Syllabus Description

For

Department of Materials Engineering

College of Engineering

University of Basrah

Basrah, Iraq

1. Introduction

1.1 Overview of Department of Materials Engineering

The materials engineering department was established in 1999-2000 to meet the emerging needs of the governmental and private sector agencies and companies for skilled materials engineers and to keep abreast of the scientific and technical progress in the world.

Since its inauguration, MAE department adopted a well- established academic program equal to the materials engineering departments worldwide by focusing on both theoretical and practical integrated aspects of the materials engineering field of study.

The undergraduate study at the department is four years in length; from the moment of receiving the fresh first year students whose average grades qualify them to join up until the graduation of the senior final year students where they get their Bachelor of Science degree in the materials engineering.

1.2 Program Educational Objective

The Program Educational Objectives (**PEOs**) clearly reflect the professional expectations from the graduates of the materials engineering department and prepare them to meet those challenges.

1. Graduates will be engaged in materials engineering related careers that could serve the needs of both of the industry and academia, in the private and public sectors, as well. The objective is to apply the essential elements of MAE competently, which are defined by the inter-relationships among composition, structure, properties, processing and performance of the engineering materials.
2. Graduates must know devise, design and conduct experimental, analytical and computational exercises necessary to further explore the essential elements of materials and engineering .the pursuit of knowledge and active, continuous and lifelong professional development through the continuous reading of up to date scientific researches, the engagement in the further/continual education courses, and admission to graduate studies.
3. Graduates will contribute to help solve the complex engineering problems by applying the related principles of the engineering materials disciplines and by functioning effectively within the multidisciplinary teams. The welfare of society is to

be consistent with the development of its professional standards through the responsible practice of the engineering disciplines.

1.3 Program Curriculum

The Bachelor of Science (B.Sc.) in Materials Engineering approved by the Department, and the student can choose it by the competition in the average of primary school. Throughout the first and second years all student take a general subject with the Materials engineering, and specialties starting from the third year of study by adding a pure specialties subjects.

1.4 Program Outcomes

The graduate of the B.Sc. in Materials Engineering program will:

1. Engage in Materials Engineering profession in public and private sectors including, but not limited to, relevant governmental sectors, consulting firms, contracting companies, marketing and real estate investments.
2. Engage in ongoing professional development activities by pursuing graduate studies and / or other learning opportunities to respond to the arising challenges.
3. Advance in responsibility and leadership in their careers.

1.5 Program Outcomes (ABET):

a. An ability to apply knowledge of mathematics, science, and engineering

b. An ability to design and conduct experiments, as well as to analyze and interpret data.

c. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

d. An ability to function on multidisciplinary teams.

e. An ability to identify, formulate, and solve engineering problems.

f. An understanding of professional and ethical responsibility.

g. An ability to communicate effectively.

h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

i. A recognition of the need for, and an ability to engage in life-long learning.

j. A knowledge of contemporary issues related to engineering.

k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

2. Course Description

The units are calculated such as, the theory hours (1 hour per semester = 1 unit), practical hours (2-3 hours per semester = 1 unit), and the tutorial hours (units = 0). Prerequisites, if any, are indicated at the course description. These have been established to assure an adequate and uniform background for students in advanced classes.

Course code is presented according to three requirements:

1- University requirement started by the letter **U**

2- Engineering College requirement is started by the letter **E**

3- Department Requirement **(Materials** Engineering) is started by the letters **MAE**

Course code started by capital letters followed by number of 3-digits as following:

1st digit represents the class number

2nd digit represent the semester number, **1**: 1st Semester, **2:** 2nd Semester, **0**: Yearly

3rd digit represent the subject number

For examples:

Example: U112 represents University requirements, first year, first semester, and second subject.

Example: MAE212 represents Department Requirements, second year, first semester, and second subject.

3. Graduation Requirements

Requirements	Units	Total hours/Year
University Requirements	10	210
College Requirements	26	615
Department Requirements	112	2280
Total	148	3105

4. University Requirements: 10 Units

Subject Code	Subject	Units	Weekly hours		
			Th.	Prac.	Tut.
U116	Principles of Computer Science	3	2	2	-
U126	Computer Science	3	2	2	-
U119	English	1	1	-	1
U129	English / Technical	1	1	-	1
U218	Human Rights & Democracy Concepts	2	2	-	-
Total		10	14		

5. College Requirements: 26 Units

No.	Subject Code	Subject	Units	Weekly hours		
				Th.	Prac.	Tut.
1	E111	Mathematics I	3	3	-	1
2	E121	Mathematics II	3	3	-	1
3	E114	Engineering Drawing I	2	1	2	-
4	E124	Engineering Drawing II	2	1	2	-
5	E127	Applied Sciences	2	2	-	-
		Total for 1st Year	12	10	4	2
6	E211	Applied Mathematics I	2	2	-	2
7	E221	Applied Mathematics II	2	2	-	2
		Total for 2nd Year	4	4	0	4
8	E311	Engineering Analysis	3	2	2	2
9	E321	Numerical Analysis	3	2	2	1
		Total for 3rd Year	6	4	4	3
10	E407	Engineering Project	4	2	4	-
		Total for 4th Year	4	2	4	0
	Total		26	20	12	9
				41		

6. Department Requirements: 112 Units

Subject Code	Subject Title	Units	Weekly hours		
			Th.	Prac.	Tut.
MAE112	Engineering Mechanics / Static (MAE112)	3	3	-	1
MAE113	Materials Extraction Technology (MAE113)	2	2	-	1
MAE115	Principles of Electrical Engineering (MAE115)	3	2	2	-
MAE117	Principles of Engineering Materials (MAE117)	2	2	-	-
MAE118	Engineering Workshops (I)	1	-	2	-
MAE122	Engineering Mechanics / Dynamic (MAE122)	3	3	-	1
MAE123	Materials Extraction Methods (MAE123)	2	2	-	1
MAE125	Electrical Engineering (MAE125)	3	2	2	-
MAE128	Engineering Workshops (I)	1	-	2	-
	Total for 1st Year	*20*	*16*	*8*	*4*
MAE212	Metallurgical Thermodynamics (MAE212)	2	2	-	-
MAE213	Physical Metallurgy (MAE213)	2	2	-	-
MAE214	Mechanics of Materials (MAE214)	3	3	-	1
MAE215	Thermodynamics (MAE215)	2	2	-	-
MAE216	Introduction to Computer Programming (MAE216)	3	2	2	-
MAE217	Mechanical Drawing (I) (MAE217)	2	1	2	-
MAE219	Laboratory (I) (MAE219)	2	-	3	-
MAE222	Chemical Metallurgy (MAE222)	2	2	-	-
MAE223	Engineering Metallurgy (MAE223)	2	2	-	-
MAE224	Strength of Materials (MAE224)	3	3	-	1
MAE225	Fluid Mechanics (MAE225)	2	2	-	-
MAE226	Computer Programming (MAE226)	3	2	2	-
MAE227	Mechanical Drawing II (MAE227)	2	1	2	-
MAE228	Laboratory (II) (MAE228)	2	-	3	-
	Total for 2nd Year	*32*	*24*	*14*	*2*
MAE312	Behavior of Engineering Materials (MAE312)	3	3	-	-
MAE313	Heat Treatments of Ferrous metals (MAE313)	2	2	-	1
MAE314	Engineering Materials Technology (MAE314)	2	2	-	1
MAE315	Ceramic Materials (MAE315)	2	2	-	-
MAE316	Corrosion (I) (MAE316)	2	2	-	1
MAE317	Conduction Heat Transfer (MAE317)	2	2	-	1
MAE318	Laboratories (I) (MAE318)	2	-	3	-
MAE322	Failure of Engineering Materials (MAE322)	3	3	-	-
MAE323	Heat Treatments of non-ferrous metals (MAE323)	2	2	-	1
MAE324	Welding and Cutting (MAE324)	2	2	-	1
MAE325	Polymers Engineering (MAE325)	2	2	-	-
MAE326	Corrosion (II) (MAE326)	2	2	-	1
MAE327	Convection Heat Transfer (MAE327)	2	2	-	1
MAE328	Laboratories (II) (MAE328)	2	-	3	-
	Total for 3rd Year	*30*	*26*	*6*	*8*
MAE411	Mechanical Design (MAE411)	3	2	2	-

MAE412	Non-Destructive Testing (MAE412)	2	2	-	1
MAE413	Composite Materials (MAE413)	2	2	-	1
MAE414	Powder Metallurgy (MAE414)	2	2	-	1
MAE415	CAD & CAM (MAE415)	2	2	-	-
MAE416	Industrial Engineering (MAE416)	2	2	-	1
MAE418	Laboratories (I) (MAE418)	2	-	3	-
MAE421	Selection of Engineering Materials for Design (MAE421)	2	2	-	1
MAE422	X-Ray Diffraction and Microscopy (MAE422)	2	2	-	1
MAE423	Advance Materials (MAE423)	2	2	-	1
MAE424	Stress Analysis and Plasticity (MAE424)	2	2	-	1
MAE425	Nano Materials (MAE425)	2	2	-	-
MAE426	Project Management (MAE426)	3	2	2	2
MAE428	Laboratories (II) (MAE428)	2	-	3	-
	Total for 4th Year	*30*	*24*	*10*	*10*
	TOTAL	*112*	*90*	*38*	*24*
			152		

