## MI 1141E Algebra

Version: 2024.2.0

***Mục tiêu***: Cung cấp cho sinh viên những kiến thức cơ bản về Đại số. Trên cơ sở đó, sinh viên có thể học tiếp các học phần sau về Toán cũng như các môn học kỹ thuật khác, góp phần tạo nên nền tảng Toán học cơ bản cho kỹ sư các ngành công nghệ và kinh tế.

***Objective***: This course provides the basics knowledge about Algebra. Students can understand the basics of computing technology and continue to study further.

***Nội dung***: Logic hình thức, tập hợp, ánh xạ, số phức, ma trận và định thức, hệ phương trình tuyến tính. Không gian vectơ, ánh xạ tuyến tính, không gian Euclid, dạng toàn phương, đường và mặt bậc hai.

***Contents***: Symbolic logic, sets, maps, field of complex numbers, matrices, determinant, systems of linear equations. Vector spaces, linear maps, Euclidean spaces and quadratic forms, quadratic curves and quadric surfaces.

### 1. THÔNG TIN CHUNG (COURSE INFORMATION)

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|---|---|
| **Tên học phần (Course Title):** | Đại số *(Algebra)* |
| **Đơn vị phụ trách/ Faculty** | Khoa Toán - Tin<br>(Faculty of Mathematics and Informatics) |
| **Mã số học phần (Course ID)** | MI1141E |
| **Khối lượng (Course Units)** | 4(3-2-0-8)<br>- Lý thuyết (Lecture): 45 tiết (45 hours)<br>- Bài tập/BTL (Seminar): 30 tiết (30 hours) |
| **Học phần tiên quyết/ Prerequisite** | Không/No |
| **Học phần học trước/ Co-Requisite** | Không/No |
| **Học phần song hành/ Parallel course** | Không/No |

### 2. MÔ TẢ HỌC PHẦN (COURSE DESCRIPTION)

Symbolic logic, sets, mappings, field of complex numbers, matrices, determinant, system of linear equations. Vector spaces, linear mappings, quadratic form, Euclidean spaces, quadratic curves and quadric surfaces.

### 3. MỤC TIÊU VÀ CHUẨN ĐẦU RA CỦA HỌC PHẦN (OBJECTIVE AND EXPECTED OUTCOMES)

| Mục tiêu/CĐR Objectives and expected outcomes | Mô tả mục tiêu/Chuẩn đầu ra của học phần Description | CĐR được phân bổ cho HP/ Mức độ (I/T/U) Proportional Outcomes (I/T/U) |
|---|---|---|
| [1] | [2] | [3] |

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|---|---|---|
| **M1** | Students understand and can present concepts of linear algebra which, from a modern point of view, are most important in connection with practical problems. | |
| M1.1 | Students understand and can present concepts of matrices and linear systems of equations, linear transformations and eigenvalue problems, as they arise, for instance, from electrical networks, frameworks in mechanics, processes in statistics, systems of differential equations and so on. | I/T |
| M1.2 | Students are capable to think mathematically and recognize the need for applying mathematical methods to engineering problems. | T/U |
| **M2** | **Positive working attitude and skills** | |
| M2.1 | Ability to analyze and solve problems independently | T/U |
| M2.2 | Ability to use algebra solving simple realistic problems through obsevation. | I/T/U |
| M2.3 | Critical thinking, collaboration and teamwork. | I/T |

## 4. TÀI LIỆU HỌC TẬP/ COURSE MATERIALS

**Giáo trình (Textbook)**

[1] Nguyen Thieu Huy, *Lecture on Algebra*, weblink: https://fami.hust.edu.vn/wp-content/uploads/lecture_on_algebra-2.pdf

**Sách tham khảo (Reference)**


[1] S. Axler (2015), *Linear Algebra Done Right*, 3rd edition, Springer.

[2] E.H. Connell (2004), *Elements of abstract and linear algebra*, https://www.math.miami.edu/~ec/book/book.pdf

[3] S. Lipschutz, M. Lipson (2018), *Schaum's Outline of Linear Algebra,* 6th edition, McGraw-Hill, New York.

[4] Gilbert Strang (2023), *Introduction to Linear Algebra*, 6th edition, Wellesley-Cambridge Press.

[5] Nguyễn Đình Trí (chủ biên), Trần Việt Dũng, Trần Xuân Hiển, Nguyễn Xuân Thảo (2015), *Toán học cao cấp tập 1: Đại số và hình học giải tích*, NXB Giáo dục VN.

