AL-FARABI KAZAKH NATIONAL UNIVERSITY

Faculty of chemistry and chemical technology

Department of chemical physics and materials science

EXAM PROGRAM OF THE DISCIPLINE

NN3D 7302 "Nanomaterials and Nanotechnology in 3D Printing"”

8D07113-Nanomaterials and Nanotechnologies in Chemistry

Year of study – 1

Semester – 1

Number of credits – 5

Almaty 2022

The educational and methodological complex of the discipline is compiled by Candidate of chemical sciences, Tulepov M.I.

Based on the curriculum for the educational program

8D07113-Nanomaterials and Nanotechnologies in Chemistry

Reviewed and recommended at the meeting of the Department of chemical physics and materials science

16.11.2022, Protocol 7

Head of the department \_\_\_\_\_\_\_\_\_\_\_\_\_\_ Tulepov M.I.

 (signature)

Exam program on the discipline “Nanomaterials and Nanotechnology in 3D Printing”

Introduction to additive technologies using nanomaterials. Types and types of structures for 3D printing. The latest developments in 3D Printing. Prospects for the use of nanotechnology in 3D printing. Features of the influence of external conditions on the 3D printing process. 3D printing of nano-architectural metal structures. The structure and types of extruders. 3D printing using carbon nanomaterials. Application of photopolymerization in 3D printing. Photochemical processes in 3D printing. 3D printing of nanoceramic products. Features of the morphology of nanoceramic products obtained by 3D printing. Nanoparticles in 3D printing. Functional roles of nanoparticles in composite materials obtained by 3D printing. The latest advances in bionanotechnology and 3D printing. 3D printing of bionanomaterials. Features of printing bionanomaterials by 3D printing. printing using nanomaterials in medicine. Features of 3D printing of materials for medical use. Nanoscale materials as fillers for 3D printing using a polymer base. Influence of the geometrical parameters of nanoparticles on the physicochemical properties of a 3D material. Metal- and polymer-basic nanocomposites obtained by 3D printing. 3D printing and nanolithography. Differences between 3D printing and nanolithography. 3D and 2D printing in photonics, electronics and energy. The latest advances in the application of 3D materials for energy storage (protection of presentations). 3D and 2D printing in new and advanced applications. The latest advances in 3D printing in electronics. Graphene-base composites for 3D printing. Graphene-base composites obtained by 3D printing - properties, application prospects (protection of presentations). Technological additives to achieve the desired results in 3D printing. Geometrical and physico-chemical restrictions for nanopowders in 3D printing. Prospects for further development of 3D printing and nanotechnology. 3D printing - the main vectors of development (protection of presentations).

Recommended literature:

1. Nanoscale Materials in Chemistry. Edited by Kenneth J. Klabunde. Copyright 2001 John Wiley & Sons, Inc. 285 p.

Бочков А.Л. Трехмерное моделирование в системе Компас-3Д. Практическое

руководство 2007 год, 84 с

2. Закревский К.Е., Майсюк Д.М., Сыртланов В.Р. Оценка качества 3Д моделей Маска,

2008 год 273 с

3. L. Jyothish Kumar, Pulak M. Pandey, David Ian Wimpenny 3D Printing and Additive

Manufacturing Technologies Year: Edition: 1st ed. Publisher: Springer Singapore 2019

