (diodes, transistors and operational amplifiers). 2. Principles of construction of electronic devices (on the example of designing simple devices).

enthusiast/dp/1680456873/ref=sr_1_1?crid=1WAY1Q51Y5MS9&keywords=electronics+books&qid=1694559934&s=books&sprefix=electronics%2Cstripbooks-intl-ship%2C177&sr=1-1 Access regime: limited	3. Information signal generation devices (sensors, sensors). 4. Signal processing (amplifiers, converters).
3. Martin Hartley Jones. A Practical Introduction to Electronic Circuits. Cambridge University Press, 1995. https://books.google.ru/books?id=EEcemABAU44C&sitesec=buy&hl=ru&source=gbs_atb Access regime: limited	1. The main active components of electronics (diodes, transistors and operational amplifiers). 2. Principles of construction of electronic devices (on the example of designing simple devices). 3. Information signal generation devices (sensors, sensors). 4. Signal processing (amplifiers, converters).
4. READING SCHEMATICS 101: A step by step guidebook on the basics of understanding how to read schematics for beginners. 2023. https://www.amazon.com/READING-SCHEMATICS-step-step-understanding/dp/B0BVDJ35NZ/ref=sr_1_1?qid=1694559795&refinements=p_27%3ACALVIN+BRENNAN&s=books&sr=1-1&text=CALVIN+BRENNAN Access regime: limited	1. The main active components of electronics (diodes, transistors and operational amplifiers). 2. Principles of construction of electronic devices (on the example of designing simple devices). 3. Information signal generation devices (sensors, sensors).
5. Robert Erickson. Fundamentals of Power Electronics. 3rd ed. 2020. https://www.amazon.com/Fundamentals-Power-Electronics-Robert-Erickson/dp/3030438791/ref=sr_1_14?crid=1WAY1Q51Y5MS9&keywords=electronics+books&qid=1688757983&s=books&sprefix=electronics%2Cstripbooks-intl-ship%2C177&sr=1-14 Access regime: limited	1. The main active components of electronics (diodes, transistors and operational amplifiers). 2. Principles of construction of electronic devices (on the example of designing simple devices).
6. Windell Oskay and Eric Schlaepfer. 2022. Open Circuits: The Inner Beauty of Electronic Components.	1. The main active components of electronics (diodes, transistors and operational amplifiers).

https://www.amazon.com/Open-Circuits-Beauty-Electronic-Components/dp/1718502346/ref=sr_1_2?crid=1WAY1Q51Y5MS9&keywords=electronics+books&qid=1688763786&s=books&sprefix=electronics%2Cstripbooks-intl-ship%2C177&sr=1-2 Access regime: limited	2. Principles of construction of electronic devices (on the example of designing simple devices). 3. Information signal generation devices (sensors, sensors). 4. Signal processing (amplifiers, converters). 5. Components and display devices (indicators, displays).
7. 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 Access regime: free	1. The main active components of electronics (diodes, transistors and operational amplifiers). 2. Principles of construction of electronic devices (on the example of designing simple devices). 3. Information signal generation devices (sensors, sensors). 5. Components and display devices (indicators, displays).
8. Джексон Р.Г. Новейшие датчики. – М. Техносфера. 2007. с. https://djvu.online/file/NMpd8NDLxa6bC#p=1 Access regime: free	5. Components and display devices (indicators, displays).
9. Джонс М.Х. Электроника – практический курс. Перевод выполнен на кафедре радиотехники МФТИ. – М.: Техносфера. 2006. – 512 с.ISBN 5-94836-086-5. https://studizba.com/files/show/djvu/1973-1-m-h-dzhons--elektronika-prakticheskiy.html Access regime: free	1. The main active components of electronics (diodes, transistors and operational amplifiers). 2. Principles of construction of electronic devices (on the example of designing simple devices). 3. Information signal generation devices (sensors, sensors). 4. Signal processing (amplifiers, converters).
10. Манаев Е.И. Основы радиоэлектроники / Е.И. Манаев. - М.: КД Либроком, 2019. - 512 с. https://www.elec.ru/files/2020/02/21/_Manaev_E.I.__Osnovue_radioyelektroniki.PDF Access regime: free	1. The main active components of electronics (diodes, transistors and operational amplifiers). 2. Principles of construction of electronic devices (on the example of designing simple devices). 3. Information signal generation devices (sensors, sensors).

	4. Signal processing (amplifiers, converters).
11. Марченко А. Л. Основы электроники. Учебное пособие для вузов / А. Л. Марченко. — М : ДМК Пресс, 2008. — 296 с. https://rucont.ru/file.ashx?guid=f1f0d248-779b-466a-a297-1ac04ab75a39 Access regime: free	1. The main active components of electronics (diodes, transistors and operational amplifiers). 2. Principles of construction of electronic devices (on the example of designing simple devices). 3. Information signal generation devices (sensors, sensors). 4. Signal processing (amplifiers, converters). 5. Components and display devices (indicators, displays).
12. 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 Access regime: free	1. The main active components of electronics (diodes, transistors and operational amplifiers). 2. Principles of construction of electronic devices (on the example of designing simple devices). 3. Information signal generation devices (sensors, sensors). 4. Signal processing (amplifiers, converters). 5. Components and display devices (indicators, displays).

