**APPROVED BY**

**Chair of the Faculty Academic Council \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Full name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**\_\_\_\_\_\_\_\_\_Signature\_\_\_\_\_\_\_\_\_\_\_\_**

**Minutes of meeting**

**№\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**on «\_\_\_\_\_» «\_\_\_\_\_\_\_\_\_\_\_» 20\_\_ year**

**Map of MOOC(S) integration in the educational process in the discipline**

**Digital signal processing**

**Aim –** to integrate MOOC or its elements into the educational process in the discipline

Part 1. Selection of MOOC based on comparison of general characteristics with the discipline

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| Name of the discipline: | MOOC 1 name\* Note (if you integrate two MOOCS into one discipline, duplicate this column on the right side for “MOOC 2”): | MOOC 2 name\* Note (if you integrate two MOOCS into one discipline, duplicate this column on the right side for “MOOC 2”): |
| Digital signal processing | Digital signal processing part 1. digital time signals and systems | Digital signal processing part 2. Discrete and digital filters |
| Labor intensity (hours / credits) | **Labor intensity (hours / credits)** | **Labor intensity (hours / credits)** |
| 3 credits | 8 weeks | 8 weeks |
| Educational stage | **Educational stage recommendations (if applicable)** | **Educational stage recommendations (if applicable)** |
| The course is designed for entry-level bachelors in technical areas of the faculty of information technology (computer engineering, computer science, CT&S, IS, ISS, A&C) | The course is intended for students who haveintroduction to electronic computing-primary and higher level bachelor's degree programs. | The course is intended for students who haveintroduction to electronic computing-primary and higher level bachelor's degree programs. |
| Form of study (full-time/blended learning/short-time) | **Platform** | **Platform** |
|  | Coursera | Coursera |
|  | **Course URL** | **Course URL** |
|  | https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast1#syllabus | https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast2 |
| Type of discipline in Study Plan (core/major/elective) | **Educational organization-developer** | **Educational organization-developer** |
| bachelor | Bachelor, master | Bachelor, master |
| Language of education | **Language of education** | **Language of education** |
| English | Russian | Russian |
| Term | **Availability:****(announced date/****beginning of the term/****On Demand/****monthly start up of the group).** | **Availability:****(announced date/****beginning of the term/****On Demand/****monthly start up of the group).** |
|  | from the announced date | from the announced date |
| Form of assessment (exam) | **Control test in form of *peer to peer evaluation, test, project* etc.** | **Control test in form of *peer to peer evaluation, test, project* etc.** |
| Exam in the form of testing | Testing, performing laboratory work. | Testing, performing laboratory work. |

Part 2. Selection of MOCC based on the analysis of the content and forming competencies

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| 2.1. Learning outcomes (LO) of the discipline (3-6 basic): | Learning outcomes of the MOOC 1 (if declared): | Learning outcomes of the MOOC 2 (if declared): |
| 1. Form an idea of the essence and application of the discrete Fourier transform,methods for calculating discrete filters with specified properties2. Study of typical discrete signals and formation of theoretical knowledge and practical skills on Z-transform methods3. Understand the principles of calculating discrete filters with specified properties.4. Know the mathematical characteristics, classification, and methods of spectral analysis of recursive and non-recursive digital filters.5. To be able to perform calculations associated with the analysis of computational errors in digital signal processing. | **1. Кnow the basics of the theory of discrete signals and systems.****2. Understand the laws of signal conversion in discrete systems****3. To be able to perform calculations associated with the analysis of discrete signals and systems as well as with the passage of signals through such systems** | **1.Know the definition and properties of the discrete Fourier transform.****2. To understand the principles of calculation of discrete filters with the desired properties****3. To be able to perform calculations associated with the analysis of computational errors in digital signal processing** |
| 2.2. The degree of compliance of the LO (performed on the basis of expert judgment in %)*\*Note. Specify the percentage of MOOC compliance with the discipline. For example, 80%.**If you choose two MOOCS to integrate into the same discipline - for example, MOOC1 – 80%, MOOC2 -60%.* |
| МООC 1 – 80%, МООC 2 – 80% |
| 2.3. The degree of compliance with the subject (match to more than half/match to 1 module/other)*\*Note. Briefly comment compliance in a free form.**\* Example of a comment when integrating two MOOCS into one discipline: "the subject areas of the courses are the same. The difference is that MOOC1 offers a broader overview of the theoretical foundations of project management and some economic design tools. MOOC2 on the use of the software. The program of our course (E-course in MOODLE) is aimed at mastering the technology of logicostructural design method.* |
| Corresponds to more than half. Topics not covered in the mooc course (2 topics) are revealed by the teacher during synchronous/asynchronous classes with students. |