7. MAE Program: Curriculum

Typical degree program is shown in the following Tables for Materials Engineering, where recommended MAE course plan by semester is presented

First Year

First Semester					*Second Semester*				
Subject	***Units***	***Weekly hours***			***Subject***	***Units***	***Weekly hours***		
		Th.	***Prac.***	***Tut.***			***Th.***	***Prac.***	***Tut.***
Mathematics I (E111)	3	3	-	1	Mathematics II (E121)	3	3	-	1
Engineering Mechanics / Static (MAE112)	3	3	-	1	Engineering Mechanics / Dynamic (MAE122)	3	3	-	1
Materials Extraction Technology (MAE113)	2	2	-	1	Materials Extraction Methods (MAE123)	2	2	-	1
Engineering Drawing I (E114)	2	1	2	-	Engineering Drawing II (E124)	2	1	2	-
Principles of Electrical Engineering (MAE115)	3	2	2	-	Electrical Engineering (MAE125)	3	2	2	-
Principles of Computer Science (U116)	3	2	2	-	Computer Science (U126)	3	2	2	-
Principles of Engineering Materials (MAE117)	2	2	-	-	Applied Sciences (E127)	2	2	-	-
Engineering Workshops (I) (MAE118)	1	-	2	-	Engineering Workshops (II) (MAE128)	1	-	2	-
English (U119)	1	1	-	1	English / Technical (U129)	1	1	-	1
Total	20	16	8	4	***Total***	20	16	8	4
		28					28		

Second Year

First Semester					Second Semester				
Subject	Units	Weekly hours			Subject	Units	Weekly hours		
		Th.	Prac.	Tut.			Th.	Prac.	Tut.
Applied Mathematics I (E211)	2	2	-	2	Applied Mathematics II (E221)	2	2	-	2
Metallurgical Thermodynamics (MAE212)	2	2	-	-	Chemical Metallurgy (MAE222)	2	2	-	-
Physical Metallurgy (MAE213)	2	2	-	-	Engineering Metallurgy (MAE223)	2	2	-	-
Mechanics of Materials (MAE214)	3	3	-	1	Strength of Materials (MAE224)	3	3	-	1
Thermodynamics (MAE215)	2	2	-	-	Fluid Mechanics (MAE225)	2	2	-	-
Introduction to Computer Programming (MAE216)	3	2	2	-	Computer Programming (MAE226)	3	2	2	-
Mechanical Drawing (I) (MAE217)	2	1	2	-	Mechanical Drawing II (MAE227)	2	1	2	-
Human Rights and Democracy Concepts (U218)	2	2	-	-	Laboratory (II) [Chemical Metallurgy+ Engineering Metallurgy + Strength of Mat. + Fluid Mechanics] (MAE228)	2	-	3	-
Laboratory (I) [Metallurgical thermo. + Physical Metallurgy + Mechanics of Mat. + Thermodynamics] (MAE219)	2	-	3	-					
Total	20	16	7	3	Total	18	14	7	3
		26					24		

Third Year

First Semester					Second Semester				
Subject	Units	Weekly hours			Subject	Units	Weekly hours		
		Th.	Prac.	Tut.			Th.	Prac.	Tut.
Engineering Analysis (E311)	3	2	2	2	Numerical Analysis (E321)	3	2	2	1
Behavior of Engineering Materials (MAE312)	3	3	-	-	Failure of Engineering Materials (MAE322)	3	3	-	-
Heat Treatments of Ferrous metals (MAE313)	2	2	-	1	Heat Treatments of non-ferrous metals (MAE323)	2	2	-	1
Engineering Materials Technology (MAE314)	2	2	-	1	Welding and Cutting (MAE324)	2	2	-	1
Ceramic Materials (MAE315)	2	2	-	-	Polymers Engineering (MAE325)	2	2	-	-
Corrosion (I) (MAE316)	2	2	-	1	Corrosion (II) (MAE326)	2	2	-	1
Conduction Heat Transfer (MAE317)	2	2	-	1	Convection Heat Transfer (MAE327)	2	2	-	1
Laboratories (I) [Heat treatments + Eng. Mat. Technology + ceramic + corrosion + heat transfer] (MAE318)	2	-	3	-	Laboratories (II) [Heat treatments + Welding & Cutting + Polymers + corrosion + heat transfer] (MAE328)	2	-	3	-
Total	18	15	5	6	**Total**	18	15	5	5
		26					25		

Forth Year

First Semester					Second Semester				
Subject	Units	Weekly hours			Subject	Units	Weekly hours		
		Th.	Prac.	Tut.			Th.	Prac.	Tut.
Mechanical Design (MAE411)	3	2	2	-	Selection of Engineering Materials for Design (MAE421)	2	2	-	1
Non-Destructive Testing (MAE412)	2	2	-	1	X-Ray Diffraction and Microscopy (MAE422)	2	2	-	1
Composite Materials (MAE413)	2	2	-	1	Advance Materials (MAE423)	2	2	-	1
Powder Metallurgy (MAE414)	2	2	-	1	Stress Analysis and Plasticity (MAE424)	2	2	-	1
CAD & CAM (MAE415)	2	2	-	-	Nano Materials (MAE425)	2	2	-	-
Industrial Engineering (MAE416)	2	2	-	1	Project Management (MAE426)	3	2	2	2
Engineering Project (E407)	2	1	2	-	Engineering Project (E407)	2	1	2	-
Laboratories (I) [Non-destructive Tests + Powder Metallurgy + CAD& CAM] (MAE418)	2	-	3	-	Laboratories (II) [Eng. Mat. Selection + X-Ray Diffraction + Nano Mat.] (MAE428)	2	-	3	-
Total	17	13	7	4	*Total*	17	13	7	6
		24					26		

Summer Training

The **Materials Engineering** curriculum requires students to complete one month of summer training at private industries or governmental firms. This training is a compulsory component of graduation requirements. It is supervised by the Summer Training Committee of the department.

8. MAE Curriculum / Units Requirements

- 4 - Years Program (Full - Time Study)
- **148 Units for the Materials Engineering included:**
  - **Mathematics and basic Science: 22 Units**
  - **Engineering Topics: 120 Units.**
  - **General Education: 6 Units.**

9. How the Curriculum Aligns with the Program Educational Objectives

The faculty has complete authority to define, revise, implement, and achieve program educational objectives. Input is required from the students, alumni, and the employers of our alumni in the implementation of program objectives. The major role of the faculty is to create, revise, and evaluate subjects for the program as well as define and revise program educational objectives and ensure achievement of student outcomes. Therefore, the above process ensures alignment of the curriculum with Program Educational Objectives as shown in various tables. The **Materials Engineering** department insures that the students receive all the engineering analysis within the context of engineering program. At our faculty meetings, the discussion is possible subjects to be introduced in the different subjects and brainstorm on ways to bring engineering program and open-ended problems into our subjects.

Program Outcomes: For the purpose of achieving its objectives, the Materials Engineering Department has developed eleven Program Outcomes (POs) as an initial set of POs. These outcomes are, in effect, what the students expected to know and achieve post-graduation. The following Table shows these program outcomes:

OUTCOMES	Code
PO1: an ability to apply knowledge of mathematics, science, and engineering fundamentals.	a
PO2: an ability to outline and conduct experiments as well as analyze and interpret data.	b
PO3: an ability to design an integrated system and its various components and processes, within realistic economic, environment, social, political, ethical, health and safety, manufacturability, and sustainability constraints.	c
PO4: an ability to function on multi-disciplinary teams to analyze and solve problems.	d
PO5: an ability to identify, evaluate and solve engineering problems.	e
PO6: an understanding of the responsibility of engineers to practice in professional and ethical manner at all times.	f
PO7: an ability to communicate effectively using oral, written, and graphic forms.	g
PO8: the broad education necessary to understand the potential impact of engineering solutions on society and the environment.	h
PO9: an understanding of the need for up-to-date engineering tools and other knowledge acquired through life-long learning.	i
PO10: knowledge of contemporary issues related to engineering.	j
PO11: an ability to use modern engineering tools, skills and design techniques necessary for the practice of engineering.	k

1st Year/1st Semester

Subject: Mathematics-I | **Theoretical: 3 hrs/wk**
Code: E111/1st Semester | **Practical: ---**
Class: 1st Year | **Tutorial: 1 hr/wk**
Pre-requisite: None | **Units: 3**

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Brief Review:
Trigonometry, Analytic Geometry, Sets, Relations, Functions (Algebraic and Trigonometric), Differentiation and Integration.

Transcendental Functions:
Inverse Trigonometric, Natural Logarithmic, Exponential and Power:
i. Definitions ii. Properties iii. Graphs iv. Derivatives and Integrals.