4. Kelly, James Floyd 3D printing : build your own 3D printer and print your own 3D objects

Edition: 1 Publisher: Que p. 182 Year: 2014

5. Lydia Sloan Cline, Fusion 360 for Makers: Design Your Own Digital Models for 3D Printing

and CNC Fabrication Maker Media 2018

6. Ben Redwood, Filemon Schöffer, Brian Garret The 3D Printing Handbook: Technologies,

design and applications 1st ed Publisher: 3D Hubs 2017

**Introduction**

**Exam formats:** synchronous.

**Exam form** – Oral exam.

**Exam platform:** ZOOM https://us04web.zoom.us/j/4580541831?pwd=REZtU2dGSDF1aW5aVUY 0aGJmdHBUUT09#success

**Exam type** — online

**Exam control** – video recording

**The exam lasts:** For example: 20 minutes for 3 questions.

**On the exam in this discipline, the following types of questions are encountered**

Introduction to additive technologies using nanomaterials. Types and types of structures for 3D printing. The latest developments in 3D Printing. Prospects for the use of nanotechnology in 3D printing. Features of the influence of external conditions on the 3D printing process. 3D printing of nano-architectural metal structures. The structure and types of extruders. 3D printing using carbon nanomaterials. Application of photopolymerization in 3D printing. Photochemical processes in 3D printing. 3D printing of nanoceramic products. Features of the morphology of nanoceramic products obtained by 3D printing. Nanoparticles in 3D printing. Functional roles of nanoparticles in composite materials obtained by 3D printing. The latest advances in bionanotechnology and 3D printing. 3D printing of bionanomaterials. Features of printing bionanomaterials by 3D printing. printing using nanomaterials in medicine. Features of 3D printing of materials for medical use. Nanoscale materials as fillers for 3D printing using a polymer base. Influence of the geometrical parameters of nanoparticles on the physicochemical properties of a 3D material. Metal- and polymer-basic nanocomposites obtained by 3D printing. 3D printing and nanolithography. Differences between 3D printing and nanolithography. 3D and 2D printing in photonics, electronics and energy. The latest advances in the application of 3D materials for energy storage (protection of presentations). 3D and 2D printing in new and advanced applications. The latest advances in 3D printing in electronics. Graphene-base composites for 3D printing. Graphene-base composites obtained by 3D printing - properties, application prospects (protection of presentations). Technological additives to achieve the desired results in 3D printing. Geometrical and physico-chemical restrictions for nanopowders in 3D printing. Prospects for further development of 3D printing and nanotechnology. 3D printing - the main vectors of development (protection of presentations).

**Rules for conducting the exam form**

IMPORTANT - the exam is held on a schedule that must be known to students and teachers in advance. This is the responsibility of the departments and the faculty.

TEACHER Uploads the developed examination questions to the IS Univer questionnaire (univer.kaznu.kz). 1. Places in the Univer system, in the "Program of the final exam in the discipline" tab, the document "Final exam in the discipline «Carbon Nanotubes, Fullerenes and Hydrophobic soot» in PDF format, which should contain: • rules for conducting the exam; • assessment policy; • schedule of the event; • exam platform and link to scheduled exam video conferencing.

IMPORTANT. It is forbidden to publish exam questions. Only the final exam program is presented.

2. The teacher, without fail, informsthe students where the rules of the final exam are located afterthe date of the exam is set in the schedule.

3. In the event of a change in the platform and / or a link to the videoconferencing, it is obligatoryto notify students in advance (no later than a day before the exam) about the changes. 4. According to the exam schedule, the organizer of the exam-conference - a teacher or a memberof the examination committee, starts a conference at ZOOM sends invitations and launches exam participants.

IMPORTANT. In case the exam is accepted by the examination committee, the teacher includesthe members of the committee in the chat of the group of students in advance, so that the examinerscan also remind the students to start the exam in the general chat.

5. After all the participants have joined the conference online, the teacher or commission member: a. includes a VIDEO RECORDING of the exam; b. greets the participants of the exam; c. warns that video is being recorded; d. announces the rules of the exam: • the order of the examinees, • preparation time, • response time; • gives permission to write the theses of the answers, if necessary, on paper in pen; • warns that the examinee will have to show the abstract sheet before starting the answer; • Allows other test takers to be on standby — not be in front of the camera all the time, but not leave the meeting; e. announces the surname, name and patronymic of the examinee; f. asks the examinee to show on a video camera an identity document (UDV or passport.

IT IS FORBIDDEN to take an ID-card exam) the room in which he is located - there should be no strangers in the room, additional sources of information (if possible from the student's side); g. warns of a ban on the use of additional sources of information.

6. The chairman of the examination committee calls the full name of the student, asks him to turn on the screendemonstration, log into the IS Univer under his account, open the exam ticket and read the ticket questions.

