E-JUST

الجامعة المصرية اليابانية للعلوم والتكنولوجيا

エジプト日本科学技術大学

# Egypt – Japan University of Science and Technology

## ENGINEERING GRADUATE PROGRAMS

### M.Sc. & Ph.D. DEGREES BYLAWS

November,2012

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# EGYPT- JAPAN UNIVERSITY OF SCIENCE AND TECHNOLOGY E-JUST

## ENGINEERING GRADUATE PROGRAMS

## M.Sc. & Ph.D. Degree BYLAWS

NOVEMBER 2012

NEW BORG EL-ARAB
ALEXANDRIA, EGYPT

# 5- DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

## ARTICLE-56

### INTRODUCTION

Material comprehension is of major importance to the technology development in all issues of engineering. The internal structure of different materials should be explained in order to have clear understanding of both of Nano, micro and macro characterization and usage of all different types of materials. The research programs offered by the Department of Material Science and Engineering aimed at covering all interdisciplinary areas of the field including nanotechnology, electronic materials, photonic materials, energy materials, biomaterials, computational materials and structural materials with applications in health care, communications, transportation, recreation, energy and electronics.

## ARTICLE-57

### VISION:

The vision of the department is to be an internationally recognized in postgraduate education and innovative research, in the field of materials science and engineering and to become a top choice destination for high caliper faculty, post-doctoral fellows and distinguished students, both domestic and international".

## ARTICLE- 58

### MISSION:

The vision of the department is to create a nurturing research and educational environment, where post-graduates and researchers can prepare themselves to excel in their careers. The faculty at the Materials Science and Engineering Department at E-JUST is committed to provide in-depth understanding of materials properties, processing and applications via world-class research and national and international collaboration with leaders in the academia and industry.

## ARTICLE-59

**OBJECTIVES:**

1. To advance the state-of-the-art in the specialized fields of Materials Science and Engineering.
2. To develop distinctive education and training in materials science and engineering.
3. To prepare graduates to pursue a broad range of materials-related career opportunities.
4. To prepare graduates with strong foundation in the basic engineering and scientific principles, which underlie the structure, processing, properties, and performance of materials, thereby enabling the effective adaptation or extension to new technology as the needs of the profession and society evolve.
5. To prepare graduates to communicate ethically, and to work effectively as individuals and/or team members.

## ARTICLE-60

**M.SC. PROGRAM:**

M.Sc. students must complete a total of at least 36 credit hours, within the following guidelines:

- Course work of 18 credit hours, including 6-credit hours core courses, 9-credit hours elective courses and 3-credit hours Project-Based Learning course.
- Thesis work of 18 credit hours.

M.Sc. students have to pass successfully six courses with three credit hours each.

***Core courses:***

MSE 501 - Materials Properties and Chemical Changes

MSE 502 - Phase Equilibrium and Transformations

***Elective courses:***

The student has to select three courses from the following group or from any other graduate program, according to the recommendations of the academic advisor.

MSE 503 - Microstructural Analysis of Solids

MSE 504 - Electronic and Photonic Properties of Materials

MSE 505 - Polymer Science and Engineering

MSE 506 - Recycling and Processing of Engineering Materials

MSE 507 - Advanced Testing and Characterization Techniques

MSE 508 - Modeling and Simulation

MSE 509 - Advanced Mechanics of Materials.

MTH 501-Advanced Mathematics and Statistics I

***Project-Based Learning Courses:***

M.Sc. students have to participate in the following teamwork project, which is based on self-learning; Students have to present innovative concepts and competitive solutions. The total credits of the course are three.

MSE 701- Project Based Learning in Materials Development, Characterization and Integration in Engineering Systems.

***M.Sc. Thesis:***

The M.Sc. candidate should prepare and defend a Thesis based on a high-valued research work in one research topic in the fields of Materials Science and Engineering.

