

MATERIALS ENGINEERING PROGRAM

PROGRAM GOALS AND OBJECTIVES

The program aims to supply the students with the basic and global concepts of science and technology in order to comprehend the relation between materials' structure and its properties and applications, which will open the field to develop and manufacture materials with special properties that fits the required application. This will help in developing various industries and setting specifications and criteria for quality assurance. Materials engineering applications incorporates different metals, ceramics, plastics, composite materials, semiconductors and other materials that could be used in electronics, communication, environmental, medicine, biotechnology, nanotechnology and other applications. Now this field attracts global attention which makes it important to be included into the higher educational system in Egypt.

DEPARTMENT REQUIREMENT COURSE LIST (APPLIED ENGINEERING)

Code	Course Title	Credits
ECHM 230	Introduction to Organic Chemistry	3
ENGR 231	Fluid Mechanics I	3
ECHM 231	Introduction to Polymer Science	3
MATL 240	Crystalline Structure of Materials	4
MATL 241	Mechanical Behaviour of Materials	4
MATL 242	Production Technology	4
MATL 350	Materials Production	4
ENGR 350	Fluid Mechanics II	3
MATL 351	Phase Transformation	4
ENGR 351	Electrical Circuits & Power	4
MATL 352	Measurements and Communication	3
MATL 360	Mass Transfer	4
ENGR 361	Fundamentals of Solid State Electronics	4
MATL 361	Materials Fabrication	4
ENGR 470	Thermodynamics of Multi-component Systems	4
MATL 470	Materials Manufacturing Lab	3
MATL 471	Materials for Electronic Applications	4
MATL 472	Properties of Polymeric Materials	4
MATL 480	Heat Transfer	4
ENGR 480	Solutions Thermodynamics	4
MATL 481	High Temperature Materials	4
ENGR 481	Industrial Projects	3
MATL 590	Senior Thesis (1)	4
MATL 591	Materials Selection	3
MATL 592	Materials and the Environment	3
MATL 590	Senior Thesis (2)	4
MATL 600	Seminars and Industrial Practice	3
MATL 601	Materials for Construction	3
Total Credit Hours		101

TECHNICAL ELECTIVE LIST OF COURSES

4 Elective courses with a total of 16 Credit Hours

Code	Course Title	Credits
MATL 580	Modern Iron and Steel Making	4
MATL 581	Sustainable Materials Processing	4
MATL 582	Ceramic Science	4
MATL 583	Properties and Processing of Composites	4
MATL 584	Characterization of Nanomaterials	4
MATL 585	Synthesis and Applications of Nanomaterials	4
MATL 586	Sustainable Materials Processing	4

MATERIALS ENGINEERING COURSE DESCRIPTION

ECHM 230 INTRODUCTORY ORGANIC CHEMISTRY (3 credit hrs:2-2-2)

Prerequisite: ECHM 110

An introduction to the chemistry of mono-functional aliphatic and aromatic compounds.

2 hrs lecture+ 2 hr tutorial+ 2 lab ... /week

ECHM 231 INTRODUCTION TO POLYMER SCIENCE (3 credit hrs:2-2-2)

An overview of important synthetic and natural polymers with emphasis on polymer structure, the chemistry of polymer formation. An introduction to polymer characterization.

2 hrs lec + 2hrs tut + 2hrs lab

ENGR 231 FLUID MECHANICS (I) (3 credit hrs:2-2-2)

Prerequisite: EMAT 120

Fluid properties and statics, conservation laws, applications of the continuity, momentum and energy equations, dimensional analysis and similarity, boundary layer flow, internal and external flows.

2 hrs lecture+ 2 hr tutorial+ 2 hr lab ... /week

ENGR 351 ELECTRICAL CIRCUITS AND POWER (4 credit hrs:3-2-2)

Fundamentals of electromechanical energy conversion. Motors and generators, transformers, single and polyphase power circuits, synchronous and induction machines, power measurements.

3 hrs lecture+ 2 hrs tutorial+ 2 hrs lab ... /week

ENGR 350 FLUID MECHANICS (II) (3 credit hrs)

Prerequisite: EMAT 231, ENGR 231

The laws of statics and dynamics in both compressible and incompressible fluids. Equations of conservation and modern turbulence and boundary layer theory applied to submerged and conduit flow. Similitude, unsteady flow, measuring devices and fluid machinery.

2 hrs lecture+ 2 hrs tutorial + 2hrs lab .../week

ENGR 361 FUNDAMENTALS OF SOLID STATE ELECTRONICS (4 credit hrs:3-2-2)

Prerequisite: ENGR 351

Electrons in solids, with emphasis on semiconductors. Electron band model. Metals, dielectrics and semiconductors. Electron and hole behaviour in electric and magnetic fields. Optical properties of solids. Doped semiconductors.

3 hrs lecture+ 2 hr tutorial+ 2 hr lab ... /week

ENGR 470 THERMODYNAMICS OF MULTICOMPONENT SYSTEMS (4 credit hrs:3-2-2)

Prerequisite: ENGR 360

Reaction equilibrium in solution; stability diagrams; ternary phase diagrams; aqueous and high temperature electrochemistry; use of computerized thermodynamic databases.

