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**Cairo University  
Faculty of Engineering**

**Department of Mining, Petroleum,**

**and Metallurgical Engineering**

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| **Course Specifications** | | | | | | | | | | | | | | | | | |
| **Program(s) on which this course is given:** | | | | | | **Materials and Metallurgical Engineering** | | | | | | | | | | | |
| **Department offering the program:** | | | | | | **Department of Mining, Petroleum, and Metallurgical Engineering** | | | | | | | | | | | |
| **Department offering the course:** | | | | | | **Department of Mining, Petroleum, and Metallurgical Engineering** | | | | | | | | | | | |
| **Academic Level:** | | | | | | **Metallurgical Engineering B.Sc.** | | | | | | | | | | | |
| **Date** | | | | | | **April, 2015** | | | | | | | | | | | |
| **Semester (based on final exam timing)** | | | | | | **Fall Spring** | | | | | | | | | | | |
| **A- Basic Information** | | | | | | | | | | | | | | | | | |
| **1. Title:** | **Heat Transfer** | | | | | | | | **Code:** | | | | **MET 308** | | | | |
| **2. Units/Credit hours per week:** | | **Lectures** | | | **4** | | **Tutorial** | | | **2** | **Practical** | | | **---** | **Total** | | **6** |
| **B- Professional Information** | | | | | | | | | | | | | | | | | |
| **1. Course description:** | | | | **Topics include the followings: steady and unsteady heat conduction; forced and free convection; external and internal flows; and radiation heat transfer.**  **Objectives:**   1. **Make students familiar with fundamental heat transfer concepts: conservation of energy, and mechanisms of heat transfer (conduction, convection, and radiation).** 2. **Evaluate the relative contributions of different modes of heat transfer.** 3. **Teach balance of energy applied to integral- and differential-volumes.** 4. **Know the basic differential equations for heat transfer.** 5. **Formulate basic equation for heat transfer problems.** 6. **Solve differential and algebraic equations associated with thermal systems using analytical and numerical approaches.** 7. **Teach the physics of steady thermal conduction in solids (metals, plastics) and composites such as insulation through walls, cylinders, and spheres and define thermal conduction resistance.** 8. **Calculate and evaluate the impacts of initial and boundary conditions on the solutions of a particular heat transfer problem.** 9. **Apply heat transfer principles to design and to evaluate performance of thermal systems.** 10. **Understand the critical radius of insulation and the heat transfer in fins.**   **11.Have students become knowledgeable in unsteady one-dimensional heat**  **conduction.**  **12.Understand the differences between laminar and turbulent flows.**  **13.Have students become knowledgeable in internal and external forced convection.**  **14.Understand the basics of free convection.**  **15.Teach physics of thermal radiation and surface properties.**  **16.Define view-factor resistance.**  **17.Calculate radiation heat transfer between objects with simple geometries.**  **18.Determine the reduction in radiation heat transfer using radiation shields.** | | | | | | | | | | | | | |
| **2. Intended Learning**  **Outcomes of Course**  **(ILOs):** | | | | **a) Knowledge and Understanding** | | | | | | | | | | | | | |
| **1. Know heat transfer modes (conduction, convection, and radiation).**  **2. Understand how heat is transferred between the elements of a system for**  **different configurations.** | | | | | | | | | | | | | |
| **b) Intellectual Skills** | | | | | | | | | | | | | |