**MSE 801 - M. Sc. Thesis**

**ARTICLE-61**

## Ph.D. PROGRAM:

Ph.D. students must complete a total of at least 48 credit hours, within the following guidelines:

- Course-work of 18 credit hours, including four elective courses of 12 credit hours, selected from the following group or from any other graduate program, according to the recommendations of the academic advisor and research seminar courses of 6 credit hours.
- Thesis work of 30 credit hours.

Ph.D. students have to pass successfully six courses with three credit hours each.

The student has to select four courses (3 - credit hours each) from the following group or from any other graduate program, according to the recommendations of the principal supervisor.

***Elective Courses:***

MSE 601 – Composite Materials

MSE 602 - Surface Science and Corrosion

MSE 603 – High Performance Ceramics and Glasses

MSE 604 - Advanced Semiconductors

MSE 605 -Solid-state and Thin-film Reaction Kinetics

MSE 606 – Nano-materials and Nanotechnology

MSE 607- Biomedical materials

MSE 608 - Magnetic and Superconducting Materials

MSE 609 -Materials for Photovoltaic Devices

MSE 610 -Active and Sensing Materials

MSE 611 - Fuel Cells, Batteries and Super capacitors

MSE 612 -Fracture and Fatigue

MTH 611 - Advanced Mathematics and Statistics II

MTR 504-Micro Electro-Mechanical Systems (MEMS)

***Advanced Research Seminar Courses:***

Ph.D. students have to participate in two of the following seminars activities, which are based on self-learning, and presentations of new advanced topics in her/his discipline. The total credit hours of the seminars are six.

MSE 702- Seminar on Advanced topics of Materials Science and Technology.

MSE 703 -Seminar on Advanced topics and progress in the research project of the students.

***Ph.D. Thesis:***

The Ph.D. candidate should prepare and defend a Thesis based on a high-valued research work in one research topic in the fields Materials Science and Engineering.

The Thesis should present a new contribution (s) in the respective field of research.

**MSE 802 - Ph.D. Thesis**

Success Factors and Risks – Overview of Customer Relationship Management (CRM) – Developing a Customer Strategy – Customer Lifecycle Management and Lifetime Value – CRM Technology – Operational CRM – Analytical CRM – Collaborative CRM – CRM Project Management – Building a Business Case for CRM.

**IEM 654 – Information Technology Services and e-Business Management :** Electronic Services – electronic business – electronic government – Strategic e-Business – e-Business Corporate Strategy – e-Business Business Strategy – Strategic E-Business Challenges, Strategic e-Business Applications, e-Business Architecture – e-Supply Chain Management – Building an e-Business – Trends in mobile commerce.

**IEM 701 – Project Based Learning in Industrial Engineering and Systems Management:** Students will participate in project-based learning activities in topics of applied nature related to the fields of specialization .

**IEM 702 – Seminar on Advanced Industrial Engineering and Systems Management:** Lecture given by distinguished professor in new published papers .

**IEM 703 – Seminar on Current Trends in Industrial Engineering and Systems Management:** Research seminars conducted by Ph.D. based on presentation of recent journals papers .

**IEM 801 – M.Sc. Thesis**

**IEM 802 – Ph.D. Thesis**

## 5- MATERIALS SCIENCE AND ENGINEERING

**MSE 501-Chemical Change and Materials Properties:** Recognize MSE nomenclature, microstructure, associate terms with the appropriate structure/phenomena, and be able to differentiate between related structures/phenomena– Calculations to quantify material properties and microstructural characteristics – Recognize the effect of composition and microstructure on material properties – Processing sequence to produce materials with specific microstructure and/or properties. Structure/property relationship of crystalline, quasicrystalline, nanocrystalline and amorphous solid –Structure and properties of polymer, ceramics and composites – Semiconductor, magnetic materials and optical materials properties, processing and applications –

Environmental degradation of engineering materials – Materials and process selection– Materials balance.