3 hrs lecture+ 2 hrs tutorial+ 2 hrs lab ... /week

ENGR 480 SOLUTIONS THERMODYNAMICS (4 credit hrs:3-2-2)

Prerequisite: ENGR 470

Thermodynamic activity in solid and liquid systems: Gibbs energy of solutions; binary phase diagrams; equilibrium constant; reaction equilibrium in gases; Ellingham diagrams.

3 hrs lecture+ 2hrs tutorial + 2 hrs lab ... /week

ENGR 481 INDUSTRIAL PROJECTS (3 credit hrs:2-2-2)

Projects, in cooperation with industry, involving materials design in manufacturing, complemented by workshops in group problem solving and design methodology.

2 hrs tutorial+ 2hrs lec + 2 hrs lab ... /week

MATL 240 CRYSTALLINE STRUCTURE OF MATERIALS (4 credit hrs:3-2-2)

Prerequisite: ENGR 230

Crystal geometry, point groups, space groups, x-ray diffraction methods for the determination of crystalline structures and chemical compositions, electron and neutron diffraction methods, microanalysis, crystalline defects, physical properties of crystals, crystal growth, phase analysis, phase diagrams, phase transitions, protein crystallography.

3 hrs lecture+ 2 hr tutorial+ 2 hr lab/week

MATL 241 MECHANICAL BEHAVIOUR OF MATERIALS (4 credit hrs:3-2-2)

Prerequisite: ENGR 230

How materials are made strong, tough, ductile, formable. How to prevent failures. Materials selection using computer databases.

3 hrs lecture+ 2 hr tutorial+ 2 hr lab ... /week

MATL 242 PRODUCTION TECHNOLOGY (4 credit hrs:3-2-2)

Prerequisite: ENGR 230

Introduction to production technology. Properties of engineering material and material selection. Casting and joining of metals. Forming processes. Basic machining processes. Measurement. Standardization. International measuring systems. Cost analysis and estimation. Maintenance systems types and programming. Organization structure.

3 hrs lecture + 2hrs tut + 2hrs lab .../week

MATL 350 MATERIALS PRODUCTION (4 credit hrs:3-2-2)

Prerequisite: MATL 241, MATL 242

Surface science and technology related to the preparation of fine particles of minerals, metals and ceramics for industrial production. Application of electrochemistry for diverse materials processing, such as electrometallurgy, thin film production and anodizing.

3 hrs lecture+ 2hr tutorial+ 2 hr lab ... /week

MATL 351 PHASE TRANSFORMATIONS (4 credit hrs:3-2-2)

Prerequisite: MATL 240

Review of thermodynamics, binary phase diagrams and solid state diffusion. Role of interfaces; solidification, diffusion and martensitic transformations; welding; oxidation. Metallographic examination will be featured in Lab work.

3 hrs lecture+ 2 hr tutorial+ 2 hr lab. .. /week

MATL 352 MEASUREMENTS AND COMMUNICATION (3 credit hrs:2-2-2)

Prerequisite: MATL 240

Basic experimental, simulation and data collection skills relating to materials structure and properties. Written and presentation skills development through lab report writing, assignments and plant visits.

2 hrs lecture+ 2 hrs tutorial + 2 hrs lab ... /week

MATL 360 MASS TRANSFER (4 credit hrs:2-2-2)

Prerequisite: ENGR 360, MATL 351

Phenomenological and mechanistic approaches to diffusion; boundary conditions; diffusion in fluids and solids; point defects in solids.

3 hrs lecture+ 2 hrs tutorial + 2hrs lab .../week

MATL 361 MATERIALS FABRICATION (4 credit hrs:3-2-2)

Prerequisite: MATL 350

Offered jointly by the Departments of Mechanical Engineering and Materials Science and Engineering. Processing methods for a wide range of materials, including metals, ceramics and plastics. The analytical basis for understanding and optimizing materials processes. Exercises in mathematical modeling and the use of software packages to optimize processes.

3 hrs lecture + 2hrs tut + 2hrs lab .../week

MATL 470 MATERIALS MANUFACTURING LAB (3 credit hrs:1-0-4)

Prerequisite: MATL 361

A sequence of experiments based on processing methods used in the metal and ceramic industries. Structure-property relationships are assessed at each step of the processing route.

1 hr lecture+ 4 hrs lab ... /week

MATL 471 MATERIALS FOR ELECTRONIC APPLICATIONS (4 credit hrs:3-2-2)

Prerequisite: ENGR 361

Fundamental properties of materials used in electronic applications, operation of devices and fabrication methods of electronic circuits and packaging. Includes description of dielectric, magnetic and optoelectronic properties.

3 hrs lecture+ /week + 2hrs tut + 2hrs lab ... /week

MATL 472 PROPERTIES OF POLYMERIC MATERIALS (4 credit hrs:3-2-2)

Prerequisite: ECHM 231

Structure of amorphous and crystalline polymeric materials; mechanical, electrical and optical properties, and their modification through processing.

