**MINISTRY OF EDUCATION**

**AZERBAIJAN REPUBLIC**

**AZERBAIJAN STATE OIL AND INDUSTRY UNIVERSITY**

**SYLLABUS**

**Approved by:** Doctor in Mathematics, Prof. A.R.Əliyev

(head of department)

**Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date: «31» August, 2020**

**Department:** General and applied mathematics

**Faculty:** Information Technologies and Management

**I. Information about the subject:**

Subject Name: Linear Algebra

Load (hours) total: 45; lecture: 30; seminar: 15; practice (laboratory): 0

Academic year: 2020/2021; Semester: 1; Specialty: 050509 – Computer Science

Number of credits: 4

**II. Information about instructors:**

**lecturer – Gasimova Gunel Mirbala, PhD candidate**

(last name, first name, patronymic, academic title and academic degree)

Consultation days and hours: every week on Wednesday at 16:00

Email: [gxg557@alumni.bham.ac.uk](mailto:gxg557@alumni.bham.ac.uk), gunel.qasimova@asoiu.edu.az

Work phone number: (+99412) 4986592 (landline number), 4-19 (extension number)

**III. Required textbooks and tutorials:**

***Principal:***

1. Gilbert Strang. Introduction to Linear Algebra, 5th edt. Wellesley-Cambridge Press, 2016, 584 p.
2. David Poole. Linear Algebra: A Modern Introduction, 4th edt. Cengage Learning, 2014, 720 p.
3. Gareth Williams. Linear Algebra with Applications, 8th edt. Jones & Bartlett Learning, 2012, 560 p.
4. Ron Larson. Elementary Linear Algebra, 7th edt. Cengage Learning, 2012, 448 p.
5. David C. Lay. Linear Algebra and Its Applications. Pearson, 5th edt., 2016.

***Supplementary:***

1. Philip Klein. Coding the Matrix: Linear Algebra through Applications to Computer Science. Newtonian Press, 2013, 548 p.
2. Gerald Farin and Dianne Hansford. Practical Linear Algebra: A Geometry Toolbox, 3rd edt. A K Peters/CRC Press, 2013, 514 p.
3. Kuldeep Singh. Linear Algebra: Step by Step. Oxford University Press, 2013, 528 p.

**IV. Purpose and description of the subject:**

**Brief description of the course**: This course is intended for the introductory linear algebra generally taken by sophomores and juniors majoring in engineering, computer science, mathematics, economics, statistics, science, and operations research. The course incorporates a flexible blend of theory, important computational techniques, and interesting applications. The primary prerequisite for this course is algebra, but familiarity with analytic geometry and trigonometry is also assumed. Calculus is not a prerequisite for this course.

***Course objective:*** The primary objective of this course is to provide a solid foundation in the mathematics of linear algebra, to introduce some of the important computational aspects of linear algebra, and to discuss interesting applications so that students know when and how to apply linear algebra in practice.