[6] Nguyễn Đình Trí, Tạ Văn Đĩnh, Nguyễn Hồ Quỳnh (2006), *Bài tập Toán học cao cấp, tập 1: Đại số và hình học giải tích*, NXB Giáo dục, Hà Nội.

[7] Vũ Thị Ngọc Hà, Tạ Thị Thanh Mai, Lê Đình Nam, Nguyễn Hải Sơn, Đoàn Duy Trung (2021), *Bài giảng đại số*, NXB Bách Khoa Hà Nội.


## 5. CÁCH ĐÁNH GIÁ HỌC PHẦN (ASSESSMENT)

| Components | Evaluation method | Description | Assessed expected outcomes | Proportion |
|---|---|---|---|---|
| [1] | [2] | [3] | [4] | [5] |
| **A1. The process mark** | | | | **50%** |

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| **A1.1. Attendance and performance*** | Attendance and performance in class | | M2.3 | **10%** |
| **A1.2. Continuous assessment** | Continuous assessment test | Online multiple choice tests | M1.1, M1.2 | **10%** |
| **A1.3. Midterm exam** | Midterm exam<br>**Content: From the 1st week to the 7th week** | Multiple choice and constructed response test | M1.1, M1.2, M2.1, M2.2, M2.3 | **30%** |
| **A2. Final exam** | **Final exam** | Essay | M1.1, M1.2, M2.1, M2.2, M2.3 | **50%** |

**Attendance and performance in class are evaluated according to the Rule of Faculty of Mathematics and Informatics accompanied with the Regulations of Higher Education of Hanoi University of Science and Technology.*

## 6. KẾ HOẠCH GIẢNG DẠY

| Tuần/ Week | Nội dung/Content | CĐR học phần/ Outcomes | Hoạt động dạy và học/ Teaching and learning activities | Bài đánh giá/ Evaluation |
|---|---|---|---|---|
| [1] | [2] | [3] | [4] | [5] |
| 1 | **Chapter 1: Symbolic Logic, Sets, mappings (maps) and complex numbers**<br>1.1. Symbolic Logic<br>- Mathematical propositions and truth values<br>- Logical operations: conjunction, disjunction, negation, implication and equivalence<br>- Propositions with quantifiers | M1.1<br>M1.2<br>M2.1<br>M2.2<br>M2.3 | **Lecturer:**<br>- Introduction<br>- Teaching<br>- Discussion<br>- Q & A<br>**Students:**<br>- Preparation for the next lecture<br>- Do exercises (classroom and homework) | A1.1<br>A1.2<br>A1.3<br>A2 |
| 2 | 1.2. Sets and set operations<br>- Notations, subset, set equality<br>- Operations: Intersection, union, set difference, complement<br>1.2. Mappings<br>- Definition and examples | M1.1<br>M1.2<br>M2.1<br>M2.2<br>M2.3 | **Lecturer:**<br>- Teaching<br>- Discussion<br>- Q & A<br>**Students:** | A1.1<br>A1.2<br>A1.3<br>A2 |

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| | - Properties: injective, surjective, bijective mappings<br>- Image, preimage<br>- Composition of maps, inverse of maps | | - Preparation for the next lecture<br>- Do exercises (classroom and homework) | |
| 3 | 1.4. Field of complex numbers<br>- Binary operations<br>- Concepts and examples of groups, rings, fields | M1.1<br>M1.2<br>M2.1<br>M2.2<br>M2.3 | | A1.1<br>A1.2<br>A1.3<br>A2 |
| 4 | - Canonical and trigonometric forms<br>- Operations: Addition, Subtraction, Multiplication, Division, Power, Root<br>- Fundamental theorem of algebra (without proof) | M1.1<br>M1.2<br>M2.1<br>M2.2<br>M2.3 | | A1.1<br>A1.2<br>A.1.3<br>A2 |
| 5 | **Chapter 2: Matrices, determinants, linear systems of equations**<br>2.1. Basic concepts of matrices<br>- Definitions, character<br>- Matrix operations: addition, scalar multiplication, matrix multiplication<br>2.2. Determinants<br>- First, second, third order determinant, determinant of higher order<br>- Properties of determinant, determinant of matrix product<br>- Evaluating determinant using elementary operations | M1.1<br>M1.2<br>M2.1<br>M2.2<br>M2.3 | | A1.1<br>A1.2<br>A1.3<br>A2 |
| 6 | 2.3. Rank of a matrix, inverse of a matrix<br>- Rank of a matrix, rank of an echelon matrix<br>- Evaluation rank using elementary operations<br>- Inverse of a matrix, properties<br>- Inverse of a matrix using minors, elementary operations | M1.1<br>M1.2<br>M2.1<br>M2.2<br>M2.3 | | A1.1<br>A1.2<br>A1.3<br>A2 |
| 7 | 2.4. Linear systems of equations<br>- Concepts, solutions, homogeneous and nonhomogeneous systems<br>- Cramer systems, existence and uniqueness of solution, solution formula | M1.1<br>M1.2<br>M2.1<br>M2.2<br>M2.3 | | A1.1<br>A1.2<br>A1.3<br>A2 |