Part 3. Choosing a MOOC integration model (please do NOT use the "Only MOOC" model in the project»)

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| 3.1.The choice of the model:Model 1. MOOC-support: MOOC is used as an additional part for the discipline in its traditional implementation as a self-student work, with or without the use of the "inverted class" technology.Model 2. Blended learning «+MOOC": partial replacement of classroom classes (mainly lectures), as well as partial transfer of individual MOOC topics with or without the use of "inverted class" technology.Model 3. Blended learning "MOOC+": using MOOC with partial retention of lectures, practical and seminars, as well as using the results of study on MOOC for the current certification and final control of the discipline |
| Selected model: 3. Blended learning "MOOC+". |
| 3.2. Formulate your own goal of using MOOC in teaching your subjects |
| Studying the course "Digital signal processing part 1. signals and discrete time systems" and "Digital signal processing Part 2. Discrete and digital filters" will allow students to better understand the principles and methods of digital signal processing , to form students ' understanding of the essence and application of the discrete Fourier transform, methods for calculating discrete filters with specified properties, methods for changing the signal sampling rate, and manifestations of quantization and rounding effects in digital signal processing systems. |
|  |
| 3.3. Justification of the choice of the model (in free form, 30-60 words) and its correlation with the goal (p. 3. 2.)*Please explain your choice of MOOC and its integration model in the form of an essay, explaining which selection criteria you used and what guided your choice. The course topics "Digital signal processing part 1. signals and discrete time systems" and "Digital signal processing Part 2. Discrete and digital filters" correspond to the syllabus of the Digital signal processing discipline by 80% (13 topics). topics not covered in the mooc are revealed by the teacher during synchronous and asynchronous classes. Moocs demonstrate examples of practical implementation of the material being studied, video lectures are accompanied by practical and laboratory tasks , as well as surveys in the form of tests to test the knowledge gained. The use of CAR washes, with additional lectures by the teacher, will cover the entire range of subjects of the discipline"* |

Part 4. Plan for the integration of MOOC in teaching discipline (example, one section)

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| **4.1. The name of the model (see 3.1)** |
|  Blended learning "MOOC+". |
| **4.2. Calendar (schedule) for the implementation of the course content** |
| **Learning outcomes and indicators of achievement in the course** |

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| **Module name** | **Learning outcome** | **Achievement indicator** |
| **Module 1.** Signals and systems discrete time | **LO 1.** Analyze and apply the basic methods and principles of digital signal processing when implementing them in various computer systems. | **AI 1.1. Determine the sampling rate and quantization level;****AI 1.2. To use the methods of conversion of analog information in digital form;****AI 1.3. Know Kotelnikov's theorem** |
| **LО 2.** To understand the laws of transformation of signals in discrete systems. Know the basics of the theory of discrete signals and systems | **AI 2.1.** Understand the laws of signal conversion in discrete systems**AI 2.2.** Know the basics of the theory of discrete signals and systems**AI 2.3.** Apply inverse and forward Fourier transform |
| **LО 3.** Be able to perform calculations related to the analysis of discrete signals and systems, as well as the passage of signals through such systems. | **AI 3.1.** Know the basics of the theory of FIR and IIR filters**AI 3.2**. Analyze discrete signals |
| **Module 2. Discrete and digital filters** | **LО 4.** Know the definition and properties of the discrete Fourier transform ,methods for calculating discrete filters with specified properties, methods for changing the signal sampling rate, and manifestations of quantization and rounding effects in digital signal processing systems. | **AI 4.1.** Determine the causes of spectrum spreading**AI 4.2.** Use the properties of the discrete Fourier transform.  |
| **LО 5.** Be able to perform calculations related to the analysis of computational errors in digital signal processing systems. | **AI. 5.1.** Explain how to calculate idealized filters **AI.5.2.** Describe a window method for synthesizing discrete filters**AI 5.3.** Tobe able to perform calculations related to the analysis of computational errors in digital signal Processing systems. |

