**University**: Benha University

**Faculty**: Faculty of Engineering at Shoubra

**Department offering the program**: Mechanical Engineering Department

**Department offering the course**: Mechanical Engineering Department

**1- Course Data (Basic Information)**

**Course Code:** MDP132 **Course Title:** Engineering Materials & metallurgy

**Semester/ Academic year:** First semester / 2020-2021

**Prerequisite Course(s):** None

**Credit Hours:** 3 **Weekly Contact Hours**: **Lecture:** 2 **Tutorial:** 2 **Laboratory:** 0

**2- Course Aims**

The aim of this course is to provide the students with the basic knowledge and skills of the fundamentals of materials science and engineering. In addition to understand the relationship between the structure, processing, and properties of metals. Moreover, identify the types of phase diagrams, diffusion mechanisms, and heat-treatments cycles.

**3- Course Contents** (As indicated in the program Bylaw)

Introduction to the types/classifications of the engineering materials: metals, polymers, ceramics, composite, electronic and biomaterials. Crystal structure, crystalline and amorphous materials, crystal systems, atomic packing factor, polymorphism, crystallographic directions and planes, X-ray diffraction. Metallography, types of microscopes. Binary solutions, types of solid solutions, Hume–Rothery rule. Phase diagrams: Cu-Zn, Ag-Sn, Fe-C. Basics of heat-treatments: annealing, normalizing, quenching, aus-tempering, and case hardening. Deformation of metals: dislocation, twinning, yielding and defects. Diffusion mechanisms: steady-state and non-steady-state, carburizing.

**4- Program Competencies Served by The Course (A1, A2 and B1)**

**Level (A) Engineering Competencies**

**A1.** Identify, formulate, and solve complex engineering problems related to metallurgy.

**A.2** Develop and conduct appropriate experimentation and/or simulation, analyze and interpret data, assess and evaluate findings, and use statistical analyses and objective engineering judgment to draw conclusions.

**Level (B) Mechanical Engineering Competencies**

**B.1** Model, analyze and design physical systems applicable to the specific discipline by applying the concepts of Thermodynamics, Heat Transfer, solid mechanics, Material Processing, Material Properties, and heat-treatment cycles Design

**5- Learning Outcomes (LO’s)**

*At the end of this course, the student will be able to:*

|  |  |
| --- | --- |
| Cognitive Domain | |
| #1 | Recognize engineering materials classifications, crystal systems, directions, and planes. |
| #2 | Construct tie arm rule to calculate the weight percentage of phases present in a solid solution. |
|  |  |
| Psychomotor Domain | |
| #3 | Select the proper heat-treatment cycle of carbon-steels to meet the customer needs. |
| #4 | Design the diffusion time and temperature to control the thickness of a carburized layer. |
|  |  |
| Affective Domain | |
| #5 | Discuss the solid solution formability by Hume–Rothery criterion. |
|  |  |

**6- Mapping Learning Outcomes (LO’s) with Competencies**

|  |  |  |  |
| --- | --- | --- | --- |
| **LO’s NARS** | **A1** | **A2** | **B1** |
| Cognitive Domain | | | |
| #1 | ◼ |  |  |
| #2 | ◼ |  |  |
|  |  |  |  |
| Psychomotor Domain | | | |
| #3 |  | ◼ | ◼ |
| #4 |  |  | ◼ |
|  |  |  |  |
| Affective Domain | | | |
| #5 |  | ◼ |  |
|  |  |  |  |

**7- Lecture Plan**

1. Topics to be Covered weekly & Matrix of LO’s

| Week | Topics | Planned Hours | Learning Outcomes | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| #1 | #2 | #3 | #4 | #5 |  |  |  |
| W1 | - Introduction to engineering materials. | **2** | ◼ |  |  |  |  |  |  |  |
| W2 | - Crystal structure (cubic, hexagonal) | **4** | ◼ |  |  |  |  |  |  |  |
| W3 | - Crystal structure (directions, planes, APC, density) | **4** | ◼ |  |  |  |  |  |  |  |
| W4 | -Materials characterization using X-ray diffraction | **4** | ◼ |  |  |  |  |  |  |  |
| W5 | - Solid Solutions | **4** |  |  |  |  | ◼ |  |  |  |
| W6 | - phase diagram (Cu-Ni, Ag-Sn) | **4** |  |  |  |  |  |  |  |  |
| W7 | - phase diagram (Pb-Sn, Fe-C) | **4** |  | ◼ |  |  |  |  |  |  |
| W8 | - phase diagram (Fe-C) | **4** |  | ◼ |  |  |  |  |  |  |
| W9 | - Deformation of metals | **4** | ◼ |  |  |  |  |  |  |  |
| W10 | - Heat treatment of carbon steels (annealing, normalizing, quenching) | **4** |  |  | ◼ |  |  |  |  |  |
| W11 | - Heat treatment of carbon steels (tempering, | **4** |  |  | ◼ |  |  |  |  |  |
| W12 | - Diffusion (steady-state) | **4** |  |  |  | ◼ |  |  |  |  |
| W13 | - Diffusion (non-steady-state) | **4** |  |  |  | ◼ |  |  |  |  |
| W14 | - Non-ferrous metals | **4** | ◼ |  |  |  |  |  |  |  |