Application of the Definite Integral:
i) Areas between curves. ii) Volumes of revolution. iii) (Length of the curve. iv) Surface Area of revolution.

Hyperbolic Function:
i) Definition, ii) Properties iii) Graphs iv) Inverse hyperbolic.
v) differentiation and Integration

Methods of Integration
Trigonometric Substitutions , Quadratics, Partial Fractions.

Subject: Engineering Mechanics/ Static | **Theoretical: 3 hrs/wk**
Code: MAE112/1st Semester | **Practical: ---**
Class: 1st Year | **Tutorial: 1 hr/wk**
Pre-requisite: None | **Units: 3**

- **Introduction to Engineering Mechanics**
- **Operation with Forces**
- **Force systems, components, moment:** Resultant of Forces system Couple and Resultant, components
- **Equilibrium:** Equilibrium in Two and Three Dimensions, free body diagram, Equilibrium Conditions.
- **Centroids and Moments of Inertia:** centroids of composite bodies, center of mass, Area moment of inertia, composite areas, radius of gyration, transfer of axes.
- **Friction:** frictional phenomena, applications.
- **Trusses and Cables:** Structures, Frame and machine

Subject: Principles of Engineering Materials (I) **Theoretical: 2 hrs/wk**
Code: MAE117/1st Semester **Practical: -----**
Class: 1st Year **Tutorial: -----**
Pre-requisite: None **Units: 2**

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-Atomic Structure: The Structure of the Atom, The Electronic Structure of the Atom, The Periodic Table, Atomic Bonding, Binding Energy and Interatomic Spacing

-Atomic and Ionic Arrangements: Short-Range Order versus Long-Range Order, Amorphous Materials: Principles and Technological Applications, Lattice, Unit Cells, and Crystal Structures, Points, Directions, and Planes in the Unit Cell, Interstitial Sites, Crystal Structures of Ionic Materials, Covalent Structures

-Imperfections in the Atomic and Ionic Arrangements: Point Defects, Other Point Defects, Dislocations, Significance of Dislocations, Influence of Crystal Structure, Surface Defects, Importance of Defects

-Atom and Ion Movements in Materials: Applications of Diffusion, Stability of Atoms and Ions, Mechanisms for Diffusion, Activation Energy for Diffusion, Rate of Diffusion (Fick's First Law), Factors Affecting Diffusion, Composition Profile (Fick's Second Law), Diffusion and Materials Processing

-Principles of Solidification: Technological Significance, Nucleation, Applications of Controlled Nucleation, Growth Mechanisms, Solidification Time and Dendrite Size, Cooling Curves, Cast Structure, Solidification Defects, Casting Processes for Manufacturing Components, Continuous Casting and Ingot Casting, Directional Solidification (DS), Single Crystal Growth, and Epitaxial Growth, Solidification of Polymers and Inorganic Glasses, Joining of Metallic Materials

- Equilibrium Phase Diagram: Phases and the Phase Diagram, Solubility and Solid Solutions, Conditions for Unlimited Solid Solubility, Solid-Solution Strengthening, Isomorphous Phase Diagrams, Relationship Between Properties and the Phase Diagram, Solidification of a Solid-Solution Alloy, Nonequilibrium Solidification and Segregation, Intermetallic Compounds, The Eutectic Phase Diagram, Strength of Eutectic Alloys, Nonequilibrium Freezing in the Eutectic System, Combination Phase Diagram

Subject: Materials Extraction Technology **Theoretical: 2 hrs/wk**
Code: MAE113/1st Semester **Practical: --**
Class: 1st Year **Tutorial: 1 hrs/wk**
Pre-requisite: None **Units: 2**

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Raw Materials
Concentration of raw materials, preparation of raw materials, fragmentation,
Devices used for cracking
Screening, separation using liquid and foam concentrate float
Magnetic separation, electrostatic, clustering, environmental influences.
Thermal Method and roasting
Oxide ores extraction, Metallurgical water Method
Introduction in Fluid Mechanics

Subject: Principle of Computer Science **Theoretical: 2 hrs/wk**
Code: U116/1st Semester **Practical: 2 hrs/wk**
Class: 1st Year **Tutorial: -**
Pre-requisite: None **Units: 3**

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Problem solving algorithms
Data structures, searching and sorting algorithms
V. Basic Variables
1) Variable types
2) Variable Names
3) Declarations

Assignment statements and expressions in V. Basic
Logical expressions and operators
Mathematical expressions and operators
Conditional Decisions and Loops
(a) Conditional Decisions
1) If/Then/End If statement
2) If/Then/Else/End If statement
3) If/Then/ElseIf/End If statement
4) Select Case statement
5) Switch statement
6) IIf statement
7) Choose statement

(b) Loops
1) For-Next statement
2) While-Wend statement
3) Do Until-Loop statement
4) Do While-Loop statement

5) Do-Loop Until statement
6) Do-Loop While statement

ARRAYS

Declaring Arrays
Input and Output Arrays
Generate Specific Array Elements
Computational (mathematical) processes that take place on the matrices (arrays)

Subject: Engineering Drawing I — **Theoretical: 1 hrs/wk**
Code: E114/1st Semester — **Practical: 2 hrs/wk**
Class: 1st Year — **Tutorial: ---**
Pre-requisite: None — **Units: 2**

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- Introduction to engineering drawing
- Engineering Operation
- Projection
- Free Hand Drawing & Dimensions
- Descriptive Geometry / Introduction / Projection / Point representation

Subject: Principles of Electrical Engineering — **Theoretical: 2 hrs/wk**
Code: MAE115 /1st Semester — **Practical: 2 hrs/wk**
Class: 1st Year — **Tutorial:**
Pre-requisite: None — **Units: 3**

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Introduction

Atoms, molecules, low of resistance, units of resistivity, conductance and conductivity, temperature coefficients of resistivity, types of resistor, Electric field, Coulomb's law

Electrical Parameters

Resistance, voltage difference, effect of electric current, Joule's law of electric heating, resistance in series and in parallel.

Electrical circuit

electromotive force sources, DC circuits, short and open circuits, short and open in series and open circuits

Subject: Engineering Workshops (I) | **Theoretical:**
Code: MAE118 /1st Semester | **Practical: 2 hrs/wk**
Class: 1st Year | **Tutorial:**
Pre-requisite: None | **Units: 1**

- **General :** Studies of mechanical tools, components and their applications: (a) Tools: Screw drivers, spanners, allen keys, Cutting pliers etc.
- **Turning Workshop**
- **Shaping Workshop**
- **Milling Workshop**

Subject: English | **Theoretical: 1 hrs/wk**
Code: U119 /1st Semester | **Practical:**
Class: 1st Year | **Tutorial: 1 hrs/wk**
Pre-requisite: None | **Units: 1**

Outcome:
1) To encourage the students to speak English
2) To enable students to use English in day-to-day communication
3) To build up their confidence in the usage of English
4) To expose them to light prose and poetry
5) To develop their written communicative competence

Unit One: Spoken Communication
1) Meeting People, Exchanging Greetings and Taking Leave 2) Introducing Yourself 3) Introducing People to Others 4) Answering the Telephone and Asking for Someone 5) Dealing with a Wrong Number 6) Taking and Leaving Messages 7) Making Inquiries on the Phone 8) Calling for Help in an Emergency

Unit Two: Grammar and Vocabulary:
Articles, prepositions, modal auxiliaries, antonyms, synonyms, one-word substitutes

Unit Three: Written Communication: Summarizing

1st Year/2nd Semester

Subject: Mathematics (II) — **Theoretical: 3 hrs/wk**
Code: E121/2nd Semester — **Practical: ---**
Class: 1st Year — **Tutorial: 1 hrs/wk**
Pre-requisite: Mathematics-I — **Units: 3**

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Methods of Integration II: Integration by parts, Further Substitutions.
Approximation Integral: i) Trapezoidal ii) Simpson
Vector Algebra: i) Representation of Vectors in space (I,j.k) (unit vectors ii) Scalar Product iii) Vector product.
Complex Numbers:
i) Invented number systems ii) The Argand diagram. iii) Addition, Subtraction, product, Qutient, Power and Roots. iv) Demoivers theorem.
Polar Coordinates:
i) The polar coordinate system. ii) Graphs of polar equations. iii) Plane area in polar coordinates.
Matrices and Determinats:
i) Definition ii) Properties. iii) Inverse of a matrix. iv) Solution of Equations (Cramer's rule).

Subject: Engineering Mechanics / Dynamic — **Theoretical: 3 hrs/wk**
Code: MAE122/2nd Semester — **Practical: ---**
Class: 1st Year — **Tutorial: 1 hrs/wk**
Pre-requisite: Engineering Mechanics/ Statics — **Units: 3**

- **Introduction to dynamics:** Newton's Law, gravitation
- **Kinematics of particles:** rectilinear motion, curvilinear motion, rectangular coordinates, projectiles, normal and tangential coordinate, polar coordinate, relative motion, constraint motion of connected particles(pulleys),
- **Kinetics of Particles:** Force and Acceleration, forces in rectilinear and curvilinear motion
- **Work and kinetic Energy:** Potential energy and power,
- **Impulse and Momentum, Impact**
- **Dynamic of Rigid Bodies:**Fixed axis rotation, Translations motion and general plane motion.