**MSE 502-Phase Equilibrium and Transformation:**

Laws of Thermodynamic–Functions of state – Internal energy, heat and work – Types of paths (isobaric, isochoric, isothermal, adiabatic) – Enthalpy, heat capacity, heat of formation, phase transformations –Changes in composition – Chemical potential – Maxwell equations –Theory of Martensitic Transformation – Multi-component (ternary, quaternary) phase diagrams. Kinetics of phase transformations – Activation free energy barrier –Thermodynamics of diffusion – Supercooling and superheating – Driving force for phase transformation – Mechanisms of nucleation–Solidification and growth morphologies–measurement techniques.

**MSE 503-Microstructural Analysis of Solids:**

Key concepts in the atomic structure and bonding of solids such as metals, ceramics, and semiconductors - Symmetry operations - Point groups - Lattice types - Space groups - Simple and complex inorganic compounds - structure/property comparisons - structure determination with X-ray diffraction - Ionic, covalent, metallic bonding compared with physical properties - Perfect and imperfect solids – Point, line surface and volume imperfections – Theory of dislocation – Staking fault and twinning – Homogeneity, segregation and precipitation.

**MSE 504-Electronic and Photonic Properties of Materials:** Behavior of electrons in material – Wave function – Schrödinger equation – Lattice vibration – Classical theory of electron transfer – Fundamental properties of semiconductors – Dielectrics – Introduction to magnetic and superconducting materials – Luminescence from atoms – Photoluminescence – Cathode luminescence – Electroluminescence – Sonoluminescence – Chemiluminescence

**MSE 505-Polymers Science and Engineering:** Polymer chain configuration – Polyolefins – Styrene polymer and copolymer – Polyvinyl chloride – Plasticizers – Engineering thermoplastics – Engineering thermosetting plastics – Thermoset elastomers and their applications – Thermoplastic elastomers and their applications – Fibers – Adhesives and Sealant chemistry – Industrially important

polysaccharides – Electrically conductive polymers – Epoxy resins – Water soluble polymers – White and coloured pigments. Polymer processing techniques – Plastic technology, design considerations and commercial considerations – Polymer materials for microelectronic and imaging applications – Polymer for electric packaging.

**MSE 506 - Recycling and Processing of Engineering Materials:** Recycling concepts and processing techniques – Characterization and separation techniques – Recycled products – Environmental concerns – Potential commercial applications (cost analysis) – Modern analytical techniques – Principles to the separation of recyclable materials: pyro-separation – Hydro-separation – Electro-separation – Magnetic separation – Computational techniques to the separation methods – Case studies; steel scrap, aluminum scrap, electronics scrap, car scrap.

**MSE 507 - Advanced Testing and Characterization Techniques**: Tools of analytical chemistry – Mass & x-ray spectroscopic: XRD, XRF, XPS – Classical methods of analysis -Advanced instrumental techniques – Electro – analytical techniques: cyclic voltammetry and polarography – Industrial applications: Pharma, Biotechnology, Food etc. – Spectroscopic techniques: UV-Vis, Fluorescence, IR, FTIR, Raman, AAS, AES-Environment health & Safety – Advanced chromatographic techniques.

**MSE 508- Modeling and Simulation**: Molecular dynamics – Intermolecular force – Equation of motion – Verlet integration – Runge-Kutta methods – Ewald summation – Quantum behavior of electrons – Hückel methods – Slater determinant – Hartree-Fock method – Hohenberg-Kohn theorem – Density functional theory – Kohn-Sham equation – Car-Parrinello method.

**MSE 509- Advanced Mechanics of Materials:** Prototypes of the theory of elasticity and viscoelasticity – Tensor analysis – Stress tensor – Analysis of strain – Conservation laws – Elastic and plastic behavior of materials – Linear elasticity – Solution of problems in elasticity by potentials – Two dimensional problems in elasticity – Variational calculus – Energy theorems – Viscoelasticity

**MSE 601-Composite Materials and Fiber Science:** Theoretical maximum strength of materials – The effect of defects on practical (lower) strength – Reinforcement of materials – Principles for reinforcement with inclusions – Fibers;

relevant fibers, their structure, fabrication, and properties – Statistical analysis of fiber strength – Micromechanical models for composite materials – Interface between fibers and matrix – Interface mechanics – Load transfer between fiber and matrix – Critical fiber length – Debonding and fiber pull-out energy for composite materials – Single and multiple cracking – Internal stresses in two-phase materials – Volumetric composition of composite materials – Porosity; stiffness, strength and fracture energy for composite materials –Development techniques and applications of composite materials.

