**University**: Benha University

**Faculty**: Faculty of Engineering at Shoubra

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

**Department offering the course**: Energy and Sustainable Energy Engineering Program

**- Course Data (Basic Information)**

**Course Code & Title:** MEC231Heat and Mass Transfer (1) **Semester/Year:** First/ 2023-2024

**Prerequisite Course(s):** BAS015 Physics of Light and Magnetism **Core or Elective:** Core Course

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

**2- Course Aims**

The aim of this course is to provide students with the basic knowledge and fundamentals of heat and mass transfer. Moreover, provide the basic principles of heat transfer and its different modes. In addition, the course enables the students to solve the steady conduction heat transfer problems in one and two dimensions, as well solving the unsteady conduction heat transfer problems in one dimension.

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

Introduction to heat and mass transfer. Steady-state and unsteady-state heat transfer. Steady-state and unsteady-state mass transfer. Interphase transport and transfer coefficients. Convective heat and mass transfer. Internal and external forced convection. Heat transfer equipment. Natural convection. Boiling and condensation. Radiation heat transfer.

**4- Program Competences Served by The Course (A1, A2, A10 and B1)**

**Level (A) Engineering Competences**

**A.1** Identify, formulate, and solve complex engineering problems by applying engineering fundamentals, basic science and mathematics.

**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.

**A.5**  Practice research techniques and methods of investigation as an inherent part of learning.

**Level (B) Sustainable Energy Competences**

**B.1** Model, analyze and design physical systems applicable to the specific discipline by applying the concepts of: Thermodynamics, Heat Transfer, Fluid Mechanics, solid Mechanics, Material Processing, Material Properties, Measurements, Instrumentation, Control Theory and Systems, Mechanical Design and Analysis, Dynamics and Vibrations

**5- Learning Outcomes (LO’s)**

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

|  |
| --- |
| Cognitive Domain |
| LO1 | Define the different modes of heat transfer by conduction, convection and Radiation. |
| LO2 | Compare the different modes of heat transfer by conduction, convection and Radiation |
| LO3 | Understand the concentration gradient and the physical mechanism of mass transfer |
| Psychomotor Domain |
| LO4 | Assess and evaluate the steady and unsteady heat conduction |
| LO5 | Solve engineering problems based on heat transfer by conduction and convection. |
| LO6 | Select appropriate solutions for engineering heat transfer problems based on analytical thinking. |
| Affective Domain |
| LO7 | Present and share the collected information from research of a selected topic such as the different insulating materials and its applications. |
| LO8 | Analyze the different modes of heat transfer and distinguish the analogy between heat and mass transfer |

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **LO’s NARS** | **A1** | **A2** | **A10** | **B1** |
| Cognitive Domain |  |
| LO1 | ◼ |  |  |  |
| LO2 |  | ◼ |  |  |
| LO3 | ◼ |  |  |  |
| Psychomotor Domain |  |
| LO4 |  |  |  | ◼ |
| LO5 | ◼ |  |  |  |
| LO6 |  | ◼ |  |  |
| Affective Domain |  |
| LO7 |  |  | ◼ |  |
| LO8 |  | ◼ |  |  |

**7- Lecture Plan**

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

| Week | Topics | Planned Hours | Learning Outcomes |
| --- | --- | --- | --- |
| LO1 | LO2 | LO3 | LO4 | LO5 | LO6 | LO7 | LO8 |
| W1 | -Introduction to Heat Transfer, Basics of Heat Transfer.-Heat Transfer modes and their laws, Thermal Conductivity-Lab: Conduction Heat Transfer Experiment | **5** | ◼ |  | ◼ |  | ◼ |  |  |  |
| W2 | One-Dimensional, Steady State Heat Conduction Without Internal Generation in Plane Walls, Cylinders and Spheres, Thermal Resistance Concept-Lab: Thermal Conductivity Measurement Experiment | **5** |  | ◼ |  | ◼ |  |  |  |  |
| W3 | One-Dimensional, Steady State Heat Conduction Without Internal Generation in Multilayer Plane Walls, cylinders and Spheres, Thermal Resistance Concept-Lab: Thermal Resistance Experiment 1 | **5** |  | ◼ |  | ◼ |  |  |  |  |
| W4 | -Thermal Contact Resistance Concept, -Good Conductors and Insulators, -Critical Radius of Insulation-Heat Transfer in Common Configuration.-Lab: Thermal Resistance Experiment 1 | **5** |  |  |  |  | ◼ |  | ◼ |  |
| W5 | -Heat Generation in a Solid.-One-Dimensional, Steady State Heat Conduction Equation with Internal Heat Generation in Plane Walls.-Lab: Thermal Contact Resistance Experiment | **5** |  | ◼ |  | ◼ |  |  |  |  |
| W6 | One-Dimensional, Steady State Heat Conduction Equation with Internal Heat Generation in Cylinders and Spheres.-Lab: Critical Radius of Insulation Experiment | **5** |  | ◼ |  | ◼ |  |  |  |  |
| W8 | -Unsteady State Heat Conduction, One-Dimensional -Lumped System Analysis.-Lab: Unsteady State Heat Conduction Experiment 1 | **5** |  | ◼ |  | ◼ |  |  |  |  |
| W9 | One-Dimensional Unsteady State Heat Conduction in Large Plane Walls, Long Cylinder and Spheres using Heisler Charts-Lab: Unsteady State Heat Conduction Experiment 2 | **5** |  | ◼ |  | ◼ |  |  |  |  |
| W10 | Introduction to Convection Heat Transfer-Lab: Convection Heat Transfer Experiment  | **5** | ◼ |  |  |  |  |  |  | ◼ |
| W11 | -Forced Convection Heat Transfer- External Forced Flow.-Lab: Forced Convection “External Forced Flow “ Experiment | **5** |  |  |  |  | ◼ |  |  | ◼ |
| W12 | Forced Convection Heat Transfer- Internal Forced Flow-Lab: Forced Convection “Internal Forced Flow “ Experiment | **5** |  |  |  |  | ◼ | ◼ |  | ◼ |
| W13 | Free Convection Heat Transfer- External Free Flow-Lab: Free Convection “External Free Flow “ Experiment | **5** |  |  |  |  | ◼ |  |  | ◼ |
| W14 | Free Convection Heat Transfer- Internal Free Flow-Lab: Free Convection “Internal Free Flow “ Experiment | **5** |  |  |  |  | ◼ | ◼ |  | ◼ |
| W15 | Introduction to Mass Transfer, Basics of Mass Transfer, Mass Transfer Mechanisms and their laws.-Lab: Mass Transfer Experiment | **5** |  |  | ◼ |  |  |  |  | ◼ |