Subject: Material Extraction Methods **Theoretical: 2 hrs/wk**
Code: MAE123/2nd Semester **Practical: ---**
Class: 1st Year **Tutorial: 1 hrs/wk**
Pre-requisite: Material Extraction Technology **Units: 2**

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- Production of cast iron, iron ore
- Steel production, conversion method, the Martin way, the electrical method, the direct method and open hearth.
- Production of aluminum, copper, zinc, tin and nickel and magnesium, Production of lead, chromium, gold, silver and uranium

Subject: Computer Science **Theoretical: 2 hrs/wk**
Code: U126/2nd Semester **Practical: 2 hrs/wk**
Class: 1st Year **Tutorial: ---**
Pre-requisite: Principles of Computer Science **Units: 3**

==========

- Review of basic instructions of V. Basic to prepare for advanced V. basic
- Built in Functions, User defined functions and subroutines
- Sequential files, Random Files
- Flowcharts: symbols, conversion algorithm to Flowchart, loops, overlaps
- Engineering applications, start writing the matter to write the program

Subject: Engineering Drawing (II) **Theoretical: 1 hrs/wk**
Code: E124/2nd Semester **Practical: 2 hrs/wk**
Class: 1st Year **Tutorial: ---**
Pre-requisite: Engineering Drawing (I) **Units: 2**

==========

- Missing projections
- Isometric drawing
- Sectional Projections
- Descriptive Geometry / Line representation / Plane representation

Subject: Electrical Engineering **Theoretical: 2 hrs/wk**
Code: MAE125/2nd Semester **Practical: 2 hrs/wk**
Class: 1st Year **Tutorial: ---**
Pre-requisite: Principles of Electrical Engineering **Units: 3**

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- Ohm's and Kirchhoff's laws, work, power, and energy, Maximum power Transfer, Power Transfer Efficiency.
- Theories compositions Tvenn and the Norton, division of current in parallel circuits, Compensation Theorem.
- Delta and the star conversions, delta/star transform, Star/delta Transform,

Subject: Applied Sciences **Theoretical: 2 hrs/wk**
Code: E128/2nd Semester **Practical: ---**
Class: 1st Year **Tutorial: ---**
Pre-requisite: **Units: 2**

==========

- Atomic structure and Bonding, Chemical Bonding, Hybridization,
- Cement / Electro-chemical Corrosion, Hydration Reaction, Weathering of Cement.
- Thermal Chemistry / Chemical Kinetics, Exthothermic And Endothermic Reaction, heat of Formation, fuel and Watergas, Rocket Propulsions, Energy and collision,
- Water Treatments, Petroleum Refining.
- Hydrocarbons, Aromatic Compounds, Benzene Structure, Homologues of Benzene, Reactions, Substitution of Benzene, Addition reaction, Poly-substitution in benzene ring, Reactions.
- **Material Properties**: solids, crystalline solids types, crystalline structures, stress, strain, Elasticity and plasticity, Elasticity Modulus, Poisson's ratio, Energy stored in stressed body.
- **Motion**: Equation of Motion, pendulum, damping Motion, Forced motion. Wave Motion, , longitudinal wave in Pipes.
- **Sound Waves**: Power and intensity, relations of sound and temperature, Dopller Phenomenon.

Subject: Engineering Workshops (II) **Theoretical:**
Code: MAE128 /2nd Semester **Practical: 2 hrs/wk**
Class: 1st Year **Tutorial:**
Pre-requisite: Engineering Workshops (I) **Units: 1**

- Drilling Workshop
- Welding Workshop
- Carpentry Workshop
- Casting Workshop

Subject: English / Technical | **Theoretical: 1 hrs/wk**
Code: U129 /2nd Semester | **Practical:**
Class: 1st Year | **Tutorial: 1 hrs/wk**
Pre-requisite: English | **Units: 1**

Unit One: Technical Communication in Teams

a. Use email and instant messaging in a professional manner.
b. Define the stages of team work.
c. Understand the importance of teamwork in 21st century business and technical writing.

Unit Two: Technical Communication Essentials

a. Understand how technical communication is used in the workplace.
b. Describe the writing process most useful in today's technical writing environment.
c. Analyze an audience and consider appropriate writing situations to meet the audience's needs.
d. Understand the ethics of the workplace and apply those ethics to your technical and business writing.

Unit Three: Writing Memorandums and Letters

a. Analyze and provide solutions to a case study problem.
b. Write a professional memorandum or letter in response to the problem.
c. Proofread and edit documents for professional presentation.
d. Understand the steps of searching for a job.
e. Write an effective application letter.
f. Demonstrate expertise in a professional resume.

Unit Four: Document Design

a. Understand and use the principles of design in your business and technical communication.
b. Create and use graphics that complement your business and technical communication.

Unit Five: Technical Communication Strategies and Researched Report Writing

a. Apply useful descriptive language to your technical documents.
b. Define terms clearly in technical documents.
c. Explain instructions and processes clearly.
d. Write clear proposals for business and technical situations.
e. Research and manage information.
f. Write an analytical report.

2nd Year/1st Semester

Subject: Applied Mathematics (I) — **Theoretical: 2 hrs/wk**
Code: E211/1st Semester — **Practical: ---**
Class: 2nd Year — **Tutorial: 2 hrs/wk**
Pre-requisite: None — **Units: 2**

==========

- **Vectors Calculus**, plane curves and parametric equations, polar coordinates and graphs, tangent line and curve sketching, polar equation for conics, area and arc length, space coordinates and vectors in space, dot produvt, cross product, line and planes, surface in space, Cylindrical and spherical coordinates
- **Vector-Valued Functions**, differentiation and integration of vector valued functions, velocity and Acceleration, Tangent Vectors and Normal Vectors, Arc Length and Curvature
- **Matrices and linear equations**, Determinants, operation of Matrices.

Subject: Metallurgical Thermodynamics — **Theoretical: 2 hrs/wk**
Code: MAE212/1st Semester — **Practical:**
Class: 2nd Year — **Tutorial:**
Pre-requisite: None — **Units: 2**

==========

- Introduction to thermodynamics, Zeroeth law of thermodynamics, First law of thermodynamics, Thermodynamically reversible changes, Gas Expansion: maximum work, Heat capacity, Thermo-chemistry and its applications in metallurgy.
- Introduction to second law, Entropy, free energy and chemical equilibrium, some thermodynamic relationships involving entropy, some thermodynamic relationships involving free energy, Chemical equilibrium, controlled atmospheres, the equilibrium constant and the stability of compounds, Ellingham Diagrams.
- Introduction to solutions, ideal solutions: Raoults law, deviations from Raoults law, activities and activity coefficient, Henry's law and Sievert's law, Regular solutions, Free energy of mixing, The Gibbs-Duhem equation.
- Phase equilibrium, Thermodynamic phase equation, Phase rule, Phase diagrams, Unary Systems, Binary Systems, Ternary Systems.

Subject: Physical Metallurgy **Theoretical: 2 hrs/wk**
Code: MAE213/1st Semester **Practical:**
Class: 2nd Year **Tutorial:**
Pre-requisite: Note **Units: 2**

==========

- Introduction: Atomic Structure, Crystal Structure, Solidification
- Mechanical Properties of Metals
- Binary Alloys, Cooling Curve
- Construction of Phase Diagrams for Binary Alloys
- Solid Solution System
- Eutectic System
- Peritectic System

Subject: Mechanics of Materials **Theoretical: 3 hrs/wk**
Code: MAE214/1st Semester **Practical:**
Class: 2nd Year **Tutorial: 1 hrs/wk**
Pre-requisite: **Units: 3**

==========

- **Stress analysis**

Direct stress, direct strain, Hooke's Law, Young Modulus, double shear, factor of safety, temperature stresses. Compound bars.

- **Shear force and bending moments diagrams**

Concentrated load only, Distributed load, combined loads, points of contraflexure, inclined load, distributed loads of increasing value.

- **Slope And Deflection**

Direct integration method, Macaulay's method, Mohr's "area-moment" method, Principle of superposition, Energy method, Maxwell's theorem.

- **Shear Stress Distribution**

Distribution of shear stress due to bending, Application to different sections, Vertical and horizontal shear, Limitation of shear stress distribution theory

- **Bending, Simple bending theory**

Bending of composite, combined loading, Shear stresses owing to bending, Strain energy in bending, Built-in beam carrying different load conditions, Advantages and disadvantages of built-in beams.