**MSE 602- Surface Science and Corrosion:** Electrical concepts relevant to corrosion matters of substance – Chemical and electrochemical concepts relevant to corrosion – Thermodynamic aspects of aqueous corrosion – Kinetics of corrosion –Different forms of corrosion and their mechanisms – Failure analysis – Materials selection for corrosion prevention – Corrosion protection by coatings – New methods of conditioning corrosive environment – Recent trends in cathodic and anodic protections – Recent technologies in online corrosion testing and monitoring.

**MSE 603- High performance Ceramics and Glass:** Processing and characterization of structural and functional ceramic materials –Microstructure-property relationships for the ceramics –Ceramics as superconductors; devices based upon superconductivity – Ceramics as piezoelectric – Hot Glass - Kiln glass - Architectural glass Drawing.

**MSE 604- Advanced Semiconductors:** Band structure – Band gap – p-n junction – Principles of diodes, solar cells, and transistors– Mobility of carrier electrons and holes – Effective mass – Direct/indirect transition – Optical elements – Group IV semiconductors – III-V semiconductors – Organic electroluminescence – Organic field-effect-transistors – Dye-sensitized solar cells.

**MSE 605- Solid-State and Thin-Film Reaction Kinetics:** Thermodynamics for surfaces and thin films – Physical and chemical interaction on surfaces – Mechanism of crystal growth – Nucleation – Discontinuity – Morphology – Advances in chemical and physical vapor deposition – Thickness measurement and analytical techniques. Development of frontier carbon materials: carbon

nanotubes and graphene –Technological applications of carbon nanotubes and graphene thin films.

**MSE 606-Nanomaterials and Technology:** Fundamental of nanomaterials science: Quantum mechanics and atomic structure – Bonding and band structure – Surface science of nanomaterials – Nanomaterials characterization. Nanomaterials fabrication: Thin film deposition (top-down approach) – Nanolithography (top -down approach), SynThesis of nanoparticles and their self-assembly (bottom-up approach). Nanomaterials properties and applications: Nanoelectronic materials – Nano biomaterials – Nanostructured materials – NanoElectromechanical Machines (NEMs).

**MSE 607- Biomedical materials:** Biocompatability - Relationship between structure and function of biomaterials – Physical properties of synthetic and natural biomaterials – Molecular level interactions between biomolecules and biomaterials – Design of engineered implants, tissues and organs– Cellular and, tissue and implants biomechanics: force analysis, mechanics of deformable bodies, stress and strain, multiaxial deformations, stress analysis, and viscoelasticity. Biomechanics of soft and hard tissues – Basic concepts and physiochemical principles of drug delivery – design considerations and applications of Drug delivery systems – Hydroxyapatite– Tri-calcium phosphate – Ti-bio implants – Stent materials – Spinal fixation – Hip joint – Bone regeneration – Bio-ceramic scaffolds – Collagen scaffolds – Bone tissue engineering – Biomimetic materials.

**MSE 608- Materials for Photovoltaic Devices:** Solar energy harvesting properties of sunlight – Interaction of light with matter. Semiconductors for solar cell applications – Fabrication routes and working principles –Theory of conventional pn-junction – Excitonic solar cells – Material issues and effect of nanostructures in silicon based – Thin film, Tandem – Dye-sensitized and organic solar cells, including emerging solar cell concepts such as intermediate band and bio-inspired solar cells.

**MSE 609- Magnetic and Superconducting Materials:** Engineering application of superconductors – Generation of large-scale and intense magnetic fields – Electromagnetic theory; magnet design and operational issues, including "usable" superconductors, field and stress analyses, magnet instabilities, ac losses and

mechanical disturbances, quench and protection, experimental techniques, and cryogenics – New high-temperature superconductors for magnets.

