

Federal Independent Educational Institution
«NATIONAL RESEARCH TOMSK POLYTECHNIC UNIVERSITY»

APPROVED BY

Deputy Director of Engineering School of
Advanced Manufacturing Technologies

 K.K. Manabaev
«25» 10 2020

VERIFIED BY

Vice Rector for Academic Affairs

 M.A. Soloviev
«25» 10 2020 г.



**Admissions Assessment Policies and Procedures
For master Degree Program
Materials Science
Field of Study 22.04.01 Materials Science and materials technology**

**Director of educational program
Professor**



S.V. Panin

Tomsk 2020



ABSTRACT

Study plan: 22.04.01 « Materials Science and materials technology »
Master degree Program: Materials science

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The entrance test (ET) program in 22.04.01 "Materials Science and materials technology" was developed on the basis of Federal State Standards for Higher Education (level "Bachelor") and is interdisciplinary in nature.

The purpose of the entrance examinations is to select the entrants who are most capable and prepared to study the chosen educational program, as well as to ensure interuniversity and interprogram mobility of undergraduate graduates entering the main professional educational programs of higher education at the master's level.

GENERAL REQUIREMENTS FOR ENTRANTS

The exam for entrants of the Master's program in 22.04.01 "Materials Science and materials technology" (master degree program implemented in English) is conducted in the form of an oral interview.

An oral conversation is carried out by the examination committee with each applicant (entrant) individually. The applicant is asked questions that allow assessing the level of development of basic engineering (general professional) competencies.

Each entrant has no more than 30 minutes.

The criteria for evaluating the interview are communicated to applicants at least 3 months before the start of the entrance test.

The interview with each applicant includes 4 questions – one randomly selected question from the sections of the entrance test program – "Contents of the sections and topics of the entrance test program." To prepare for the ET, an applicant can use the section "Recommendations for preparing for the entrance test."

An entrance test in the form of an oral interview is conducted by the examination committee and can be organized at special sites (in the classroom) or remotely. If necessary, an observer controls the procedure for conducting an admissions test in a remote form.

Applicants are admitted to the audience where the exam is held according to the list in which each applicant is assigned the time for the interview.

The procedure for passing the entrance test in a remote form is regulated by the documents in the current edition approved by the orders of the rector: the Regulations on the conduct of entrance tests to the TPU magistracy and the Procedure for the conduct of entrance tests.

The examination committee may ask 1-2 additional questions on the topics of sections of the test program. The applicant's answers to the questions of the oral interview are recorded in the exam report which is drawn up immediately after and is brought to the attention of the applicant under the signature of the applicant.

An applicant who does not agree with the exam assessment and (or) in connection with the violation of the exam procedure has the right to appeal. The procedure for filing and considering an appeal is regulated by the Regulation on the Appeal Commission TPU.

EVALUATION CRITERIA

The maximum total score of the entrance exam is 100.

The minimum score confirming the successful completion of the entrance test is 56*.

The total score is determined as the sum of points for the answers to each of the questions including additional ones.

The answer to each of the questions is evaluated by the examination committee separately taking into account the following criteria:

Score	Criteria
0-7	An empty answer, ignorance of the basic concepts, inability to apply knowledge in practice.
8-14	Partially correct or insufficiently complete answer or solution of the problem indicating significant gaps in the theoretical and practical preparation of the subject; formal answers, misunderstanding of the essence of the question.
15-20	Sufficiently complete understanding of the subject, good knowledge, skills and practical experience; the necessary learning outcomes are formed. Fairly complete answer is presented; there are minor flaws in the presented solution of the practical problem.
21-25	Informal and informed, deep and complete answer (theoretical and practical). There was demonstrated an excellent understanding of the subject, comprehensive knowledge, ability to substantiate the answer and prove the judgments by practical solution of the problem.