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 | Self-Reading | Presentation | Collaborate Learning (Team Project) | Research and Reporting | Brain Storming  |
| **Cognitive Domain** | LO1 | ⚫ |  | ⚫ |  |  |  |  |  | ⚫ | ⚫ |
| LO2 | ⚫ |  | ⚫ | ⚫ | ⚫ |  |  |  | ⚫ | ⚫ |
| LO3 | ⚫ | ⚫ | ⚫ |  |  |  |  |  |  |  |
| **Psychomotor Domain** | LO4 |  | ⚫ | ⚫ |  |  | ⚫ |  |  | ⚫ |  |
| LO5 | ⚫ |  | ⚫ | ⚫ | ⚫ | ⚫ |  | ⚫ | ⚫ |  |
| LO6 |  | ⚫ | ⚫ | ⚫ |  |  |  |  |  |  |
| **Affective Domain** | LO7 | ⚫ |  | ⚫ | ⚫ |  |  | ⚫ | ⚫ |  | ⚫ |
| LO8 |  | ⚫ | ⚫ |  |  |  |  |  | ⚫ |  |

**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.
* Social media communication such as Whatsapp groups, Microsoft teams chat, … etc

**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** | LO1 | ⚫ |  |  | ⚫ |  |  |  | ⚫ |  | ⚫ |
| LO2 | ⚫ |  |  |  | ⚫ | ⚫ |  | ⚫ |  | ⚫ |
| LO3 |  | ⚫ |  | ⚫ | ⚫ |  |  | ⚫ |  |  |
| **Psychomotor Domain** | LO4 |  | ⚫ |  |  | ⚫ |  | ⚫ |  |  |  |
| LO5 | ⚫ |  |  | ⚫ | ⚫ | ⚫ |  |  | ⚫ |  |
| LO6 | ⚫ |  |  |  |  |  |  | ⚫ |  |  |
| **Affective Domain** | LO7 |  |  |  |  |  |  | ⚫ | ⚫ | ⚫ | ⚫ |
| LO8 | ⚫ |  |  | ⚫ |  |  |  | ⚫ |  |  |

**b- Assessment Schedule and Weight**

|  |  |  |
| --- | --- | --- |
| **Assessment Tools** | **Week** | **Weight** |
| First Midterm Examination | 7 | 20 % |
| Second Midterm Examination | 11 | 20% |
| Final Examination | (As Scheduled) | 40 % |
| Quizzes (3 times) | 3, 5, 9 | 10 % |
| Home assignments | 3,4,5,8,10,11 | 10 % |
| **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

**b- Books**

1. **Yunus A. Cengel, “Heat Transfer: A Practical Approach”, McGraw-Hill, 3rd Edition, 2007.**
2. **Kreith, F. and Black, W. Z., Basic Heat Transfer, Harper and Row Publishers, New York (2000).**

**c- Recommended Books**

1. **Frank P. Incropera, David P. Dewitt. "Fundamentals of Heat and Mass Transfer", 7th Edition, 2011.**
2. **Yunus A. Cengel and Afshin J. Ghajar, “Heat and Mass Transfer: Fundamentals and Applications”, McGraw-Hill, 6th edition, 2020**

**- Course Coordinator: Assoc. Prof. Dr. Mohamed Reda Salem Signature:**

**Dr. Ashraf Elsayed Signature:**

**- Program Coordinator: Prof. Dr. Ahmed Reda Signature:**