**V. Thematic plan of the subject:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Week** | **Topic title and short description** | **The number of hours allotted for** | |
| **lecture** | **seminar** |
| 1. | **Topic № 1**  Systems of Linear Equations  **Brief description:**   * Introduction to Systems of Linear Equations * Linear Equations in Variables * Systems of Linear Equations * Solving a System of Linear Equations * Graphical Interpretation of Solution   **Materials for reading**:  Chapter 1, Paragraph(s) 1, Textbook 4 | 2 |  |
| 2. | **Topic № 1**  Systems of Linear Equations  **Brief description:**   * Elementary Row Operations * Gaussian Elimination with Back Substitution * Gauss-Jordan elimination * Homogeneous Systems of Linear Equations   **Materials for reading**:  Chapter 1, Paragraph(s) 2, Textbook 4 | 2 | 2 |
| 3. | **Topic № 1**  Systems of Linear Equations  **Brief description:**   * Applications of Systems of Linear Equations * Polynomial Curve Fitting * Network Analysis * Graphing Linear Equations * Underdetermined and Overdetermined Systems of Linear Equations   **Materials for reading**:  Chapter 1, Paragraph(s) 3, Textbook 4 | 2 |  |
| 4. | **Topic № 2**  Matrices  **Brief description:**   * Operations with matrices * Matrix Addition. Scalar Multiplication * Matrix Multiplication * Representation of Systems of Linear Equations in Matrix Form * Partitioned Matrices.   **Materials for reading**:  Chapter 2, Paragraph(s) 1, Textbook 4 | 2 | 2 |
| 5. | **Topic № 2**  Matrices  **Brief description:**   * Properties of Matrix Operations * Properties of Matrix Addition and Scalar Multiplication * Properties of Zero Matrices. Properties of Matrix Multiplication * Properties of the Identity Matrix * The Transpose of a Matrix * Properties of Transposes.   **Materials for reading**:  Chapter 2, Paragraph(s) 2, Textbook 4 | 2 |  |
| 6. | **Topic № 2**  Matrices  **Brief description:**   * The Inverse of a Matrix * Uniqueness of an Inverse Matrix * Finding the Inverse of a Matrix by Gauss-Jordan Elimination. Singular Matrices * Properties of Inverse Matrices * The Inverse of a Product * Cancellation Properties * Systems of Equations with Unique Solutions   **Materials for reading**:  Chapter 2, Paragraph(s) 3, Textbook 4 | 2 | 2 |
| 7. | **Topic № 2**  Matrices  **Brief description:**   * Elementary matrices * Representing Elementary Row Operations * Row Equivalence * A Property of Invertible Matrices * The LU-Factorization   **Materials for reading**:  Chapter 2, Paragraph(s) 4, Textbook 4 | 2 |  |
| 8. | **Topic № 2**  Matrices  **Brief description:**   * Applications of Matrix Operations * Stochastic Matrices * Cryptography * Leontief Input-Output Models * Least-Squares Regression Analysis   **Materials for reading**:  Chapter 2, Paragraph(s) 5, Textbook 4 | 2 | 2 |
| 9. | **Topic № 3**  Determinants  **Brief description:**   * The Determinant of a Matrix * The Determinant of a Matrix of Order 2 * Minors and Cofactors of a Matrix * Expansion by Cofactors * The Determinant of a Matrix of Order 3 * Triangular Matrices   **Materials for reading**:  Chapter 3, Paragraph(s) 1, Textbook 4 | 2 |  |
| 10. | **Topic № 3**  Determinants  **Brief description:**   * Evaluation of a Determinant Using Elementary Operations * Elementary Row Operations and Determinants * Determinants and Elementary Column Operations * Conditions that Yield a Zero Determinant   **Materials for reading**:  Chapter 3, Paragraph(s) 2, Textbook 4 | 2 | 2 |
| 11. | **Topic № 3**  Determinants  **Brief description:**   * Properties of Determinants * Determinant of a Matrix Product * Determinant of a Scalar Multiple of a Matrix * Determinants and the Inverse of a Matrix * Determinants and the Transpose of a Matrix   **Materials for reading**:  Chapter 3, Paragraph(s) 3, Textbook 4 | 2 |  |
| 12. | **Topic № 3**  Determinants  **Brief description:**   * Applications of Determinants * The Adjoint of a Matrix * The Inverse of a Matrix Given by Its Adjoint * Cramer’s Rule * Area, Volume, and Equations of Lines and Planes * The Cayley-Hamilton Theorem   **Materials for reading**:  Chapter 3, Paragraph(s) 5, Textbook 4 | 2 | 2 |
| 13. | **Topic № 4**  Eigenvalues and Eigenvectors  **Brief description:**   * Eigenvalues and Eigenvectors * Eigenspaces * Finding Eigenvalues and Eigenvectors * Eigenvalues of Triangular Matrices * Diagonalization * Diagonalizable Matrix * Condition for Diagonalization * Sufficient Condition for Diagonalization   **Materials for reading**:  Chapter 7, Paragraph(s) 1-2, Textbook 4 | 2 |  |
| 14. | **Topic № 4**  Eigenvalues and Eigenvectors (continued)  **Brief description:**   * Symmetric Matrices and Orthogonal Diagonalization * Eigenvalues of Symmetric Matrices * Dimensions of the Eigenspaces of a Symmetric Matrix * Orthogonal Matrices * Property of Orthogonal Matrices * Property of Symmetric Matrices * Eigenvectors of a Symmetric Matrix * Orthogonal Diagonalization * Fundamental Theorem of Symmetric Matrices * Orthogonal Diagonalization of a Symmetric Matrix   **Materials for reading**:  Chapter 4, Paragraph(s) 3, Textbook 4 | 2 | 3 |
| 15. | **Topic № 4**  Eigenvalues and Eigenvectors (continued)  **Brief description:**   * Applications of Eigenvalues and Eigenvectors * Population Growth * Finding a Stable Age Distribution Vector * Systems of Linear Differential Equations (Calculus) * Quadratic Forms * Finding the Matrix of a Quadratic Form * Rotation of a Conic * Rotation of a Quadric Surface   **Materials for reading**:  Chapter 4, Paragraph(s) 4, Textbook 4 | 2 |  |

**VI. The form of the exam - writing, oral, in the form of a dialogue or tests:**

The exam will be held in the writing (main) form.

**VII. Evaluation during the semester and alignment of points:**

The maximum number of points is 100.

1. **The maximum number of points scored during the semester is 50 points.**

|  |  |
| --- | --- |
| The independent work of the student (abstract, presentation, research, etc.) | 20 points |
| Intermediate examinations are held 2 times only in the writing form | |
| The first midterm exam - one of the days: 26.10.2020-30.10.2020  (based on materials covering the period of 15.09.2020 –23.10.2020) | 5 points |
| The second midterm exam - one of the days 07.12.2020-11.12.2020  (based on the materials covering the period of 15.09.2020 – 04.12.2020) | 25 points |
| An appeal for midterm exams is not carried out. | |

**Topics for students’ independent works and their final due dates:**

1. Solving Systems of Linear Equations by Gaussian Elimination Method: 18.12.2020
2. Solving Systems of Linear Equations by Gaussian-Jordan Method: 18.12.2020
3. Applications of Systems of Linear Equations: 18.12.2020
4. Performing Matrix Operations: 18.12.2020
5. Finding the Inverse of a Matrix: 18.12.2020
6. Solving Systems of Linear Equations by *LU*-factorization: 18.12.2020
7. Applications of Matrices: 18.12.2020
8. Evaluating Determinants of Matrices: 18.12.2020
9. Applications of Determinants: 18.12.2020
10. Evaluating Eigenvalues and Eigenvectors: 18.12.2020
11. ***At the end of the semester exam - maximum 50 points***

Each billet has 5 questions; for each question 10 points are given.

Note: The number of points scored by a student in the exam should not be less than 17.

1. ***Evaluation by the end of the semester (based on the scores collected during the exam and before the exam):***

|  |  |  |
| --- | --- | --- |
| **91 – 100 points** | **Excellent** | **A** |
| **81 – 90 points** | **Very good** | **B** |
| **71 – 80 points** | **Good** | **C** |
| **61 – 70 points** | **Satisfactorily** | **D** |
| **51 – 60 points** | **Credited** | **E** |
| **below 51 points** | **Unsatisfactory** | **F** |

**Instructors:** **Gasimova Gunel Mirbala Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

(second name, first name, patronymic) **Date: «31» August, 2020**