**İZMİR INSTITUTE OF TECHNOLOGY**
**GRADUATE SCHOOL OF ENGINEERING AND SCIENCES**
**DEPARTMENT OF MATERIAL SCIENCE AND ENGINEERING**
**CURRICULUM OF THE Ph.D. PROGRAM IN MATERIAL SCIENCE AND ENGINEERING**

| **Core Courses** | | **Credit** | **ECTS** |
|---|---|---|---|
| MSE 501 | Fundamentals of Materials Science and Engineering* | (3-0)3 | 8 |
| MSE 502 | Physical Properties of Materials* | (3-0)3 | 8 |
| MSE 503 | Materials Science and Engineering Thermodynamics* | (3-0)3 | 8 |
| MSE 600 | Ph.D. Thesis | (0-1)NC | 26 |
| MSE 601 | PhD Thesis Seminar | (0-2)NC | 8 |
| MSE 8XX | Special Studies | (8-0)NC | 4 |

*Students who had already taken these Core Courses in Master Program are free from obligation of these courses. Instead, they can take elective courses.

| **Elective Courses** | | **Credit** | **ECTS** |
|---|---|---|---|
| MSE 508 | Glass Science and Technology | (3-0)3 | 7 |
| MSE 509 | Atomistic Simulation of Materials-I | (3-0)3 | 7 |
| MSE 510 | Scanning Probe and Electron microscopy | (3-0)3 | 7 |
| MSE 511 | Kinetic | (3-0)3 | 7 |
| MSE 512 | Solid State Physics | (3-0)3 | 7 |
| MSE 513 | Materials Microstructure | (3-0)3 | 7 |
| MSE 514 | Molecular Aspects of Soft Materials | (3-0)3 | 7 |
| MSE 515 | Quantum Mechanics for MSE | (3-0)3 | 7 |
| MSE 516 | Nanomaterials and surface Engineering | (3-0)3 | 7 |
| MSE 517 | Spectroscopic Methods of Materials Characterization | (3-0)3 | 7 |
| MSE 518 | Electroceramic Materials | (3-0)3 | 7 |
| MSE 519 | Atomistic Simulation of Materials-II | (3-0)3 | 7 |
| MSE 520 | Transport in Nanostructures | (3-0)3 | 7 |

Students in interdisciplinary programs register for the 8XX course in the department of their advisors.

In addition to MSE elective courses, students can take any graduate courses as elective from any departments.

Total credit (min.) :21 (for students with M.S. degree)
Number of courses with credit (min.): 7 (for students with M.S. degree)
Total credit (min.) : 42 (for students with B.S. degree)
Number of courses with credit (min.): 14 (for students with B.S. degree)

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| **COURSE DESCRIPTIONS** | | **Credit** | **ECTS** |
|---|---|---|---|
| **MSE 600** | **Ph.D. Thesis** | **(0-1)NC** | **26** |

**MSE 501 Fundamentals of Materials Science and Engineering (3-0)3 8**
Fundamentals of materials, atomic bonding, crystal structures, non-crystalline structures, defects, diffusion, mechanical properties, microstructure, phase diagrams, heat treatment.

**MSE 502 Physical Properties of Materials (3-0)3 8**
Mechanical properties of materials, electrical properties of materials, thermal properties of materials, optical properties of materials, magnetic properties of materials

**MSE 503 Materials Science and Engineering Thermodynamics (3-0)3 8**
Advanced thermodynamic treatment of inorganic materials. Application of the laws of thermodynamics to the chemical behaviour of materials. Multicomponent systems, phase and chemical reactions equilibrium. Thermodynamics of phase transformations. Introduction to the surface thermodynamics.

**MSE 508 Glass Science and Technology (3-0)3 7**
The course will provide the student with the fundamental concepts towards the understanding of glass forming principles, composition, bulk and surface structure and properties of inorganic glasses. The student will also learn the traditional and advancing technologies used for glass making.

**MSE 509 Atomistic Simuluation of Materials I (3-0)3 7**
In this course, the students will be introduced with the basic concepts in modeling and simulation of materials; and they will make a fast introduction to the applications of density functional theory, which is one of the leading methods in quantum mechanical modeling of materials. Approximately half of the lectures will be reserved for hands-on tutorials.