Subject: Thermodynamics **Theoretical: 2 hrs/wk**
Code: MAE215/1st Semester **Practical:**
Class: 2nd Year **Tutorial:**
Pre-requisite: None **Units: 2**

==========

- **Introduction and Basic Concepts**

Thermodynamics and Energy, Systems and Control Volumes, State and Equilibrium, Processes and Cycles, The Steady-Flow Process, Zeroth Law of Thermodynamics, Variation of Pressure with Depth, Pressure Measurement Devices

Energy Conversion and General Energy Analysis

Forms of Energy, Types of Energy, Mechanical Forms of Work, The First Law of Thermodynamics, Energy Balance, Energy Change of a System, ΔE system,

Phases of a Pure Substance

Phase-Change Processes of Pure Substances, Saturated Liquid and Vapor, Property Diagrams, The T-s Diagram, The P-v Diagram, Enthalpy, Mixture, The Ideal-Gas Equation of State.

Energy Analysis of Closed Systems

Polytropic Process, Energy Balance for Closed Systems, Specific Heat Relations of Ideal Gases, Internal Energy, Enthalpy, and Specific Heat, **The Second Law of Thermodynamics**

Thermal Energy Reservoirs, Heat Engines, Thermal Efficiency, The Second Law of Thermodynamics: Kelvin–Planck Statement, Refrigerators and Heat Pumps, Heat Pumps, Cycles.

Entropy

Entropy, Internally Reversible Processes, Entropy Change, The Entropy Change of Ideal Gases, Multistage Compression with Intercooling.

Subject: Introduction to Computer Programming | **Theoretical: 2 hrs/wk**
Code: MAE216/1st Semester | **Practical: 2 hrs/wk**
Class: 2nd Year | **Tutorial: -**
Pre-requisite: None | **Units: 3**

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* **Introduction:** General introduction, basic features, A quick presentation on MATLAB, Getting started, Mathematical functions.
* **Blotting:** Basic plotting, Stair graph, Histogram graph, Rose graph, Pareto graph, Area graph, Pie chart, 3D graph, Animating plot.
* **Loops and controlling command:** Introduction, Loops, Controlling command.
* **Matrix:** Entering a vector, Entering a matrix, Matrix indexing, colon operator, linear spacing, colon operator in a matrix, creating a sub matrix, deleting row or column, dimension, continuation, Transposing a matrix, Concatenating matrices, matrix generators, Special matrices, matrix inverse, matrix functions.

Subject: Mechanical Drawing I | **Theoretical: 1 hr/wk**
Code: MAE217/1st Semester | **Practical: 2 hrs/wk**
Class: 2nd Year | **Tutorial: ---**
Pre-requisite: None | **Units: 2**

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- Dimensions
- Drawing without tools
- Screw and Nuts
- Rivets and welding
- Columns, pulleys, bearings

Subject: Human Rights and Democracy Concepts **Theoretical: 2 hrs/wk**
Code: U218/1st Semester **Practical: ---**
Class: 2nd Year **Tutorial: ---**
Pre-requisite: **Units: 2**

==========

- Fundamental of freedom
- Intellectual freedom and cultural
- Freedom of politics, Economic and Social freedom
- The future of public freedoms.
- Universal Declaration of Human Rights and Freedoms
- Freedom in Islam
  - A brief explanation of the types of democracy.
  - Democracy and the entrance to it.
  - Applications of democracy.
  - Administrative and financial corruption
  - Democracy in Islam

2nd Year/2nd Semester

Subject: Applied Mathematics II **Theoretical: 2 hrs/wk**
Code: E221/ 2nd Semester **Practical: ---**
Class: 2nd Year **Tutorial: 2 hrs/wk**
Pre-requisite: Applied Mathematics (I) **Units: 2**

==========

- **Ordinary differential equations**

multi variable functions, homogenous and non-homogenous, solution of first order and Second order equations, D-operator method, linear O.D.E. with constant coefficients Non-Homogenous, undetermined coefficients, methods of variation of parameters,

- **Laplace transform**

applications in matters of Mechanical Engineering, Gamma Function, theories, Laplace Inverse, Partial Fractions, The Unit step Function, double and multiple integral, Green theorem and Line Integral.

- **Infinite series and sequences**

Taylor polynomials, sequences, series and convergence, the integral test and p-series, comparison of series, Alternating Series, The ratio and Root Tests, power Series, representation of functions by power series, Taylor and Maclaurin Series.

Subject: Chemical Metallurgy | **Theoretical: 2 hrs/wk**
Code: MAE222/2nd Semester | **Practical:**
Class: 2nd Year | **Tutorial:**
Pre-requisite: Metallurgical Thermodynamics | **Units: 2**

- Introduction to Reaction kinetics, Homogeneous reaction, Rate Reaction, Rate-Controlling Step, Order of Reaction (First-order , Second-Order), Reversible reaction, Heterogeneous Reactions in metallurgical system), Rate Equation, Types of Reactions, Heat and Mass Transfer (Conduction, Convection and Radiation), Mass Transport in Heterogeneous Reactions, Diffusions (Diffusion in the solid state), Kirkendall Effect
- Introduction to Electrochemistry or Electrometallurgy, Electrolytes (Classification of Electrolytes) and Electrodes, Conduction in electrolytes, Example of Electrolysis, Arrhenius Concept (Ionic Mobilities), Reduction and oxidation potentials: the standard potentials, Cell Types, Cell Design Optimization, Cell Operation , The effects of polarization :decomposition voltage discharge potential, Electrowinning , Electrorefining.
- Introduction to Interfacial Phenomena, Surface energy, Surface tension, Interfacial energy of the other gas/liquid interface:the three phase interface.
- Adsorabtion, Adsorption Process, Adsorbent Material, Adsorption Isotherms, Langmuir , Adsorption Isotherm, Freundlich, Adsorption Potential.
- Nucleation, Classical nucleation theory, Homogeneous nucleation, Heterogeneous nucleation, The spinodal region, Experiments on the nucleation of crystals.
- Evaporation, Transpiration, Sublimation, Energy Balance Method, Aerodynamic method, Combined method.

Subject: Engineering Metallurgy **Theoretical: 2 hrs/wk**
Code: MAE223/2nd Semester **Practical:**
Class: 2nd Year **Tutorial:**
Pre-requisite: Physical Metallurgy **Units: 2**

==========

- Iron-Carbon System
- Classifications and Applications of Steel
- Effect of Carbon Percentage on Microstructure and Mechanical Properties of Steel
- Types of Alloy Steel
- Types of Cast Iron
- Non-Ferrous Metals: Copper and its Alloys, Aluminum and its Alloys

Subject: Strength of Materials **Theoretical: 3 hrs/wk**
Code: MAE224/2nd Semester **Practical:**
Class: 2nd Year **Tutorial: 1 hrs/wk**
Pre-requisite: Mechanics of Materials **Units: 3**

==========

- **Torsion**

Torsion theory, Polar second moment of area, Shear stress and shear strain in shafts, , Torsional rigidity, hollow shafts, thin-walled tubes, Composite shafts connections , Strain energy in torsion, Power transmitted by shafts, Combined stress systems

.

- **Thin Cylinders and Shells**

Internal pressure, stresses, Thin rotating ring and spherical shell, pressure Vessels, Cylindrical vessel with hemispherical end, Effects of end plates and joints.

- **Thick cylinders**

Longitudinal stress, Maximum shear stress, Compound cylinders, Shrinkage or interference allowance, Compound cylinder -different materials, Thick cylinder - internal pressure only, Comparison with thin cylinder theory

- **Complex Stresses**

Stresses on oblique planes, Material subjected to pure shear, two mutually perpendicular direct stresses, combined stresses, Graphical solution - Mohr 's stress circle, Three-dimensional stresses -graphical representation

Subject: Fluid Mechanics **Theoretical: 2 hrs/wk**
Code: MAE225/2nd Semester **Practical:**
Class: 2nd Year **Tutorial:**
Pre-requisite: None **Units: 2**

==========

- **Thermal and Physical properties**

shear stress, velocity and flow rate, , density &specific heat, viscosity, kinematic viscosity, surface tension, compressibility,

- **Pressure and velocity distributions**

Pascal law, pressure head, manometers, piezometer, differential Manometer, inverted manometer, barometer, Bourdon Gauge, forces on immersed curved surfaces, equilibrium of flotation surfaces, pressure distribution,

- **Flow of Fluids**

gas and liquid, ideal gas, gas mixture, enthalpy and entropy, phase transformation, constant temp. process, constant pressure process, isochoric process, adiabatic process, isotropic process, polytrophic process, control volume, Bernoulli equation, momentum and flow rate, Euler equation.

- **Non-dimensional Analysis**

Flow in pipes, dimensional Analysis, laminar and turbulent flow, Rynold's number, boundary layers, pressure drop, friction losses, velocity distributions.

Subject: Computer Programming **Theoretical: 2 hrs/wk**
Code: MAE226/2nd Semester **Practical: 2 hrs/wk**
Class: 2nd Year **Tutorial: ---**
Pre-requisite: Introduction to Computer Programming **Units: 3**

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*** Programming of linear equation:** Array operations, Solving linear equations.
* **Programming in MATLAB:** Introduction, M-File scripts, M-File functions, Anatomy of a M-File function, Input and output arguments, Output commands.
*** Debugging M-File:** Introduction, Debugging process
*** GUI (Graphical User Interface):** Introduction, Getting started, How to create GUIs with MATLAB.