3hrs lecture+ 2 hrs lab + 2 hrs tut ... /week

MATL 480 HEAT TRANSFER (4 credit hrs:3-2-2)

Prerequisite: ENGR 470 – Restricted to Term 8

Steady and unsteady conduction and convection, condensation and boiling. Understanding fundamentals behind heat exchangers, and finned arrangements. Numerical simulations of complex heat transfer systems.

3 hrs lecture+ 2 hrs tutorial + 2hrs lab ... /week

MATL 481 HIGH-TEMPERATURE MATERIALS PRODUCTION (4 credit hrs:3-2-2)

Prerequisite: ENGR 470 – Restricted to Term 8

Fundamentals of processing, building on a knowledge of heat and mass transfer. High temperature processing of materials, focusing on heat sources, solid state processing of powders and liquid state processing, high temperature production routes for most important metals.

3 hrs lecture+ 2 hr tutorial+ 2 hr lab ... /week

MATL 590 SENIOR THESIS

Individual experimental research problem with a selected supervisor. A preliminary written and oral report is required at the end of the first term. The thesis is defended orally. A minimum of six unscheduled hours each week, both terms.

8 credit hours for both terms

MATL 591 MATERIALS SELECTION IN DESIGN AND MANUFACTURING (3 credit hrs:2-2-2)

Prerequisite: ENGR 230

Importance of materials selection in design and manufacturing, overview of materials properties, materials selection charts, performance indices, case studies with simple and complex design constraints, fabrication process selection.

2 hrs lecture+ 2 hr tutorial+ 2 hr lab ... /week

MATL 592 MATERIALS AND THE ENVIRONMENT (3 credit hrs:2-2-2)

Prerequisite: Restricted to Level 9

The environments experienced by engineering materials in service, and economic methods for ensuring their survival. The basic science of high temperature oxidation and aqueous corrosion leads to an appreciation of methods for corrosion control.

2 hrs lecture + 2hrs tut + 2hrs lab ... /week

MATL 600 SEMINARS AND INDUSTRIAL PRACTICE (3 credit hrs:2-2-2)

Prerequisite: MATL 242

Seminars and discussions by technical personnel from industry. Corresponding plant visits made by the class and reported both in written and oral form. Workshops on: Statistical Process Control; ISO 9000; Industrial Health and Safety; Entrepreneurship.

2 hr lecture+ 2 hrs tutorial+ 2 hrs lab or plant vision ... /week

Technical Elective Courses

MATL 473 CERAMIC SCIENCE (4 credit hrs:3-2-2)

The unique properties of structural and functional ceramics are explored, including ferroelectric, piezoelectric and magnetic ceramics, clays, porcelains and refractory. The importance of processing for achieving properties is emphasized.

3hrs lecture+ 2 hr tutorial+ 2 hr lab ... /week

MATL 474 PROPERTIES AND PROCESSING OF COMPOSITES (4 credit hrs:3-2-2)

Intrinsic properties of matrix materials and fibres; mechanics and thermodynamics of interfaces; mechanical properties and fabrication of engineering composites.

3hrs lecture+ 2 hr tutorial+ 2 hr lab ... /week

MATL 580 MODERN IRON AND STEELMAKING (4 credit hrs:3-2-2)

Theory and practice of iron making. New processes for reduced energy consumption and pollution. Thermodynamics and kinetics of steelmaking. Steel refining. Casting, including new near net shape technologies. Specialty steelmaking.

3 hrs lecture+ 2 hr tutorial+ 2 hr lab ... /week

MATL 581 SUSTAINABLE MATERIALS PROCESSING (3 credit hrs:2-2-2)

Sustainable development, traditional economic growth, materials cycles, methods for measuring environmental impact, life cycle analysis, waste treatment technologies and recycling technologies. Assessment will consist of a combination of individual assignments and a group project.

2 hrs lecture+ 2 hr tutorial+ 2 hr lab ... /week

MATL 584 CHARACTERIZATION OF NANOMATERIALS (4 credit hrs:3-2-2)

Interaction of electrons and photons with matter. Imaging methods with electron microscopy, scanning probe techniques, x-ray photoelectron spectroscopy and X-ray absorption analysis with high spatial resolution.

3hrs lecture+ 2 hr tutorial+ 2 hr lab ... /week

MATL 585 SYNTHESIS AND APPLICATIONS OF NANOMATERIALS (4 credit hrs:3-2-2)

Introduction to synthesis routes for nano-materials, bottom-up and top-down approaches, specific properties of materials at the nano-scale including carbon nano-tubes, nano-particles and quantum dots.

3 hrs lecture+ 2 hr tutorial+ 2 hr lab ... /week

ENGR 600 ENGINEERING: ITS HISTORY AND CONTEMPORARY CONTEXT (3 credit hrs:3-0-0)

History of engineering from antiquity to modern times, with special emphasis on scientific technology. Cultural significance of engineering to civilization. Nature and problems of industrial technology. Benefits and risks of technological progress. Engineering as a learned profession.

3 hrs lecture ... /week