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| Week  | Name of theme  | Learningoutcomes | AI | Number of hours | Max scores | Knowledge assessment form | Form of the lesson/platform |
| **Module 1** Discrete-time signals and systems |  |
| 1 | **L 1.** Introduction to the course. Main characteristics of discrete signals | LO 1 | AI 1.1. | 2 |  |  | Synchronous lecture, MSTeams |
| 1 | **Sem 1 (could be Practical or Lab task)** | LO 1  | AI 1.1. | 2 | 10 | Report | Distance learning courses  in the Univer system» |
| 2 | **L 2. Fourier transform in discrete time** | LO 1,LO 2 | AI 1.2AI 2.1 | 2 |  |  | Synchronous lecture, MSTeams |
| 2 | **Sem 2 (could be Practical or Lab task). Investigation of the characteristics of discrete signals.** | LO 1, | AI 1.2. | 2 | 10 | Verbal survey | Webinar with a teacher: on schedule, MS Teams |
| 3 | **L 3. Z-transform** | LO 1, | AI 1.2.AI 1.3. |  |  |  | МООC 1<https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast1> |
| 3 | **Sem (could be Practical or Lab task)** | LO 1, | AI 1.3. | 2 | 20 | Test taskWeb conference | МООC 1<https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast>1Webinar with a teacher: on schedule, MS Teams |
| 3 | **SIWSI 1 Consultation on the IWS 1 implementation** |  |  |  |  |  |  |
| 3 | **IWS 1****“Levels of representation of discrete signals”** | LO 1 | AI 1.2, AI 1.3 |  |  |  | Webinar with a teacher: on schedule, MS Teams |
| 4 | **L 4. Sampling and recovery of analog signals** | LO 1 | AI 1.3. | 2 |  |  | МООC 1<https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast1> |
| 4 | **Sem 4 (could be Practical or Lab task). Sampling and recovery of analog signals** | LO 1 | AI 1.2, AI 1.3 | 2 | 20 | Test taskWeb conference | МООC 1<https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast1>Webinar with a teacher: on schedule, MS Teams |
| 5 | **L 5. Principle of operation and characteristics of linear stationary discrete systems** | LO 1 | AI 1.3 | 2 |  |  | МООC 1<https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast1> |
| 5 | **Sem 5 (could be Practical or Lab task). Study of the characteristics of stationary discrete systems** | LO 1 | AI 1.2, AI 1.3 |  2 | 20 | Test taskWeb conference | МООC 1<https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast1>Webinar with a teacher: on schedule, MS Teams |
| 5 | **SIWSI 2 Consultation on the IWS 1 implementation “Levels of representation of discrete signals”** | LO 1 | AI 1.2, AI 1.3 |  | 20 | Individual task( Report) | Distance learning courses  in the Univer system» |
| 5 | **IE 1** |  |  |  | 100 |  |  |
| 6 | **L 6. Methods for describing linear stationary discrete systems** | LO 1 | AI 1.3.,AI2.1 | 2 |  |  | МООC 1<https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast1> |
| 6 | **Sem 6 (could be Practical or Lab task). Study of the characteristics of stationary discrete systems** | LO 3 | AI 2.1AI 2.2 | 2 | 20 | Test taskWeb conference | МООC 1https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast1Webinar with a teacher: on schedule, MS Teams |
| 6 | **SIWSI 3 Consultation on the IWS 2 implementation “Discrete-time signals and systems”** | LO 1, LO 2 | AI 1.2,AI 1.3AI 2.1 |  |  | Web conference | Webinar with a teacher: on schedule, MS Teams |
| 7 | **L 7. Forms of implementation of discrete systems** | LO 2 | AI 2.2 | 2 |  |  | МООC 1https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast1 |
| 7 | **Sem 7 (could be Practical or Lab task). Forms of implementation of discrete systems** | LO 2 | AI 2.2AI 2.3 | 2 | 15 | Test taskWeb conference | МООК 1https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast1Webinar with a teacher: on schedule, MS Teams |
| 7 | **SIWSI 4 Consultation on the IWS 2 implementation “Discrete-time** **signals and systems”** | LO2, LO 3 | AI 2.2AI 2.3AI 3.1 |  | 20 | Certificate | MOOC 1 Webinar with a teacher: on schedule, MS Teams |
| **Module 2. Discrete and digital filters** |
| 8 | **L 8. Definition and properties of the discrete Fourier transform. The spreading of the spectrum** | LO 1, LO 2 | AI 1.3AI 2.2AI 2.3 | 2 |  |  | МООC 2https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast2 |
| 8 | **Sem 8 (could be Practical or Lab task). Use properties of the discrete Fourier transform** | LO 2 | AI 2.2AI 2.3 | 2 | 15 | Test taskWeb conference | МООC 2https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast2Webinar with a teacher: on schedule, MS Teams |
| 9 | **L 9. The algorithm of the fast Fourier transform. Relationship between DFT and discrete filtering** | LO 3 | AI 3.1 | 2 |  |  | МООC 2https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast2 |