7. The Commission records the questions asked by the student for subsequent questioning.

8. Asks the student to switch the image to the camera (it is imperative that the student's face is visible)

9. Gives time to prepare an answer: • the time for preparation is determined by the teacher and / or members of the commission; • members of the commission and the teacher control the process of preparing the student by making comments if necessary or stop the student's answer (in case of gross violations of the rules of conduct on the exam, with the preparation of an act of violation); • students are allowed to use a draft to compose a summary of the answer. In this case, the studentmust demonstrate to the camera a draft sheet before and after working with it. 10. After completing the student's answer, allows the examiner to leave the videoconference.

11. Then the procedure is repeated with each student of the group.

**STUDENTS**

1. Before starting the oral examination, you must check: • Internet connection on your working device (computer, candy bar, laptop, tablet), the device mustbe provided with charging during the entire time of the exam; • serviceability of the web camera and microphone.

2. 30 minutes before the start of the exam, ALL students of the group enter the video conference room organized by the teacher or members of the commission according to the link specified in the rules of the final exam (sent by the teacher / members of the commission in case of disruptionof the video communication service).

3. 30 minutes before the start of the exam, they check the possibility of entering the Univer.kaznu.kz system through any browser, but preferably through Google Chrome (in case of losing the login and / or password, the student must contact the curator-adviser before the start ofthe exam). After verification, they log out of the account pending an invitation from the commission.

ATTENTION. A STUDENT DOES NOT HAVE THE RIGHT TO OPEN A TICKET UNTIL AN INDIVIDUAL INVITATION BY THE COMMISSION FOR THE EXAMINATION. ONLY AT THE REQUEST OF THE COMMISSION, THE STUDENT LOGS INTO THE ACCOUNT IN THE IS UNIVER, AND OPENS HIS TICKET UNDER THE VIDEO RECORDING.

4. When the time comes for the examination, the student who is called by the committee shows his identity card on camera.

5. Enables screen sharing.

6. Logs into your account in IS Univer goes to the "Exam Schedule" page, selects the actual exam - by clicking on the "Pass oral exam" button. • The function "Pass oral exam" is active only after the start of the exam time; • The function "Pass oral exam" is active only for those students who have unclosed final sheets(exam, retake, Incomplete).

7. After clicking on the link “Take an oral exam” a window will open where the student will seethe questions of his examination card.

8. The student demonstrates the screen with the ticket questions, reads them out loud.

9. Transfers the video conferencing service display to the camera and prepares to respond.

10. After completing his answer, leaves the video conference room.

IMPORTANT. It isforbidden to publish exam tickets before the start of the exam on any platformand send it to students.

If ZOOM is used for technical reasons, the examiner must schedule the exam over periodsof 30-40 minutes to reconnect. The student must complete the exam in one session. It is forbiddento start responding in one session and end the reconnection ambassador.

ATTENTION. If for technical reasons (power outage, disconnection or low Internet speed) a student who has already opened his ticket is absent from the online examfor more than 10 minutes,then his answer will be canceled. The exam is postponed to another date in agreement with the Department of Academic Affairs.

IMPORTANT. The video recording is turned off only at the end of the exam, when the answers of all examinees have been accepted.

**Evaluation policy**

When the answer to the question is complete, the 1st question is evaluated with 33 points, the 2nd question with 33 points and the 3rd question with 34 points.

**Recommended Literature Sources for Exam Preparation**

1. Nanoscale Materials in Chemistry. Edited by Kenneth J. Klabunde. Copyright 2001 John Wiley & Sons, Inc. 285 p.

Бочков А.Л. Трехмерное моделирование в системе Компас-3Д. Практическое

руководство 2007 год, 84 с

2. Закревский К.Е., Майсюк Д.М., Сыртланов В.Р. Оценка качества 3Д моделей Маска,

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and CNC Fabrication Maker Media 2018

6. Ben Redwood, Filemon Schöffer, Brian Garret The 3D Printing Handbook: Technologies,

design and applications 1st ed Publisher: 3D Hubs 2017

**Internet-resources:** https://www.sciencedirect.com/science/article/pii/S1383730306800025 https://www.intechopen.com/books/subject/nanotechnology-and-nanomaterials