| **3. Analyze problems to choose appropriate correlation.**  **4. Find a suitable mathematical relationship between the measured variables.**  **5. Solve application problems.** | | | | | | | | | | | | | |
| **c) Professional and Practical Skills** | | | | | | | | | | | | | |
| **6. Make right assumptions and approximations for tackling practical situations.**  **7. Apply fundamental heat transfer concepts to obtain design data relevant to**  **selective illustrative problems.**  **33 8. Apply finite difference method to engineering problems.** | | | | | | | | | | | | | |
| **d) General and Transferable Skills** | | | | | | | | | | | | | |
| **9. Work effectively in a team group to achieve goals.**  **10. Develop an understanding of how heat transfer is accomplished in metallurgical**  **engineering process operations.** | | | | | | | | | | | | | |
| **3. Contents** | | | | | | | | | | | | | | | | | |
| **Topic** | | | | | | | | | | | | **Total hours** | | **Lectures hours** | | **Tutorial/ Practical hours** | |
| **[1] Basic concepts of thermodynamics and heat transfer** | | | | | | | | | | | | **3** | | **3** | | **---** | |
| **[2] Modes of heat transfer** | | | | | | | | | | | | **3** | | **2** | | **1** | |
| **[3] Conservation of energy** | | | | | | | | | | | | **2** | | **1** | | **1** | |
| **[4] Integral and differential volume energy equations containing**  **heat transfer by conduction, convection, and radiation** | | | | | | | | | | | | **2** | | **2** | | **---** | |
| **[5] Introduction to conduction** | | | | | | | | | | | | **2** | | **2** | | **---** | |
| **[6] Heat conduction equation** | | | | | | | | | | | | **2** | | **2** | | **---** | |
| **[7] Boundary and initial conditions & formulation of heat conduction**  **Problems** | | | | | | | | | | | | **3** | | **2** | | **1** | |
| **[8] One-Dimensional steady state conduction** | | | | | | | | | | | | **3** | | **2** | | **1** | |
| **[9] Conduction through wall and composite walls** | | | | | | | | | | | | **5** | | **3** | | **2** | |
| **[10] Conduction through cylinder and composite cylinders** | | | | | | | | | | | | **5** | | **3** | | **2** | |
| **[11] Conduction through sphere and composite spheres** | | | | | | | | | | | | **5** | | **3** | | **2** | |
| **[12] Overall heat transfer coefficient** | | | | | | | | | | | | **2** | | **1** | | **1** | |
| **[13] Critical radius of insulation** | | | | | | | | | | | | **2** | | **1** | | **1** | |
| **[14] Temperature varying conductivity** | | | | | | | | | | | | **2** | | **1** | | **1** | |
| **[15] Heat transfer in fins** | | | | | | | | | | | | **4** | | **2** | | **2** | |
| **[16] Transient conduction** | | | | | | | | | | | | **5** | | **3** | | **2** | |
| **[17] Numerical methods in heat conduction** | | | | | | | | | | | | **3** | | **2** | | **1** | |
| **[18] Convection ….. basic concepts** | | | | | | | | | | | | **1** | | **1** | | **---** | |
| **[19] Nusselt, Prandtl, and Reynolds numbers** | | | | | | | | | | | | **1** | | **1** | | **---** | |
| **[20] Laminar and turbulent flows** | | | | | | | | | | | | **1** | | **1** | | **---** | |
| **[21] Analytical relations and correlations for the Nusselt number** | | | | | | | | | | | | **1** | | **1** | | **---** | |
| **[22] Forced convection – external Flow** | | | | | | | | | | | | **2** | | **1** | | **1** | |
| **[23] Forced convection - internal Flow** | | | | | | | | | | | | **2** | | **1** | | **1** | |
| **[24] Free Convection** | | | | | | | | | | | | **4** | | **2** | | **2** | |
| **[25] Radiation basic concepts** | | | | | | | | | | | | **1** | | **1** | | **---** | |
| **[26] Blackbody radiation** | | | | | | | | | | | | **1** | | **1** | | **---** | |
| **[27] Radiation: processes and properties** | | | | | | | | | | | | **1** | | **1** | | **---** | |