| 9 | **Sem 9 (could be Practical or Lab task). Investigation of the Cooley-Tukey fast Fourier transform algorithm** | LO 3 | AI 3.1 | 2 | 15 | Test taskWeb conference | МООC 2https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast2Webinar with a teacher: on schedule, MS Teams |
| 10 | **L 10. Problem statement and classification of synthesis methods**. | LO 3 | AI 3.1AI 3.2 | 2 |  |  | МООC 2https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast2 |
| 10 | **Sem 10 (could be Practical or Lab task). The simplest first-and second-order filters** | LO 3 | AI 3.1AI 3.2 | 2 | 15 | Test taskWeb conference | МООC 2https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast2Webinar with a teacher: on schedule, MS Teams |
| 10 | **МТ (Midterm Exam)** |  |  |  | 100 |  |  |
| 11 | **L 11. Idealized filters. Window method** | LO 4 | AI 4.1 | 2 |  |  | МООC 2https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast2 |
| 11 | **Sem 11 (could be Practical or Lab task). Optimal method** | LO 4 | AI 4.1AI 4.2 | 2 | 20 | Test taskWeb conference | МООК 2https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast2Webinar with a teacher: on schedule, MS Teams |
| 11 | **SIWSI 5 Consultation on the IWS 3 implementation “Discrete and digital filters”** | LO 4 | AI 4.1 |  |  |  | Webinar with a teacher: on schedule, MS Teams |
| 12 | **L 12. The concept of multi-speed signal processing. Interpolation.Oversampling** | LO 4 | AI 4.1AI 4.2 | 2 |  |  | МООC 2https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast2 |
| 12 | **Sem 12 (could be Practical or Lab task). Resampling the signal with a rational coefficient** | LO 4 | AI 4.1AI 4.2 | 2 | 15 | Test taskWeb conference | МООC 2https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast2 |
| 13 | **L 13. Representation of numbers in digital systems. Format with a fixed decimal point. Floating-point format** | LO 5 | AI 5.1 | 2 |  |  | МООC 2https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast2 |
| 13 | **Sem 13 (could be Practical or Lab task). The study of the quantization process** | LO 5 | AI 5.1AI 5.2 | 2 | 15 | Test taskWeb conference | МООC 2https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast2Webinar with a teacher: on schedule, MS Teams |
| 14 | **L 14. Quantization and rounding errors in digital filters** | LO 5 | AI 5.1AI 5.2 | 2 |  |  | МООC 2https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast2 |
| 14 | **Sem 14 (could be Practical or Lab task).**  | LO 5.1 | AI 5.1AI 5.2 | 2 | 15 | Test taskWeb conference | МООК 2https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast2Webinar with a teacher: on schedule, MS Teams |
| 15 | **L 15. Self-noise spectrum. Limit cycle.** | LO 4 LO 5 | AI 4.2AI 5.3 | 2 |  |  | МООК 2https://www.coursera.org/learn/cifrovaya-obrabotka-signalov-chast2 |
| 15 | **Sem 15 (could be Practical or Lab task).**  | LO 4LO 5 | AI 5.1AI 5.2AI 5.3 | 2 | 15 | Test taskWeb conference | Webinar with a teacher: on schedule, MS Teams |
|  | **SIWSI 6****Consultation on the IWS 3 implementation**  | LO 4LO 5 | AI 4.2AI 5.2 |  | 20 | Certificate | MOOC 2Webinar with a teacher: on schedule, MS Teams |
|  | **IE 2** |  |  |  | 100 |  |  |
|  | **FE** |  |  |  | 100 | Test task | In the “Univer” system |

 **[Abbreviation:** **S-TQ – self-test questions;** **TT – typical tasks;** **IA – individual assignments;** **CT – check test;** **IE– Interim examination,****IWS - independent work of a student,** **SIWSI - Student’s independent work under supervision of the instructor,** **AI - achievement indicator,** **L - Lecture****LO - Learning outcome****Sem - Seminar (could be Practical or Lab task)** |
| \* When using several MOOCs, their numbering and names must be entered.**4.3 Express yours comments about your expectations and concerns regarding the use of MOOCs in your discipline****\* Example of comments:*****Expectations:******Using moocs will allow students to gain in-depth knowledge in the field of digital signal processing. Examples of practical implementation of various signal processing methods provided in the course will complement the understanding of the possibility of using the acquired knowledge and skills in practice.******Interest in the course will increase******Quality assurance and diversity of project experience******The range of application of design tools will be expanded******Risks:******Closing the mooc course on the platform, by the decision of the author or copyright holder.******The solution is to switch the student learning mode to synchronous/asynchronous learning with a teacher.******Planning students' time to work in MOOCS*** |

**Conclusion of the Chair of the Faculty Academic Council\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Chair of the Faculty Academic Council Gusmanova F. R.**

**Lecturer Sadykova B. M.**