Subject: Mechanical Drawing (II) **Theoretical: 1 hr./wk.**
Code: MAE227/2nd Semester **Practical: 2 hrs/wk**
Class: 2nd Year **Tutorial:-**
Pre-requisite: Mechanical Drawing (I) **Units: 2**

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- Gears and Pipelines
- Lifting devices and mechanical connections
- Clearance & Tolerances
- Operating codes
- Assembly of Mechanical Elements

3rd Year/1st Semester

Subject: Engineering Analysis **Theoretical: 2 hr/wk**
Code: E311/1st Semester **Practical: 2 hr/wk**
Class: 3rd Year **Tutorial: 2 hr/wk**
Pre-requisite: None **Units: 3**

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Complex variables

Complex number and variable operations, derivative and analytic functions, Cauchy remann equation, geometry of analytic function.

Complex integration

Line integral in the complex plane, cauchy's integral theoreom, cauchy's integral formula, derivatives of analytic functions.

Fourier series

Periodic functions, fourier series, even and odd functions, half range expansion, complex fourier series, fourier integral, fourier cosine and sine transforms, fourier transform.

Partial Differential Equations

Basic concept, modeling vibrating string, wave equation, heat equation, separation of variables, D'Alembert solution of the wave equation, modeling of membrane 2D wave equation, rectangular membrane , Laplacian in polar coordinate, solution by laplace transform.

Subject: Behaviors of Engineering Materials **Theoretical: 3 hrs/wk**
Code: MAE312/1st Semester **Practical: ---**
Class: 3rd Year **Tutorial: ---**
Pre-requisite: None **Units: 3**

==========

- Introduction: The engineering requirements in materials
- The mechanical properties of materials
- Magnetic properties.
- Optical properties, thermal and electrical properties

Subject: Heat Treatments of Ferrous Metals **Theoretical: 2 hrs/wk**
Code: MAE313/1st Semester **Practical:**
Class: 3rd Year **Tutorial: 1 hr./wk**
Pre-requisite: None **Units: 2**

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Carbon Steel

Annealing, cementite spheroidizing, normalizing, the hardening treatment by continuous cooling, isothermal transformation, aging of hardened steel, tempering, hardenability, sub-zero treatment, surface hardening.

Cast Iron

heat treatments of grey cast iron, stress relief, heat treatments for while cast iron, heat treatments for ductile cast iron.

Alloy steels

Heat treatments for steel containing Nickel, Heat treatments for steel containing Chromium, Heat treatments for steel containing Chromium and Nickel. Heat treatments for steel containing molybdenum, vanadium, manganese, tungsten, cobalt, Heat treatments for high speed steel.

Heat treatments for rolled steel

Heat treatments for, cold drawn rolled steel, hot drawn rolled steel, wires, steel casting, forging, spring, gears, cutting tools, steel drills, screw tap tools, surfaces of high speed cutting tools, measuring instruments, drop forging and metal casting dies.

Subject: Engineering Materials Technology **Theoretical: 2 hrs/wk**
Code: MAE314/1st Semester **Practical:**
Class: 3rd Year **Tutorial: 1 hrs/wk**
Pre-requisite: None **Units: 2**

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Introduction of Engineering Materials Technology

Materials Technology, Manufacturing Technology, Classification of Basic Manufacturing, Classification of Materials according to their bonding types, Classification of Manufacturing Methods

Furnaces

Types of Furnaces, Heat losses from the furnace during the melting, Standing gas or oil fired furnace, Tilting Furnace, Electric Furnaces, Arc Furnace , Induction Furnace, Calculation Furnace Performance

Casting

Basic Component of Casting, Advantages and Disadvantages of Casting Methods, Metal Casting Design, Casting Methods, Continuous Casting.

Forming Technology

Classification, Massive forming, Pressing, Extrusion, Open die forging, Swaging, Sheet metals forming, Deep drawing, Separating, Pulse magnetic forming, Classification, Supporting types, Pulse magnetic forming, Type, Electroforming

Coating Technology

Field of application, Classification of coating, Electrochemical coating, Cathode coating, Lacquer coating, Powder coating, Enamel coating, Hot dipping

Subject: Ceramics Materials **Theoretical: 2 hrs/wk**
Code: MAE315/1st Semester **Practical:**
Class: 3rd Year **Tutorial:**
Pre-requisite: None **Units: 2**

- Introduction to Ceramics
- Elementary Crystallography
- Ceramic Microstructures
- Traditional vs. Advanced Ceramics
- Sintering and Microstructure of Ceramics
- Thermodynamics of Sintering
- Experimental Aspects of Sintering
- Solid Phase Sintering
- Sintering with Liquid Phase
- Sintering Additives, Pressure Sintering
- Alumina Ceramics
- Zirconia, Ceramic Steel

Subject: Corrosion (I) **Theoretical: 2 hrs/wk**
Code: MAE316/1st Semester **Practical:**
Class: 3rd Year **Tutorial: 1 hrs/wk**
Pre-requisite: None **Units: 2**

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- The technology & evaluation of corrosion: Economics, safety, electrochemical nature of corrosion, the forms of corrosion and corrosion rate determination.
- Electrochemical thermodynamics and electrode potential: Electrode sign conventions, potential/pH diagrams, and experimental measurements.
- Electrochemical kinetics of corrosion: Faraday's Law, mixed potential theory, experimental methods, and instrumentation.
- Passivity and properties of passive films on metals: Alloy evaluation and experimental methods.
- Polarization methods for measuring corrosion rates: Tafel extrapolation & polarization resistance, instrumental methods and commercial corrosion monitoring devices.
- Galvanic, concentration cell, pitting and crevice corrosion: How to characterize the different forms of corrosion, their evaluation and prevention methods.

Subject: Conduction Heat Transfer **Theoretical: 2 hrs/wk**
Code: MAE317/1st Semester **Practical:**
Class: 3rd Year **Tutorial: 1 hrs/wk**
Pre-requisite: None **Units: 2**

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Introduction

Conduction, convection, radiation, relation with thermodynamic, units and dimensions.

Heat conduction

Initial and boundary conditions, diffusion equation. plane wall, composite wall, insulation systems, thermal and contact resistance, radial systems, the sphere, extended surface, determination of heat transfer rate, the energy balance method, finite difference solutions.

Transient heat conduction,

Lumped capacitance method, 1D system with convective surface conditions, discretization of the heat equation, energy balance method.

3rd Year/2nd Semester

Subject: Numerical Analysis — **Theoretical: 2 hrs/wk**
Code: E321/2nd Semester — **Practical: 2 hrs/wk**
Class: 3rd Year — **Tutorial: 1 hrs/wk**
Pre-requisite: None — **Units: 3**

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Roots of equations
introduction, bisection, Newton's Raphson, modified Newton's method, The secant Method, root solving as inverse interpolation

Interpolation and extrapolation
Gregory Newton interpolation, central differences, nonequally spaced data , Lagrange Polynomials, cubic spline functions, extrapolation.

Finite Difference calculus
Forward and backward Differences, higher order expressions, central differences, differences and polynomials.

Solution of algebraic equations,
Gauss and Gauss-Jordan Elimination, Gauss siedel iteration

Curve fitting,
Least squares curve fitting of discrete points, the approximation of continuous function.

Numerical Integral
Trapezoidal rule, Simpson's rule, Gauss Quadrature, dealing with singularities.

Solution of ordinary and partial differential equations
General initial value problem, euler method, truncation error, convergence and stability, runge-kutta type formulas, predictor-corrector methods, the solution of sets of simultaneous first order differential equations.

Subject: Failure of Engineering Materials — **Theoretical: 3 hrs/wk**
Code: MAE322/2nd semester — **Practical: ---**
Class: 3rd Year — **Tutorial: ---**
Pre-requisite: ---- — **Units: 3**

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- Basics of fracture toughness
- Distorsion and failure of metals
- Wear and Tear
- Strengthening mechanisms
- Destructive Test of Materials

Subject: Heat Treatments of Non-Ferrous Metals **Theoretical: 2 hrs/wk**
Code: MAE323/2nd Semester **Practical:**
Class: 3rd Year **Tutorial: 1 hr/wk**
Pre-requisite: Heat Treatments of Ferrous Materials **Units: 2**

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Heat treatments for Non-ferrous Metal and Alloys

Heat treatments for, pure copper, copper zinc alloys, copper-tin alloys, copper-Aluminum alloys, single and two phase Cu-Al Alloys, copper-Berylium Alloys, copper-nickel-silicon Alloys, copper-nickel –manganese Alloys, zinc and its Alloys, pure zinc, Titanium and its Alloys, Aluminum and its Alloys, Magnesium and its Alloys.