RECOMMENDED ONLINE COURSES

Section 1. Theoretical mechanics
1. Introduction to Engineering Mechanics (Coursera)
   https://coursera.org/learn/engineering-mechanics-statics
2. Particle Dynamics (Coursera)
   https://www.coursera.org/learn/particle-dynamics
3. Physics 101 - Rotational Motion and Gravitation (Coursera)
   https://www.coursera.org/learn/physics-101-rotational-motion-gravitation
4. Rigid Body Dynamics (Coursera)
   https://www.coursera.org/learn/rigid-body-dynamics

Section 2. Engineering graphics and basics of designing
1. How to Read Engineering Drawings – a Simple Guide (MakeUK)
   https://www.makeuk.org/insights/blogs/how-to-read-engineering-drawings-a-simple-guide
2. Engineering Graphics/Drawing (MyGreatLearning)

https://www.mygreatlearning.com/academy/learn-for-free/courses/engineering-graphics-drawing
3. Engineering Graphics and Design (ClassCentral)
https://www.classcentral.com/course/swayam-engineering-graphics-and-design-43589
4. Nihar Ranjan Patra. Engineering Graphics. (ClassCentral)
https://www.classcentral.com/course/swayam-engineering-graphics-5305

Section 3. Mechanics of a deformable solid body
1. Strength of Materials (FreeVideoLectures)
https://freevideolectures.com/course/96/strength-of-materials
2. Strength of Materials (FreeVideoLectures)
https://freevideolectures.com/course/2361/strength-of-materials
3. Mechanics of Materials I: Fundamentals of Stress & Strain and Axial Loading (Coursera)
https://www.coursera.org/learn/mechanics-1
4. Mechanics of Materials III: Beam Bending (Coursera)
https://www.coursera.org/learn/beam-bending
5. Mechanics of Materials IV: Deflections, Buckling, Combined Loading & Failure Theories (Coursera)
https://www.coursera.org/learn/materials-structures

Section 4. Fluid and Gas Mechanics
1. Механика сплошных сред: газодинамика, Жмур В. В., 06.09.2021г. - YouTube
https://www.youtube.com/watch?v=bt_CoRnkbFY
2. Механика сплошных сред | Видеолекции Физтеха: Лекторий МФТИ - видеолекции по физике, математике, биологии, биоинформатике, информатике и другим дисциплинам (lectoriy.ru)
3. https://mipt.lectoriy.ru/course/TheoreticalPhysics-ContinuumMechanics-14L
4. https://www.udemy.com/course/fluid-mechanics

Section 5. Automatic Control Theory
1. Classical Control Theory (Brian Douglas).
https://www.youtube.com/playlist?list=PLUMWjy5jgHK1NC52DXXrriwihVrYZKqjk
2. Principles of Automatic Control (MIT Open Corseware)
https://ocw.mit.edu/courses/16-06-principles-of-automatic-control-fall-2012/pages/lecture-notes/
3. Control Systems. (ClassCentral)
https://www.classcentral.com/course/youtube-control-systems-48209/classroom

Section 6. Electrical Engineering
1. Circuits And Electronics (MIT Open Corseware)
https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/
2. Introduction to circuit analysis (Udemy)
https://www.udemy.com/course/full-course-circuit-analysis/
3. Circuits and Electronics 1: Basic Circuit Analysis (EdX)
https://www.edx.org/course/circuits-and-electronics-1-basic-circuit-analysi-2
4. Linear Circuits 2: AC Analysis (Coursera)
https://www.coursera.org/learn/linear-circuits-ac-analysis
5. Basic Electrical Circuits (ClassCentral)

https://www.classcentral.com/course/swayam-basic-electrical-circuits-618

Section 7. Electronics

1. Введение в цифровую электронику.
   https://www.intuit.ru/studies/courses/588/444/
2. Introduction to Electronics (Coursera)
   https://www.coursera.org/learn/electronics
3. Semiconductor Physics (Coursera)
   https://www.coursera.org/learn/semiconductor-physics.
4. Basic Electronics For Beginners (YouTube)
   https://youtu.be/uXr4lXYjXuU
5. Beginner Electronics (YouTube)
   https://youtube.com/playlist?list=PLah6faXAgguOeMUIxS22ZU4w5nDvCl5gs
6. Semiconductor Fundamentals (EdX)
   https://www.edx.org/course/semiconductor-fundamentals