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| | - Homogeneous system: *n* equations, *n* unknowns<br>- Knonecker - Capelli theorem, Gauss elimination method<br>**Chapter 3: Vector spaces**<br>3.1. Concepts<br>- Definition and examples<br>- Properties | | | |
| 8 | 3.2. Subspaces<br>- Definition, criterion, example: solution spaces of homogeneous linear systems<br>- Subspaces generated by vectors | M1.1<br>M1.2<br>M2.1<br>M2.2<br>M2.3 | | A1.1<br>A1.2<br>A2 |
| 9 | 3.2. Dimension and Coordinate<br>- Linear independence, dependence, generator, basis, dimension of vector spaces<br>- Coordinate,<br>- Change of basis and coordinate<br>- Rank of a vector system, finding rank using coordinates, the dimension of subspaces generated by vectors | M1.1<br>M1.2<br>M2.1<br>M2.2<br>M2.3 | | A1.1<br>A1.2<br>A2 |
| 10 | **Chapter 4: Linear mappings and transformations**<br>4.1. Linear mappings<br>- Definitions and examples<br>- Kernels, ranges, injective, surjective and bijective properties for linear maps | M1.1<br>M1.2<br>M2.1<br>M2.2<br>M2.3 | | A1.1<br>A1.2<br>A2 |
| 11 | 4.2. Matrix of a linear mapping<br>- Matrix of a linear mapping<br>- Matrix of a linear transformation via change of basis<br>- Matrix similarity | M1.1<br>M1.2<br>M2.1<br>M2.2<br>M2.3 | | A1.1<br>A1.2<br>A2 |
| 12 | 4.3. Eigenvalues and eigenvectors<br>- Eigenvalues and eigenvectors of a matrix<br>- Eigenvalues and eigenvectors of a linear transformation<br>- Matrix diagonalization<br>**Chapter 5: Bilinear forms, quadratic forms, Euclidean spaces, quadratic curves and quadric surfaces** | M1.1<br>M1.2<br>M2.1<br>M2.2<br>M2.3 | | A1.1<br>A1.2<br>A2 |

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| | 5.1. Bilinear and quadratic forms<br>- Bilinear and symmetric bilinear forms | | | |
| 13 | - Quadratic forms, positive and negative definite quadratic forms,<br>- Matrix of bilinear forms and change of basis<br>- Quadratic form in canonical form<br>- Lagrange method | M1.1<br>M1.2<br>M2.1<br>M2.2<br>M2.3 | | A1.1<br>A1.2<br>A2 |
| 14 | 5.2. Euclidean spaces<br>- Inner product, length of vectors, orthogonality, angle between vectors, Cauchy Schwarz inequality<br>- Euclidean spaces, orthogonal and orthonormal basis<br>- Orthogonal projections<br>- Gram-Schmidt process<br>- Orthogonal matrices<br>- Orthogonal diagonalization | M1.1<br>M1.2<br>M2.1<br>M2.2<br>M2.3 | | A1.1<br>A1.2<br>A2 |
| 15 | 5.3. Quadratic form reduction<br>- Jacobi method<br>- Sylvester criterion<br>- Orthogonal diagonalization method<br>- Sylvester's law of inertia<br>5.4. Quadratic curves and quadric surfaces<br>- Quadratic curves in planes<br>- Quadratic surfaces in spaces<br>- Quadratic curves and quadric surfaces classification | M1.1<br>M1.2<br>M2.1<br>M2.2<br>M2.3 | | A1.1<br>A1.2<br>A2 |
| 16 | **Summary** | | | A1.1<br>A2 |

## 7. QUY ĐỊNH CỦA HỌC PHẦN/OTHER REGULATIONS

(Các quy định của học phần nếu có)

## 8. NGÀY PHÊ DUYỆT/APPROVAL DATE ……..

**Faculty of Mathematics and Informatics**