Subject: Welding and Cutting **Theoretical: 2 hrs/wk**
Code: MAE324/2nd Semester **Practical:**
Class: 3rd Year **Tutorial: 1 hr/wk**
Pre-requisite: None **Units: 2**

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Welding

Weldability effecting factors, Physical and chemical properties of welding, Classification of welding process, Condition for obtaining satisfactory welds, Welding quality and performance, Selection of welding process and filler metal, Type of Arc Welding, High Frequency Resistance Welding, Solid Phase Welding, Ultrasonic Welding, Explosive Welding, High Energy Density Welding Process, Laser Beam Welding, Electron Beam Welding, Calculation of welding Parameters,

Primary Shaping

Definition, Classification, Castable Materials, Casting Process of Metals

Cutting Tool Materials

Classification, Cemented Carbide High Speed Steel, High Carbon Steel, Cast Nonferrous Alloy, Diamond, Ceramic, Cermets, Cutting Tool Geometry, Wear and Tool Life, Coolants

Cutting with geometrically defined cutting edges

Classification, Definition, Process and requirements, Distribution of temperatures , Types and requirements, Types of clamping , Hybrid Turning Machine , Drilling Process, Milling, Tapping , Advantages and disadvantages, Broaching, Shapers, Planers.

Cutting with geometrically undefined cutting edges

Classification, Grinding, Types of Abrasives, wear, Advantages and Disadvantages of Honing, Lapping, Double Wheel Grinding .

Non-Conventional Cutting Technology

Classification, Chemical removal, Types, Etching, Thermal removal, Classification, Electrical Discharges Machining EDM, Material removal mechanism Surface

formation, Wire EDM, Manufacturing system of wire EDM, Laser machining, Types, Laser mechanism , Laser source, Electrochemical removal.

Subject: Polymers Engineering **Theoretical: 2 hrs/wk**
Code: MAE325/2nd Semester **Practical:**
Class: 3rd Year **Tutorial: -**
Pre-requisite:--- **Units: 2**

- Introduction to polymer science: Chain conformations in polymers, Rubber elasticity Polymer solutions, Amorphous state and glass transition Crystalline state
- Molecular structure of polymers
- Polymer chain flexibility
- Molecular motion and Glass
- Rubber transition temperature
- Free volume theory & Tg Crystallization
- Mechanical tests
- Elastic Modulus
- Creep and Stress relaxation
- Polymer viscoelasticity and modeling
- Superposition principle and WLF equations
- Tensile properties
- Stress concentration and fracture Hardness, Impact resistance, HDT and VICAT tests Dynamic Mechanical Properties

Subject: Corrosion (II) **Theoretical: 2hrs/wk**
Code: MAE326/2nd Semester **Practical:**
Class: 3rd Year **Tutorial: 1 hrs/wk**
Pre-requisite: Corrosion (I) **Units: 2**

- Effects of metallurgical structure on corrosion: Intergranular corrosion, weldment corrosion, and susceptibility to hydrogen damage.
- Corrosion in selected corrosive environments: Specific examples of typical corrosion problems encountered in engineering applications:, sulfur bearing solutions, soils, acids, and concrete.
- Coatings & inhibitors: Organic coatings, paints, metallic coatings, inhibitors.
- Materials selection and design: Alloy selection, designing to prevent corrosion, and economics

Subject: Convection Heat Transfer | **Theoretical: 2 hrs/wk**
Code: MAE327/2nd Semester | **Practical:**
Class: 3rd Year | **Tutorial: 1 hrs/wk**
Pre-requisite: Conduction Heat Transfer | **Units: 2**

Convection Heat Transfer
Convection boundary layers, velocity boundary layer, thermal boundary layer, laminar and turbulent flow, convection transfer equations, Renolds, Prandtl and Schmidt numbers.

Heat transfer in pipes,
external flow, empirical correlations, flat plate in parallel flow, mixed boundary layer conditions, cylinder in cross flow, the sphere, flow across banks of tubes, flow conditions, fully developed region, laminar flow in circular tubes, turbulent flow in circular tubes, noncircular tubes.

Free convection
Governing equations, Laminar and turbulent on surface, effects of turbulence, Empirical correlations, rectangular cavities, concentric cylinder, concentric spheres, combined free and forced convection

Heat exchangers, types
overall heat transfer coefficient, heat exchanger analysis, parallel flow type, counter flow type, cross flow type, the effectiveness NTU type.

4th Year/1st Semester

Subject: Composite Materials | **Theoretical: 2 hrs/wk**
Code: MAE413/1st Semester | **Practical: ---**
Class: 4th Year | **Tutorial: 1 hr/wk**
Pre-requisite: None | **Units: 2**

- Introduction to Composites
- Composite Construction
- Properties of Unidirectional
- Long Fiber Composites
- Short Fiber Composites
- Linear Elasticity for Anisotropic Materials, Rotations of Stresses, Strains.
- Failure Criterion
- Laminate Analysis
- Residual Stresses
- Fracture Mechanics of Composites
- Composite Joints
- Metal and Ceramic Matrix Composites
- Applications of Composites

Subject: Non Destructive Testing | **Theoretical: 2 hrs/wk**
Code: MAE412/1st Semester | **Practical:**
Class: 4th Year | **Tutorial: 1 hr/wk**
Pre-requisite: None | **Units: 2**

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Introduction on Nondestructive Testing, Hardness Testing, Liquid Penetrant Testing, Magnetic Particle Testing, Eddy Current Testing, Ultrasonic Testing, X-ray Radiography Testing, γ-ray Radiography Testing, Temperature Testing, Thermocouples, Pyrometers, Quantitative Metallography, Volume Fractions Measurements, Grain Size Measurement, Particle Size Measurement

Subject: Mechanical Design **Theoretical: 2 hrs/wk**
Code: MAE411/1st Semester **Practical: 2 hrs/wk**
Class: 4th Year **Tutorial: ---**
Pre-requisite: None **Units: 3**

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Stress analysis

Strain analysis, Bending, Torsion, pressure vessels

Design for static strength

Theories for ductile materials max. Stress theory, max. Shear stress theory, distortion energy theory, theories for brittle materials, Coulomb –Mohr theory, modified Coulomb –Mohr theory.

Design for fatigue strength

Stress life definitions, the endurance limit, the fatigue strength, endurance limit modifying factors, fluctuating stresses, stress concentration factor, fatigue strength under fluctuating stresses, design for infinite life

Design of springs

Stresses in helical springs, the curvature effect, deflection of helical springs, extension springs, compression springs, spring materials, design of helical spring, critical frequency, fatigue loading, helical torsion springs, leaf spring

Subject: CAD & CAM **Theoretical: 2 hrs/wk**
Code: MAE415/1st Semester **Practical:**
Class: 4th Year **Tutorial: ---**
Pre-requisite: None **Units: 2**

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- Introduction
- Groover and Hughes Model
- The Product Cycle and CAD/CAM
- Automation and CAD/CAM
- Numerical Control
- NC Part Programming
  - Manual Part Programming
  - Computer-Assisted Part Programming
  - Part programming languages
  - The APT Language
    - Geometry statements
    - Motion statements
    - Postprocessor statements
    - Auxiliary statements
  - The Macro-statements in APT

- **CONTROL SYSTEM**
  - Introduction to Control System
  - Mathematical modeling of Control Systems.
  - MATHEMATICAL MODELING OF MECHANICAL
  - MATHEMATICAL MODELING OF FLUID SYSTEMS AND THERMAL SYSTEMS

Subject: Industrial Engineering **Theoretical: 2 hrs/wk**
Code: MAE416/1st Semester **Practical: --**
Class: 4th Year **Tutorial: 1 hr/wk**
Pre-requisite: None **Units: 2**

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Introduction to Industrial Engineering

Decision theory, mathematical models, game theory, linear programming, quality control, Industrial Engineering Jobs, Productivity, Industrial Maintenance, Operations Research, Web Analysis.

Production Management

Theory of substitution and replacement, maintenance and replacement models, international standard specifications(ISO)Analysis of business networks and evaluate projects, control of inventories, allocation problems, relay, balancing production lines

Subject: Powder Metallurgy **Theoretical: 2 hrs/wk**
Code: MAE414/2nd Semester **Practical: ---**
Class: 4th Year **Tutorial: 1 hr/wk**
Pre-requisite: None **Units: 2**

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-Characterization and Testings of Metal Powders
Chemical composition, Particle size and distribution, Particle shape, Specific surface, Apparent density, Flow rate,

Pressing properties: Green density, Green strength, Green spring, **Properties of sintered compacts**: Dimensional change during sintering, Sintered density, Porosity, Mechanical properties of sintered compacts

- Powder Manufacturing
Mechanical Processes: Machining, Crushing, Milling, Shotting, Graining, and Atomization.
Physico-Chemical and Chemical Processes: Condensation method, Thermal decomposition method, Reduction method, Electrodeposition method, Precipitation from aqueous solution, Precipitation from fused salts, Gaseous reduction process, Intergranular corrosion, Oxidation and decarburization .