**MSE 610 Active and Sensing Materials:** Nano-structure property relations of active and sensing materials and their devices – Shape memory alloys – Ferromagnetic, ferroelectric, pyro electric and piezoelectric materials – Thermoelectric materials– Electroactive and conducting polymers – Photoactive polymers – Electro chromic materials.

**MSE 611- Fuel Cells, Batteries and Supercapacitors:** Thermodynamics of electrochemical reaction – Kinetics of electrochemical reaction – Electrochemical techniques – Electrochemical impedance spectroscopy (EIS) and its application – Cycling voltammetry and linear polarization – Galvan static intermittent titration – Principle of battery – Advanced rechargeable battery – Li-ion batteries – Nanostructured materials for Li-ion batteries – Principle of supercapacitor – Advanced supercapacitor technology – Difference between batteries and supercapacitors – Principle of fuel cells – Types of fuel cells – New materials for proton exchange membrane fuel cell, alkaline fuel cell and solid oxide fuel cell – Applications of fuel cells – Fuel cell, battery and supercapacitor hybrid power systems.

**MSE 612 - Fracture and Fatigue**: Linear elastic and elastic-plastic – Fracture mechanics – Interface fracture mechanics – Ductile/brittle fracture – Toughening mechanisms – Crack growth resistance – Creep fracture – Fractography – Fatigue damage and dislocation substructures in single crystals –Stress/strain-life approach to fatigue – Fatigue crack growth models and mechanisms – Variable amplitude fatigue – Corrosion fatigue – Case studies of fracture and fatigue in structural, bio implant, and microelectronic components.

**MSE 701 - Project Based Learning in Materials Development and Integration in Engineering Systems:** Student will participate in project – based learning activities in topics of applied nature related to the fields of specialization.

**MSE 702- Seminar on Advanced topics of Materials Science and Technology**

**MSE 703 -Seminar on Advanced topics and progress in the research project of the students.**

**MSE 801 – M.Sc. Thesis**

**MSE 802 – Ph.D. Thesis**

## 6- ENERGY RESOURCES ENGINEERING

**ERE 501- Energy Resources Engineering:** Conventional sources of energy. Renewables: wind, wave, tidal, solar, geothermal and hydropower. Energy Usage (Egypt energy usage. Energy use in Egypt and current infrastructure to meet the electrical demand).Electricity Generation Thermal energy, steam, gas turbine, and combined cycles, diesel engines (Conventional methods of generation - oil, gas, coal, nuclear energy generation, current, and future practice. Environmental and financial aspects of traditional technologies).Environmental impact and Public perception. Solar Energy Resource issues. Photovoltaic technologies: grid connected and standalone systems. Practical demonstration of PV and CPV systems. Solar Thermal Power Generation Technology and Applications.

**ERE 502-Renewable Energy Utilization**: Heat Engines- Ocean Thermal Energy Conversion (OTEC)-Ocean wave energy conversion (AWEC)- Geothermal Energy- Tidal Energy Thermoelectricity- Fuel Cells- Hydrogen production and storage- Biomass- Photovoltaic solar cells- Solar tracking and control systems-Solar Concentrators- Solar satellite Systems- Wind Energy

**ERE 503- Solar Energy Engineering:** Introduction- Characteristics of solar Energy Systems-Solar Energy Collectors- Solar arrays- Microwave solar systems-Performance of Solar Collectors- Solar Water Heating Systems-Solar Space Heating and Cooling- Industrial Process Heat- Solar Dryers- Solar Desalination Systems- Photovoltaic Systems- Solar Thermal Power Systems-Designing and Modeling Solar Energy Systems- Solar Energy Economic Analysis

**ERE 504-Fuels and Processes**: Sources, Extraction, separation, and treatment-Transportation of petroleum- Natural Gas pipelines and Transportation- and underground storage- Basic principles of liquefaction- Liquefaction of Natural gas LNG and Transportation.