** If the applicant receives less than 56 points for the interview, he is not allowed to participate in the competition, as he did not pass the entrance test.*

CONTENTS OF SECTIONS AND TOPICS OF THE ENTRANCE TEST PROGRAM

Section	Topic
1. Materials science	1. Classification of materials by nature and applications, types of crystalline lattices
	2. Crystalline lattices. Anisotropy. Polymorphism
	3. State diagrams of binary alloys. Liquidus. Solidus. Phases, solid solution, mechanical mixture, chemical composition
	4. Crystallization. The structure of an ingot. Dendritic segregation
	5. Crystal defects
	6. Recrystallization. Cold and hot plastic deformation
	7. Failure. Fracture mechanisms and fracture structures
	8. The effect of temperature on the growth of austenitic grain upon heating. The influence of austenitic grain size on the mechanical and technological properties of steels
	9. Polymorphic, eutectic, peritectic and eutectoid transformations in Fe-C alloys
	10. Carbon steels. Classifications by applications, degree of deoxidation, quality, carbon content and position in the Fe-C diagram
	11. Cast iron. Classification by the form of graphite inclusions and the phase composition of the metal matrix. Graphitization. Advantages and disadvantages of cast irons as structural materials
	12. Cast iron. Transformation during crystallization and cooling of pre-eutectic and eutectic cast irons
	13. Diagram of isothermal decomposition of austenite. Isothermal decomposition diagram for proeutectoid and hypereutectoid steels
	14. The influence of alloying elements on the location of the diagram of isothermal decomposition of austenite and hardenability of steels
	15. Features of martensitic transformation
	16. Secondary annealing. Types of heat treatment for pre- and hypereutectoid steels
	17. Alloyed steels. Classification of alloying elements and their influence on the structure and properties of steels. Classification of alloyed steels by composition, structure and applications
	18. Copper and its alloys
	19. Aluminum and its alloys
	20. Titanium and its alloys
2. Mechanical and physical properties of materials	1. Stress
	2. Strain
	3. Plastic deformation mechanisms
	4. Dislocations. Burgers vector. Frank-Read source
	5. Interaction of dislocations
	6. Interaction of dislocations with impurity atoms
	7. Tensile testing
	8. Compression testing
	9. Flexural testing
	10. Parameters of strength and plasticity
	11. Dynamic testing

	12. Fatigue of metals
	13. Creep
	14. Brinell hardness
	15. Rockwell hardness
	16. Vickers hardness, microhardness
	17. Methods of strength improvement
	18. Ionic, covalent, metallic crystals
	19. Thermal capacity, thermal conductivity, thermal expansion of solid bodies
	20. Electrical conductivity of solids
3. Fundamentals of Solid State Physics	1. The nature of the forces of interatomic interaction in crystals (forces of attraction and repulsion)
	2. Features of the structures of crystalline and amorphous solids
	3. The shear strength of crystals is theoretical and real
	4. Basic elements of physical statistics required to describe the properties of solids
	5. Elements of the electronic structure of metallic and non-metallic materials
	6. Features of the electronic structure of semiconductors
	7. Ways to increase the strength of solids
	8. Tension curve and mechanical characteristics of solids. Theory and experiment
	9. The structure of the atom. Rutherford's model
	10. Physical meaning of Young's modulus.
4. Materials technology	1. General characteristics of the foundry. Physical bases of production of castings
	2. The essence of metal forming and types of machine-building profiles
	3. Casting defects. Correction of defects in castings
	4. Mechanical processing of workpieces
	5. Metal-cutting machines and tools. Materials used to tool manufacturing
	6. Physical basis for welding. Types of welding
	7. Technologies and equipment for the production of powder materials
	8. Types of composite materials
	9. Defects in welds
	10. Soldering metals. Types of solders. Soldering methods

RECOMMENDATIONS FOR PREPARING FOR THE EXAM

Main literature:

