Syllabus for EGM-3230

HEAT TRANSFER

COURSE DESCRIPTION

This course focuses on heat transfer by modes of conduction, convection, and radiation, including the fundamental principles of heat transfer and radiation and application to the solution of industrial heat transfer problems.

Energy exists in several forms. In heat transfer, the focus is on heat, which is the form of energy that can be transferred from one system to another as a result of temperature difference. While thermodynamics is concerned with the amount of heat transferred, heat transfer is concerned with the rate of heat transfer (heat transfer per unit time). Thermodynamics deals with equilibrium states and the amount of change from one equilibrium state to another. Heat transfer, on the other hand, deals with systems that lack thermal equilibrium, and thus it is a non-equilibrium phenomenon.

The basic requirement is that there is a temperature difference. This is the driving force for heat transfer to occur. Generally the temperature difference is specified as a temperature gradient because it includes the amount of heat that is transferred per unit time per unit length.

The three types of heat transfer are conduction, convection, and radiation. Each will be examined in detail starting with steady state and transient heat conduction, followed by external and internal forced convection. Natural convection is treated separately. Radiation heat transfer does not require the presence of a material medium and it suffers no attenuation in a vacuum. The theoretical foundation for radiation heat transfer is based on electromagnetic energy emitted by matter as a result of the changes in the electronic configuration of the atoms or molecules.

Heat exchangers generally exchange heat between two fluids that are at different temperatures while keeping them from mixing with each other. Heat transfer mechanisms usually involve convection in each fluid and conduction through the wall separating the two fluids. If the temperature of one of the conducting surfaces is high enough, radiation heat transfer may also occur (e.g., surface of a fuel pin in a nuclear reactor core that is not in contact with some coolant). We will classify numerous types of heat exchangers, each with its own characteristic overall heat transfer coefficient and logarithmic mean temperature difference (LMTD) value.

COURSE TOPICS

- Mechanisms of heat transfer
- Steady heat conduction

- Transient heat conduction
- External forced convection
- Internal forced convection
- Natural convection
- Radiation heat transfer
- Heat exchangers

COURSE OBJECTIVES

After completing this course, you will be able to:

CO 1 Solve basic heat transfer problems (conduction, convection, radiation) encountered in practice.

CO 2 Develop thermal resistance networks to solve steady state conduction problems involving single and multi-layer rectangular, cylindrical, or spherical geometries.

CO 3 Analyze the phenomena of transient heat conduction where the temperature distribution varies with both time and position in one- and multi-dimensional systems.

CO 4 Explain the mechanism of heat transfer through a fluid in the presence of bulk fluid motion that flows over a surface (external forced convection).

CO 5 Explain the mechanism of heat transfer through a fluid in the presence of bulk fluid motion that flows in a confined space (internal forced convection).

CO 6 Evaluate heat transfer by natural convection for various geometries, including finned surfaces and enclosures (vertical, horizontal, inclined plates, cylinders, and spheres).

CO 7 Calculate radiation heat transfer between black surfaces using electromagnetic radiation principles and blackbody definitions of emissivity, absorptivity, reflectivity, and transmissivity on spectral and total basis.

CO 8 Perform a general energy analysis for various types of heat exchangers given that the heat exchange process involves convection between two fluids and conduction through the wall separating them.

COURSE MATERIALS

You will need the following materials to complete your coursework. Some course materials may be free, open source, or available from other providers. You can access free or open-source materials by clicking the links provided below or in the module details documents. To purchase course materials, please visit the University's textbook supplier.

Required Textbooks

- Cengel, Y. A., Turner, R. H., & Cimbala, J. M. (2017). *Fundamentals of thermal-fluid sciences* (5th ed.). McGraw-Hill.
  ISBN-13: 978-0078027680
  [**Note:** This course will cover Part III of this book. This book is also used in EGM-221:Thermodynamics and EGM-331: Fluid Mechanics courses.]

- Pitts, D., & Sissom, L. E. (1998). *Schaum's outline of theory and problems of heat transfer* (2nd ed.). McGraw-Hill.
  ISBN-13: 978-0070502079

Resources

For those students who have not applied their Calculus I knowledge recently, the following web-linked math tutorials are recommended for refresher.