1. Additional private study/learning hours expected for students per week is FOUR hours

**8) Teaching and Learning Methods**

| **Learning Outcomes** | | **Teaching and Learning Methods** | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Face-to-face Lecture | Online Lectures | Tutorial / Exercise | Group Discussions | Laboratory | Site Visit | Presentation | Collaborate Learning (Team Project) | Research and Reporting | Brain Storming |
| **Cognitive Domain** | #1 | ⚫ | ⚫ | ⚫ |  |  |  |  |  |  | ⚫ |
| #2 | ⚫ |  | ⚫ | ⚫ |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
| **Psychomotor Domain** | #3 |  | ⚫ | ⚫ |  |  |  |  |  |  |  |
| #4 | ⚫ |  | ⚫ | ⚫ |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
| **Affective Domain** | #5 |  | ⚫ | ⚫ |  |  |  |  |  |  | ⚫ |
|  |  |  |  |  |  |  |  |  |  |  |

**Student Academic Counseling and Support**

* Students are directed to contact teaching staff for academic support during specific office hours.
* Regarding this course, Instructor and TA will be available two hours a week as indicated on the time table declared for students from the beginning of the semester.

**9- Student Assessment**

**a) Student Assessment Methods**

| **Learning Outcomes** | | **Assessment Methods** | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Written Exams | Online Exams | Oral Exam | Pop Quizzes | In-class Problem Solving | Take-Home Exam | Research Assignments | Reporting Assignments | Project Assignments | In-class Questions |
| **Cognitive Domain** | #1 | ⚫ |  | ⚫ |  |  |  |  |  |  | ⚫ |
| #2 | ⚫ |  |  | ⚫ |  |  |  |  |  | ⚫ |
|  |  |  |  |  |  |  |  |  |  |  |
| **Psychomotor Domain** | #3 | ⚫ |  | ⚫ |  | ⚫ |  |  |  |  |  |
| #4 | ⚫ |  | ⚫ |  |  |  |  |  | ⚫ |  |
|  |  |  |  |  |  |  |  |  |  |  |
| **Affective Domain** | #5 | ⚫ |  | ⚫ |  |  |  |  |  |  | ⚫ |
|  |  |  |  |  |  |  |  |  |  |  |

**b- Assessment Schedule and Weight**

|  |  |  |
| --- | --- | --- |
| **Assessment Tools** | **Week** | **Weight** |
| Midterm Examination | 7 | 20 % |
| Second Midterm Examination | - | - |
| Final Examination | (As Scheduled) | 60 % |
| Quizzes | - | - |
| Home assignments | - | - |
| Oral Exam | 14 | 20 % |
| **Total** |  | **100** % |

**10- Facilities**

The following facilities are needed for this course:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ■ | Classroom | □ | Smart Board | □ | Computer with software |
| □ | Lecture Hall | ■ | White Board | ■ | MIS system |
| □ | Sound and Microphone | ■ | Data Show | ■ | Internet Access |
| □ | Other: ………………… |  |  |  |  |

**11- List of References**

**a- Course Notes**

Lectures Notes in PDF

<https://bu.edu.eg/staff/mahmoud.abdellattif-courses/18364/files>

**b- Books**

1. William D. Callister, David G. Rethwisch “Materials Science and Engineering (An Introduction)”, 10th edition, John Wiley & Sons Ltd., 2018.
2. William F. Smith and Javad Hashemi, "Foundations of Materials Science and Engineering", McGraw Hill, 6th Edition, 2021.

**c- Recommended Books**

1. Donald R. Askeland and Pradeep P. Phule “The Science and Engineering of Materials” International Student Edition, 2006, Thomson Canada Limited.

**- Course Coordinator: Prof. Tarek Khalifa,** **Prof. Fouad Helmy, Dr. Mahmoud Khedr Signature:**

**- Program Coordinator: Prof. Ramadan Sakr Signature:**