**MSE 510 Scanning Probe and Electron Microscopy (3-0)3 7**
General aspects of electron optics, Electron beam generation, Electron–specimen interactions, Scanning electron microscopy, Transmission electron microscopy, transmission electron microscopy, Field ion microscopy, probe techniques, tunneling microscopy, Atomic force microscopy, Other scanning probe techniques.

**MSE 511 Kinetic (3-0)3 7**
The concept of kinetic. The solution of kinetic data. Chemical kinetic. Rate theories. Diffusion in solids, liquids and gases. Homogenization, carburization, decarburization, solid-gas reactions, oxidation, nitriding, dissolution in solids and liquids, precipitation in solids and liquids and deformation kinetic.

**MSE 512 Solid State Physics (3-0)3 7**
Basics of quantum mechanics, crystal structures, bonding in solids, Fourier analysis of periodic functions, reciprocal lattice and crystal diffraction, lattice vibrations, phonon heat capacity, free and non interacting electrons, electrons in periodic potential, semiconductors.

**MSE 513 Materials Microstructure (3-0)3 7**
Crystallography, crystal structures and the effect of symmetry on properties. The structure of amorphous materials. The nature and kinetic of microstructural transformations in materials. Homogenous and heterogeneous nucleation. The defects and dislocations in crystals.

**MSE 514 Molecular Aspects of Soft Materials (3-0)3 7**
Molecules and Molecular Compounds, Single molecules, Macromolecules, Supramolecules, Self-assembly.

**MSE 515 Quantum Mechanics for Material Science and Engineering (3-0)3 7**
Background for Quantum Mechanics, photoelectric effect, and de Broglie waves, The Bohr model and Electron diffraction, Probability and uncertainty, wave functions and the schrödinger wave equation, potential wells; potential barriers and tunnelling, the harmonic oscillator, hydrogen atom, zeeman effect, electron spin, m any electron atoms and the exclusion principle, X-ray spectra

**MSE 516 Nanomaterials and Surface Engineering (3-0)3 7**
"Nanomaterials," is an interdisciplinary introduction to processing, structure, and properties of materials at the nanometer length scale. The course will cover recent breakthroughs and assess the impact of this burgeoning field. Specific nanofabrication topics include epitaxy, beam lithographies, self- assembly, biocatalytic synthesis, atom optics, and scanning probe lithography. The unique size-dependent properties (mechanical, thermal, chemical, optical, electronic, and magnetic) that result from nanoscale structure will be explored in the context of technological applications including computation, magnetic storage, sensors, and actuators.

**MSE 517 Spectroscopic Methods of Materials Characterization (3-0)3 7**
Atomic structure and bonding in solids. Crystal structures of materials. Imperfections in solids. Diffusion. Mechanical Properties of Metals. Testing of mechanical properties. Dislocations and strengthening mechanisms. Failure. Phase diagrams. Phase transformations, development of microstructure and alteration of mechanical properties.

**MSE 518 Electroceramic Materials (3-0)3 7**
In this course, electronic, magnetic and electrochemical properties of ceramic materials with different electronics applications will be covered; focusing on the correlation of these physical properties to the crystal and defect structure as well as microstructure. In particular, tailoring the functional properties for a specific application will be emphasized by using representative materials in different aplications.

**MSE 519 Atomistic Simulation of Materials-II (3-0)3 7**
In this course, the students will be introduced with the concepts in modeling and simulation of materials. Computation of elastic, vibrational, thermal, optical and magnetic properties of materials will be reviewed using state-of-the-art tools. Approximately half of the lecture hours will be reserved for computations.

**MSE 520 Transport in Nanostructures (3-0)3 7**
In this course, the students will be introduced with the fundamental concepts of the nano-scale transport. They will learn about the basics of electronic, spintronic and thermal transport at the quantum limit. Transport regimes ranging from ballistic transport to diffusive transport and localization regimes will be visited. Recent advances in the literature will be addressed.

**MSE 601 PhD Thesis Seminar (0-2)NC 8**

The first two weeks of the course, effective oral/written reporting scientific results will be explained. Ethical and unethical behavior in science and scientific studies will be discussed. Moreover, awareness of the students about scientific plagiarism will be created. A seminar must be given by each student on his/her research area which is graded by academic member of staff. The topic of the seminar can be decided by the student and his/her supervisor.

**MSE 8XX Special Studies (8-0)NC 4**

Graduate students supervised by the same faculty member study advanced topics under the guidance of their advisor.