- **Graphics:** Graphics for the Calculus Classroom
- **Graphing calculator:** GraphCalc
- **Resource list:** Calculus.org
- **Sample problems:** Calculus II Sample Problems
- **Videos and visual aids:**
  - Calculus Help
  - Khan Academy
  - Larry Green's Calculus Videos
  - MathTV

COURSE STRUCTURE

Heat Transfer is a three-credit, online course consisting of **seven** modules. Modules include an overview, topics, study materials, and activities. Module titles are listed below.

- **Module 1: Heat Transfer Mechanisms**
  Course objectives covered in this module: CO 1

- **Module 2: Steady Heat Conduction**
  Course objectives covered in this module: CO 1, CO 2

- **Module 3: Transient Heat Conduction**
  Course objectives covered in this module: CO 1, CO 3

- **Module 4: Forced Convection**
  Course objectives covered in this module: CO 1, CO 4, CO 5

- **Module 5: Natural Convection**
  Course objectives covered in this module: CO 1, CO 6

- **Module 6: Radiation Heat Transfer**
  Course objectives covered in this module: CO 1, CO 7

- **Module 7: Heat Exchangers**
  Course objectives covered in this module: CO 1, CO 8

ASSESSMENT METHODS

For your formal work in the course, you are required to participate in online discussion forums, complete application exercises, and complete three exams. See below for more details.

Consult the Course Calendar for assignment due dates.

Promoting Originality

One or more of your course activities may utilize a tool designed to promote original work and evaluate your submissions for plagiarism. More information about this tool is available in this document.

💬 *Discussion Forums*

You are required to complete **seven** discussion forum assignments. Discussion forums are on a variety of topics associated with the course modules.

Meaningful participation in online discussions is relevant to the content, adds value, and advances the discussion. Comments such as "I agree" and "ditto" are not considered value-adding participation. Therefore, when you agree or disagree with a classmate, the reader, or your mentor, state and support your agreement or disagreement.

You will be evaluated both on the quality of your responses (i.e., your understanding of readings and concepts as demonstrated by well-articulated, critical thinking) and the quantity of your participation (i.e., the number of times you participate meaningfully in the assigned forums). Responses and comments should be properly proofread and edited, professional, and respectful.

For posting guidelines and help with discussion forums, please see the Student Handbook located within the General Information page of the course website.

Application Exercises

You are required to complete **seven** application exercises. The assignments are on a variety of topics associated with the course modules.

For help regarding preparing and submitting assignments, see the Student Handbook located within the General Information page of the course website.

Examinations

You are required to take **three** proctored online examinations. The exams require that you use the University's Online Proctor Service (OPS). Please refer to the "Examinations and Proctors" section of the Online Student Handbook (see Student Handbooks in the General Information area of the course website) for further information about scheduling and taking online exams and for all exam policies and procedures. You are strongly advised to schedule your exams within the first week of the semester.

Online exams are administered through the course website. Consult the Course Calendar for the official dates of exam weeks.

Practice Exams

Practice exams are provided for each exam in the course. These practice exams offer an opportunity to answer questions about course topics using the exam software in a low-stress, unproctored setting. Practice exams are the same length as the exams and have the same 180-minute time limit. They also provide detailed feedback. You are encouraged to take advantage of these unweighted, optional course activities in the Exam sections of your course space, along with the exam study guides that are also available there.

Exam 1

Note: For a list of key concepts that may appear on your exam, refer to the study guide available in the Exam 1 section of the course website.

Exam 1 is an open-book, 3-hour exam worth 13 percent of your course grade. It will consist of five problems to solve and covers topics and material from Modules 1 and 2 of the course.

You can use your book; a scientific, graphing, or financial calculator (no phones or tablets); and scratch paper during the exam.

Exam 2

Note: For a list of key concepts that may appear on your exam, refer to the study guide available in the Exam 2 section of the course website.

Exam 2 is an open-book, 3-hour exam worth 13 percent of your course grade. It will consist of five problems to solve and covers topics and material from Modules 3 and 4 of the course.

You can use your book; a scientific, graphing, or financial calculator (no phones or tablets); and scratch paper during the exam.

Exam 3

Note: For a list of key concepts that may appear on your exam, refer to the study guide available in the Exam 3 section of the course website.

Exam 3 is an open-book, 3-hour exam worth 14 percent of your course grade. It will consist of five problems to solve and covers topics and material from Modules 5, 6, and 7 of the course.