1. Gulyaev A. P. Metallurgy: textbook for universities / A. P. Gulyaev, A. A. Gulyaev. – 7th ed., Rev. and add. – Moscow: Alliance, 2012. – 644 p.: ill. – Bibliography at the end of chapters. – Subject index: p. 637–643. – ISBN 978-5-903034-98-7. Access scheme: <http://catalog.lib.tpu.ru/catalogue/simple/document/RU%5CTPU%5Cbook%5C237275>.
2. Lakhtin Yu. M. Metallurgy and heat treatment of metals: textbook / Yu. M. Lakhtin. – 5th ed., Rev. and add. – Edit. erased. – Moscow: Alliance, 2015. – 447 p.: ill. – Bibliography: p. 443–444. – Subject index: p. 445–447. – ISBN 978-5-91872-084-4. Access scheme: <http://catalog.lib.tpu.ru/catalogue/simple/document/RU%5CTPU%5Cbook%5C340947>.
3. Zolotarevsky V.S. Mechanical properties of metals. Static tests. Laboratory workshop [Electronic resource] / Zolotarevsky V. S., Portnoy V. K., Solonin A. N., Prosviryakov A. S. – Moscow: MISIS, 2013. – 116 p.
Access scheme: http://e.lanbook.com/books/element.php?pl1_id=47422.
4. Pavlov P.V. Solid state physics: textbook / P.V. Pavlov, A.F. Khokhlov. – 4th ed. – Moscow: LENAND, 2015. – 494 p. Educational fund STL TPU, 19 copies.
5. Komarov O.S. Metallurgy and technology of structural materials. Laboratory workshop [Electronic resource] / Komarov OS, Kerzhentseva LF, Urbanovich NI, Gorokhov VA; E. B. Demchenko; ed. Komarova O.S. – Minsk: New knowledge, 2016. – 308 p. Access scheme: <https://e.lanbook.com/book/90871>

Additional literature:

1. Adaskin A.M. Materials Science and Technology of Metallic, Nonmetallic and Composite Materials: Study Guide Textbook: VO – Bachelor's degree / Moscow State Technological University "Stankin". – 1. – Moscow: FORUM Publishing House, 2019. – 400 p. – ISBN 9785000914311. Access scheme: <http://new.znaniy.com/go.php?id=982105>.
2. Zemskov Yu. P. Materials science: a tutorial / Yu. P. Zemskov. – St. Petersburg: Lan, 2019. – 188 p. – ISBN 978-5-8114-3392-6. – Text: electronic // Lan: electronic library system. – URL: <https://e.lanbook.com/book/113910> – Access mode: for authorized users.
3. Dmitrenko V.P. Materials science in mechanical engineering: a tutorial / V.P. Dmitrenko, N.B. Manuylova. – Moscow: INFRA-M, 2019. – 432 p. – Text: electronic. – URL: <https://new.znaniy.com/catalog/product/949728>.
4. Pavlov P.V. Solid state physics: textbook / P.V. Pavlov, A.F. Khokhlov. – 4th ed. – Moscow: LENAND, 2015. – 494 p. Educational fund STL TPU.
5. Epifanov GI Solid state physics: textbook / GI Epifanov. – 4th ed., – St. Petersburg: Lan, 2011. – 288 p.: Educational fund NTB TPU.
Access scheme: https://e.lanbook.com/books/element.php?pl1_cid=25&pl1_id=2023.

Internet resources:

1. Scientific and technical library of TPU. <https://www.lib.tpu.ru/>
2. Scientific and electronic library eLIBRARY.RU - <https://elibrary.ru/defaultx.asp>
3. Electronic library system "Student's Consultant" <http://www.studentlibrary.ru/>
4. Electronic library system "Lan" - <https://e.lanbook.com/>
5. Electronic library system "Yurait" - <https://urait.ru/>
6. Electronic library system "ZNANIUM.COM" - <https://new.znaniy.com/>

CREATED BY:

S.V. Panin, Doctor of Technical Sciences, Professor
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APPENDIX 1

APPROVED

Chairman of the examination committee

_____ / _____ /

« ____ » _____ 2020 г.

PROTOCOL

examination committee meeting

interview on

(field code, educational program)

Date _____ 2020 г.

Entrant

Full name

Members of examination committee:

Full name	Position
	chairman

Questions asked (ticket number – _____):

№ п/п	Question	Score
1.		
2.		
3.		
4.		
5.		
TOTAL, scores		

The signatures of examination committee members

Full name	Signature

With the result of the interview _____ (agree / disagree)

_____ / _____ /

(Signature)

(Full name of the applicant)