**University**: Misr University for Science & Technology

**Faculty**: Faculty of Engineering Science and Technology

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

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

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

**Course Code & Title:** ME 546: Heat Exchanger Design **Semester/Year:** First / 2023-2024

**Prerequisite Course(s):** ME314 **Core or Elective:** Elective Course

**Credit Hours:** 2 **Weekly Contact Hours**: **Lecture:** 1 **Tutorial:** 0 **Laboratory:** 3

**2- Course Aims**

The students should understand the fundamentals of heat transfer mechanism, conduction and convection throughout heat exchangers, with an emphasis on physical mechanisms and practical applications. The heat exchangers and its classifications and use different calculation methods used for heat exchangers designs. The different methods for heat exchangers design. The operation principle of heat exchanger. The maintenance steps for heat exchanger

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

Heat transfer mechanisms leading to basic heat exchanger equations. Classification and analysis of heat exchangers including geometry, heat transfer, and flow friction characteristics. Compact and shell-and-tube heat exchanger application and design procedures. Fouling and its effect on life cycle analysis. Maintenance methodology Flow induced vibration and noise in heat exchangers.

**4- Program Competences Served by The Course (A3, B1 and C3)**

**Level (A) Engineering Competences**

**A.3** Apply engineering design processes to produce cost-effective solutions that meet specified needs with consideration for global, cultural, social, economic, environmental, ethical, and other aspects as appropriate to the discipline and within the principles and contexts of sustainable design and development

**Level (B) Mechanical Engineering 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

**Level (C) Electrical Engineering & Control Competences**

**C.3**  Design, prepare, supervise, and carry out plans for operation and maintenance of heat exchangers used in different power mechanical and energy systems.

**5- Learning Outcomes (LO’s)**

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

|  |
| --- |
| Cognitive Domain |
| LO1 | List different types and designs of heat exchanger  |
| LO2 | Discuss the operation principles and condition of heat exchangers  |
| LO3 | Solve the energy equation for heat exchangers |
| LO4 | Apply different methods and follow steps for the design heat exchangers  |
| LO5 | Detect the fouling effect on life cycle analysis for heat exchanger  |
| LO6 | plan the necessary maintenance operation for heat exchanger  |

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

|  |  |  |  |
| --- | --- | --- | --- |
| **LO’s NARS** | **A3** | **B1** | **C3** |
| Cognitive Domain |
| LO1 | ◼ |  |  |
| LO2 | ◼ |  |  |
| LO3 |  | ◼ |  |
| LO4 |  | ◼ |  |
| LO5 |  |  | ◼ |
| LO6 |  |  | ◼ |

**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 |
| W1 | Heat Exchangers, Types of heat exchangers | **4** | ◼ |  |  |  |  |  |
| W2 | Conduction heat transfer  | **4** |  | ◼ |  |  |  |  |
| W3 | Internal forced convection  | **4** |  | ◼ |  |  |  |  |
| W4 | External forced convection | **4** |  | ◼ |  |  |  |  |
| W5 | heat transfer over tube bundles | **4** |  |  | ◼ |  |  |  |
| W6 | Overall heat transfer coefficient | **4** |  |  | ◼ |  |  |  |
| W7 | Heat exchanger energy analysis. | **4** |  |  | ◼ |  |  |  |
| W8 | Single-stream steady-flow heat exchangers, Balanced-flow exchangers | **4** |  |  |  | ◼ |  |  |
| W9 | The log mean temperature difference (LMTD) method. | **4** |  |  |  | ◼ |  |  |
| W10 | Application of the log mean temperature difference (LMTD) method. | **4** |  |  |  | ◼ |  |  |
| W11 | Effectiveness and number of transfer units (ε–NTU) method, | **4** |  |  |  | ◼ |  |  |
| W12 |  Application Effectiveness and number of transfer units (ε–NTU) method | **4** |  |  |  | ◼ |  |  |
| W13 | Fouling effect on life cycle analysis  | **4** |  |  |  |  | ◼ |  |
| W14 | Heat exchanger maintenance operation | **4** |  |  |  |  |  | ◼ |
| W15 | Revision  | **4** |  |  |  |  |  |  |
| W16 | Exam  | **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 | Self-Reading | Presentation | Collaborate Learning (Team Project) | Research and Reporting | Brain Storming  |
| **Cognitive Domain** | LO1 | ⚫ |  |  | ⚫ |  |  | ⚫ |  | ⚫ | ⚫ |
| LO2 | ⚫ |  |  | ⚫ |  |  | ⚫ | ⚫ | ⚫ | ⚫ |
| LO3 | ⚫ |  | ⚫ |  |  |  |  |  |  |  |
| LO4 | ⚫ |  | ⚫ |  |  |  | ⚫ | ⚫ |  | ⚫ |
| LO5 | ⚫ |  |  | ⚫ |  |  | ⚫ |  |  | ⚫ |
| LO6 | ⚫ |  |  | ⚫ | ⚫ | ⚫ |  |  |  |  |

**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 | ⚫ |  |  | ⚫ | ⚫ |  | ⚫ |  | ⚫ |  |
| LO4 | ⚫ |  |  |  |  |  | ⚫ |  | ⚫ |  |
| LO5 | ⚫ |  |  | ⚫ | ⚫ |  |  | ⚫ |  |  |
| LO6 | ⚫ |  |  |  |  |  |  | ⚫ |  | ⚫ |

**b- Assessment Schedule and Weight**

|  |  |  |
| --- | --- | --- |
| **Assessment Tools** | **Week** | **Weight** |
| First Midterm Examination | 7 | 20 % |
| Second Midterm Examination | 12 | 20% |
| Final Examination | (As Scheduled) | 40 % |
| Quizzes (3 times) | 3, 5, 9 | 5 % |
| Home assignments | 3,4,5,8,10,11 | 10% |
| Matlab Mini Project | 8 | 5 % |
| **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**

*Please delete this blue text after updating the file.*

**a- Course Notes**

Lectures Notes in PDF

<https://bu.edu.eg/staff/mahmoudhassan3>

**b- Books**

1. Yunus Cengel and Afshin Ghajar “Heat and Mass Transfer: Fundamentals and Applications” McGraw Hill; 6th Edition 2019

**c- Recommended Books**

* Frank P. Incropera , David P. DeWitt , Theodore L. Bergman and Adrienne S. Lavine “Fundamentals of Heat and Mass Transfer” John Wiley & Sons 8th Edition 2017

**- Course Coordinator: Dr. Mahmoud Ahmed Sharafeldin Signature:**

**- Program Coordinator: Signature:**