You can use your book; a scientific, graphing, or financial calculator (no phones or tablets); and scratch paper during the exam.

Statement about Cheating

You are on your honor not to cheat during the exam. Cheating means:

- Looking up any answer or part of an answer in an unauthorized textbook or on the Internet, or using any other source to find the answer.
- Copying and pasting or in any way copying responses or parts of responses from any other source into your online test. This includes but is not limited to copying and pasting from other documents or spreadsheets, whether written by yourself or anyone else.
- Plagiarizing answers.
- Asking anyone else to assist you by whatever means available while you take the exam.
- Copying any part of the exam to share with other students.
- Telling your mentor that you need another attempt at the exam because your connection to the Internet was interrupted when that is not true.

If there is evidence that you have cheated or plagiarized in your exam, the exam will be declared invalid, and you will fail the course.

GRADING AND EVALUATION

Your grade in the course will be determined as follows:

- **Online discussions (7)**—20%
- **Application exercises (7)**—40%
- **Exam 1**—13%
- **Exam 2**—13%

- **Exam 3**—14%

All activities will receive a numerical grade of 0–100. You will receive a score of 0 for any work not submitted. Your final grade in the course will be a letter grade. Letter grade equivalents for numerical grades are as follows:

A	=	93–100	C+	=	78–79
A–	=	90–92	C	=	73–77
B+	=	88–89	C–	=	70–72
B	=	83–87	D	=	60–69
B–	=	80–82	F	=	Below 60

To receive credit for the course, you must earn a letter grade of C or better (for an area of study course) or D or better (for a course not in your area of study), based on the weighted average of all assigned course work (e.g., exams, assignments, discussion postings).

STRATEGIES FOR SUCCESS

First Steps to Success

To succeed in this course, take the following first steps:

- Read carefully the entire Syllabus, making sure that all aspects of the course are clear to you and that you have all the materials required for the course.
- Take the time to read the entire Online Student Handbook. The Handbook answers many questions about how to proceed through the course and how to get the most from your educational experience at Thomas Edison State University.
- Familiarize yourself with the learning management systems environment—how to navigate it and what the various course areas contain. If you know what to expect as you navigate the course, you can better pace yourself and complete the work on time.
- If you are not familiar with web-based learning, be sure to review the processes for posting responses online and submitting assignments before class begins.

Study Tips

Consider the following study tips for success:

- To stay on track throughout the course, begin each week by consulting the Course Calendar. The Course Calendar provides an overview of the course and indicates due dates for submitting assignments, posting discussions, and scheduling and taking examinations.
- Check Announcements regularly for new course information.

Using AI Ethically: A Guide for TESU Students

TESU's Academic Code of Conduct permits student AI use in support of their writing and research process--not as a replacement for original writing. Document AI use with an acknowledgment statement at the end of each assignment, noting the tools and prompts used. Cite any AI-generated content on the References page. Please review Using AI Ethically: A Guide for TESU Students for more detailed information.

COMMITMENT TO DIVERSITY, EQUITY, AND INCLUSION

Thomas Edison State University recognizes, values, and relies upon the diversity of our community. We strive to provide equitable, inclusive learning experiences that embrace our students' backgrounds, identities, experiences, abilities, and expertise.

ACCESSIBILITY AND ACCOMMODATIONS

Thomas Edison State University adheres to the Americans with Disabilities Act (ADA, 1990; ADAAA, 2008) and Section 504 of the Rehabilitation Act of 1973. The Office of Student Accessibility Services (OSAS) oversees requests for academic accommodations related to disabilities; a student who is pregnant, postpartum, or a student parenting a newborn who is not the birth parent [as covered under NJSA18A]; and students requesting academic accommodation for a short-term/temporary illness and/or injury. Information can be found on the Office of Student Accessibility Services webpage and questions can be sent to ADA@tesu.edu.

ACADEMIC POLICIES

To ensure success in all your academic endeavors and coursework at Thomas Edison State University, familiarize yourself with all administrative and academic policies including those related to academic integrity, course late submissions, course extensions, and grading policies.

For more, see:

- University-wide policies
- Undergraduate academic policies
- Undergraduate course policies
- Graduate academic policies
- Graduate course policies
- Nursing student policies
- Nursing graduate student policies
- International student policies

- Academic code of conduct