| **[28] View factors** | | | | | | | | | | | | **2** | | **1** | | **1** | |
| **[29] Radiation exchange between surfaces & thermal circuit**  **Diagram** | | | | | | | | | | | | **6** | | **4** | | **2** | |
| **[30] Radiation shields** | | | | | | | | | | | | **2** | | **1** | | **1** | |
| **Total** | | | | | | | | | | | | **78** | | **52** | | **26** | |
| **4. Teaching and Learning Methods** | | | | | | | | | | | | **Lectures**  **( √ )** | | **Practical Training/ Laboratory ( )** | | **Seminar/**  **Workshop**  **( )** | |
| **Class Activity ( )** | | **Case**  **Study**  **( √ )** | | **Projects**  **( )** | |
| **E-learning ( )** | | **Assignments /Homework ( √ )** | | **Other:** | |
| **5. Student Assessment** | | | | | | | | | | | | | | | | | |
| * + - * **Method** | | | | | | | | **To assess (with reference to the ILOs)** | | | | | | | | | |
| **- Assessment 1; Homework assignments** | | | | | | | | **1, 2, 3, 4, 5, 8** | | | | | | | | | |
| **- Assessment 2; Report and presentation** | | | | | | | | **1, 2, 9,10­** | | | | | | | | | |
| **- Assessment 3; Quizzes** | | | | | | | | **1, 2, 3, 4, 5** | | | | | | | | | |
| * **Assessment 4; Fins exam** | | | | | | | | **1, 2, 3, 4, 5** | | | | | | | | | |
| * **Assessment 5; Mid-term exam** | | | | | | | | **1, 2, 3, 4, 5, 6, 7, 8** | | | | | | | | | |
| **- Assessment 6; Final exam** | | | | | | | | **1, 2, 3, 4, 5, 6, 7, 8, 10** | | | | | | | | | |
| * **Assessment Schedule** | | | | | | | | **Week** | | | | | | | | | |
| **- Assessment 1; Homework assignments** | | | | | | | | **2,3,4,5,6,7,8,10,11,12** | | | | | | | | | |
| **- Assessment 2; Report and presentation** | | | | | | | | **12** | | | | | | | | | |
| **- Assessment 3; Quizzes** | | | | | | | | **3, 5, 7, 11** | | | | | | | | | |
| * **Assessment 4; Fins exam** | | | | | | | | **8** | | | | | | | | | |
| * **Assessment 5; Mid-term exam** | | | | | | | | **9** | | | | | | | | | |
| **- Assessment 6; Final exam** | | | | | | | | **At end of term** | | | | | | | | | |
| * **Weighting of Assessments** | | | | | | | | | | | | | | | | | |
| **- Assessment 1; Homework assignments** | | | | | | | | **4%** | | | | | | | | | |
| **- Assessment 2; Report and presentation** | | | | | | | | **2.67%** | | | | | | | | | |
| **- Assessment 3; Quizzes** | | | | | | | | **6.66%** | | | | | | | | | |
| * **Assessment 4; Fins exam** | | | | | | | | **3.33%** | | | | | | | | | |
| * **Assessment 5; Mid-term exam** | | | | | | | | **16.67%** | | | | | | | | | |
| **- Assessment 6; Final exam** | | | | | | | | **66.67%** | | | | | | | | | |
| **- Total** | | | | | | | | **100%** | | | | | | | | | |
| **6. List of References** | | | | | | | | | | | | | | | | | |
| **- M.N. Ozisik, Heat Transfer, A Basic Approach, McGraw-Hill, New York, 1985.**  **- Y. A. Cengel, Heat Transfer, A Practical Approach, Second Edition, McGraw-Hill, New York, 2003.**  **- J. H. Lienhard IV and J. H. Lienhard V, A Heat Transfer, Third Edition, Textbook, Phlogiston**  **Press, Cambridge, Massachusetts, U.S.A., 2008.**  **- J.P. Holman, Heat transfer, Ninth Edition, McGraw Hill, New York, 2001.**  **- F.P. Incropera and D.P. De Witt, Fundamentals of heat and mass transfer, Six Edition,Wiley, New York, 2007.** | | | | | | | | | | | | | | | | | |
| **7. Facilities Required for Teaching and Learning** | | | | | | | | | | | | | | | | | |
| **Board, and datashow.** | | | | | | | | | | | | | | | | | |
| **Course Coordinator:** | | | **Dr. Moetaz Mohamed Nabil Mohamed Mohamed Ahmed** | | | | | | | | | | | | | | |
| **Head of Department:** | | | **Prof. Dr. El-Sayed Mahmoud El-Banna** | | | | | | | | | | | | | | |

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