-Powder Conditioning
Preliminary heat treatment
Blending and mixing

- Powder Compaction.
Pressureless shaping technique
Cold pressure shaping technique
Pressure shaping technique with heat: Hot Pressing, Sinter forging, Hot rolling, Hot – Isostatic compaction, Spark sintering, Hot coining

- Sintering
Stages of sintering, Mechanisms of sintering, Liquid phase sintering, Infiltration, Sintering atmosphere

- Applications
Bearing materials, Friction materials, Tool materials, Ferrites, Cermets

Subject: Engineering Project **Theoretical: 1 hr/wk**
Code: E407/Yearly **Practical: 2**
Class: 4th Year **Tutorial: ---**
Pre-requisite: None **Units: 2**

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This is an independent study under the supervision of department members. Each student is expected to do research trying to explore and define a potential study area suitable for a senior design project. A specific engineering problem must then be identified from within the selected study area. Results from this study must be documented and submitted in the form of a design project proposal.

*** Engineering Ethics: 1hr/wk**

Course Objectives: Prepare students to understand the foundation of classical moral theory and decision making in the context of science and engineering applications. Help students to recognize and evaluate ethical challenges that they will face in their academic and professional careers through knowledge and exercises that deeply challenge their decision-making processes and ethics. Assist students in improving their effective communications and presentation skills.

1- Introduction: Background Ideas , Why Study Engineering Ethics?, Engineering Is Managing the Unknown , Personal vs. Professional Ethics , The Origins of Ethical Thought , Ethics and the Law , Ethics Problems Are Like Design Problems , Case Studies ,Summary.

2- Professionalism and Codes of Ethics: Introduction, Is Engineering a Profession? Codes of Ethics.

3- Understanding Ethical Problems: Introduction , A Brief History of Ethical Thought , Ethical Theories non-Western Ethical Thinking.

4- Ethical Problem-Solving Techniques: Introduction, Analysis of Issues in Ethical Problems , Line Drawing , Flow Charting , Conflict Problems, An Application of Problem-Solving Methods: Bribery/Acceptance of Gifts.

5- Risk, Safety, and Accidents: Introduction, Safety and Risk, Accidents.

4th Year/2nd Semester

Subject: Selection of engineering materials for Design

Code: MAE421/2nd Semester
Class: 4th Year
Pre-requisite: None

Theoretical: 2 hrs/wk
Practical:
Tutorial: 1 hr/wk
Units: 2

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- The relationship between material selection & materials processing.
- Economic Consideration in Materials Selection
- Selection of materials to resist Elastic failure
- Case Study : Hip Replacement process
- Case Study : Valve Spring of Internal Combustion Engine .
- Case Study : Materials for Bearings.
- Case Study : Failure analysis of Automobile axle

Subject: Stresses Analysis and Plasticity
Code: MAE424/2nd Semester
Class: 4th Year
Pre-requisite: None

Theoretical: 2 hrs/wk
Practical: ---
Tutorial: 1 hr/wk
Units: 2

Stress and Strain

Definitions, safety factor, design of axial loaded members and pins, Hock's Law, stress strain diagram, deflection of axially lorded rods, shearing stress on mutually perpendicular planes, stress concentration, solid noncircular members, shaft couplings, bending.

Practical Stresses Analysis

Three dimensional stress state, plane deformation, design of member by strength criteria

Fracture mechanics

Types of fractures, stress intensity factor, fracture toughness, crack propagation, J-Integral to find stress intensity factor, Extrapolation Methods

Theory of plasticity

Diagnostic Tests, Tests Performed at Long and Short Term Intervals, Temperature & Hydrostatic Pressure Influence, Variation of Elastic Parameters with Plastic Strain

Analysis of Plastics

The Classical Constitutive Equation for Perfectly Plastic Materials, Work-Hardening Materials, Isotropic Hardening, The Universal Stress Strain Curve, Constitutive Equation, The Drucker's Postulate, Kinematical Work-Hardening,Viscoplasticity Rate Type.

Stress and plasticity relations for elasticity cases

Plasticity of Metals and Life Prediction in the Range of Low-Cycle Fatigue, Experimental details for room and high temperature test, Deformation Behaviors, Macroscopic test results, Microstructural results and interpretation, Description of cyclic hardening curve, cyclic stress-strain curve and hysteresis-loop

Subject: X-Ray Diffraction and Microscopy **Theoretical: 2 hrs/wk**
Code: MAE422/2nd Semester **Practical: ---**
Class: 4th Year **Tutorial: 1 HR/WK**
Pre-requisite: None **Units: 2**

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Introduction , X-ray Production, Interference and Diffraction, Braggs Law, Continuous X-ray , Characteristic X-ray , X-ray Absorption & Filtration , Monochromatic X-ray , Diffraction Methods, Laue Method, Rotating Crystal Method, Powder Method, Diffractometer, Spectrometer , Transmission Electron Microscope (TEM) , Sample Preparation , Lens Defects , Resolving power, Depth of field, Depth of focus , TEM Construction , TEM Application, Scanning Electron Microscope (SEM) ,SEM Construction , SEM Applications.

University of Basrah
College of Engineering
Department of Materials Engineering

Subject: Advance Materials **Theoretical: 2 hrs/wk**
Code: MAE423/2nd Semester **Practical: -----**
Class: 4th Year **Tutorial: 1 hr/wk**
Pre-requisite: **Units: 2**

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-Biomaterials

Requirements for Biomaterials
Dental Materials : Cavity Fillers , Bridges, Crowns and Dentures, Dental Implants
The Structure of Bone and Bone Fractures
Replacement Joints : Hip Joints , Shoulder Joints, Knee Joints , Finger Joints and Hand Surgery
Reconstructive Surgery : Plastic Surgery, Maxillofacial Surgery , Ear Implants
Biomaterials for Heart Repair : Heart Valves, Pacemakers, Artificial Arteries
Tissue Repair and Growth
Other Surgical Applications
Ophthalmics
Drug Delivery Systems

-Electronic Materials

Ohm's Law and Electrical Conductivity
Band Structures of Solids
Conductivity of Metals and Alloys
Superconductivity
Conductivity in Other Materials
Semiconductors
Applications of Semiconductors
Insulators and Dielectric Properties
Polarization in Dielectrics
Electrostriction, Piezoelectricity, Pyroelectricity, and Ferroelectricity

-Magnetic Materials

Classification of Magnetic Materials
Magnetic Dipoles and Magnetic Moments
Magnetization, Permeability, and the Magnetic Field
Diamagnetic, Paramagnetic, Ferromagnetic, Ferrimagnetic, and Superparamagnetic Materials
Domain Structure and the Hysteresis Loop
The Curie Temperature
Applications of Magnetic Materials
Metallic and Ceramic Magnetic Materials

-Photonic Materials

The Electromagnetic Spectrum

Refraction, Reflection, Absorption, and Transmission
Selective Absorption, Transmission, or Reflection
Examples and Use of Emission Phenomena
Fiber Optic Communication System

Subject: Nano Materials **Theoretical: 2 hrs/wk**
Code: MAE425/2nd Semester **Practical:**
Class: 4th Year **Tutorial: ---**
Pre-requisite: - **Units: 2**

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1. Introduction the nanomaterial

2 Morphology of Nanomaterials
2.1. Zero dimensional nanostructures: nanoparticles
2.2. One-dimensional nanostructures: nanowires and nanorods
2.3. Two-dimensional nanostructures: thin films

3. Special nanomaterials
   3.1 Carbon fullerenes and nanotubes. Micro and mesoporous materials. Core-shell structures.
   3.2 Organic-inorganic hybrids. Intercalation compounds.
   3.3 Nanocomposites and nanograined materials. Inverse opals. Bio-induced nanomaterials.
4. Nanostructures fabricated

   4.1 Top-down approaches
   4.2 Bottom-up approaches
5. Characterization techniques for nanomaterials
   5.1 Structural characterization. Chemical characterization.
   5.2 Physical properties of nanomaterials
6. Applications of nanomaterials

Subject: Project Management **Theoretical: 2 hrs/wk**
Code: MAE426/2nd Semester **Practical: 2 hrs/wk**
Class: 4th Year **Tutorial: 2 hrs/wk**
Pre-requisite: None **Units: 3**

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Project Characteristics and Project Environment

setting Goals, The Project Manager, Risk Management, Management Styles, establishing Project Plants, Planning methods including Bar Charting, CPM and PERT, Project Organization including Functional, Project, and Matrix Structures, Conflict and Negotiation.

Financing Project

Project Budgeting and cost Estimation, Expediting Projects, Resources Loading and Resource Leveling, Project Control, Project Evaluation and Project Termination, Project Management Applications

Subject: Engineering Project **Theoretical: 1 hrs/wk**
Code: E407 Yearly **Practical: 2 hr/wk**
Class: 4th Year **Tutorial: ---**
Pre-requisite: **Units: 2**

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Summary Table

No	Class	Study Hours			No. of Units		
		First Semester	Second Semester	Total	First Semester	Second Semester	Total
1	First Year	28	28	56	20	20	40
2	Second Year	26	24	50	20	18	38
3	Third Year	26	25	51	18	18	36
4	Fourth Year	24	26	50	17	17	34
Total		104	103	207	75	73	148