Department of Chemical Engineering
College of Engineering
University of the Philippines
Diliman, Quezon City

Course No: **ChemE 131**
Course Title: **Thermal Systems**
Term: Second Semester AY 2019-2020
Sections: THW2 TTh 1:00 pm-2:30 pm
Chem Engg Bldg A403
THX1 TTh 2:30 pm-4:00 pm
Chem Engg Bldg A403

Instructors: **Prof. Marlon L. Mopon Jr.**
assistant professor
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Dr. Terence P. Tumolva
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Course Description: Fundamentals of heat transfer; application to design of heat transfer equipment

Course Prerequisite: ChemE 106 Mathematical Methods in Chemical Engineering II

Course Corequisite: ChemE 130 Process Fluid Systems

Course Credit: 3.0 units (3 h lecture)

Program Educational Objectives (BS Chemical Engineering)
The program aims to educate students such that three to five years from graduation, they:

1. take leadership roles in their respective fields and/or effectively work in or manage a team;
2. are equipped with the extensive knowledge and relevant skills necessary to succeed in their chosen careers and to become responsive citizens;
3. are able to demonstrate strong research & innovative capability as they recognize and address opportunities and challenges in their respective spheres of influence;
4. have shown strong commitment to the ethical practice of their profession; to health, safety and environment; and service to society.

Course Outcomes
At the end of the course, the student should be able to:

1. demonstrate a good understanding of the mechanism and mathematics governing heat transfer;
2. formulate appropriate mathematical equations arising from the analysis of heat transfer, and interpret the results in the context of chemical engineering practices;
3. demonstrate the ability to use computer software for the solution of combined heat and momentum transfer problems;
4. compose the thermal design of heat exchangers, condensers, boilers and evaporator equipment that comply with specifications from the process objectives; and
5. design a heat transfer equipment that provides a solution to a specific engineering problem.

Student Outcomes Satisfied by Course Outcomes

- **[a]** Ability to apply knowledge of mathematics and science to solve engineering problems
- **[c]** Ability to design a system, component, or process to meet desired needs within realistic constraints
- **[e]** Ability to identify, formulate, and solve engineering problems
- **[g]** Ability to communicate effectively
- **[k]** Ability to use techniques, skills, and modern engineering tools necessary for engineering practice

Course Outline

MEETING	TOPIC
1	Introduction and review 1. Energy balances 2. Dimensional analysis 3. Introduction to heat transfer
2-5	Conductive heat transfer 1. Thermal conductivity 2. Shell energy balances 3. Differential equations of energy
6-9	Convective heat transfer 1. Natural and forced convection 2. Temperature profiles of fluids in laminar and turbulent flow 3. Heat transfer coefficient
FIRST LONG EXAMINATION	
10-12	Radiative heat transfer 1. Radiative fundamentals 2. Combined heat transfer calculations 3. View factor calculations
13-16	Overall energy balance 1. Interphase heat transfer 2. Overall heat transfer coefficient
SECOND LONG EXAMINATION	

MEETING	TOPIC
17	Overview of heat exchangers
18-24	Design of heat exchangers without phase change 1. Design considerations for heat exchangers 2. Double-pipe heat exchangers 3. Shell-and-tube heat exchangers 4. Extended-surface heat exchangers 5. Plate heat exchangers 6. Transfer unit and effectiveness
THIRD LONG EXAMINATION	
25-28	Design of heat exchangers with phase change 1. Condensation and boiling phenomena 2. Condenser design considerations 3. Reboiler design considerations
29-32	Design of evaporators 1. Review of colligative properties 2. Overview of evaporator equipment 3. Single-effect evaporator calculations 4. Multiple-effect evaporator calculations
FOURTH LONG EXAMINATION	
DESIGN PROJECT PRESENTATION	

References

1. Bird, R. B., Stewart, W. E., Lightfoot, E. N., and Klingenberg, D. J. (2014) **Introductory Transport Phenomena**. John Wiley and Sons Inc., New York.
2. Cao, E. (2010) **Heat Transfer in Process Engineering**. McGraw-Hill Companies, Inc., New York.
3. Foust, A.S., Wenzel, L.A., Clump, C.W., Maus, L., Bryce Andersen, L. (1980) **Principles of Unit Operations 2nd Ed**. John Wiley & Sons, Inc., Singapore.
4. Geankoplis, C. J., Hersel, A. H., and Lepek, D. H. (2018) **Transport Processes and Separation Process Principles 5th Ed**. Pearson Higher Education, London, UK.
5. Green, D.W. and Perry, R. H., (Eds.) (2008) **Perry's Chemical Engineers' Handbook 8th Ed**. McGraw-Hill Companies, Inc., New York.
6. McCabe, W.L., Smith, J.C. and Harriott, P. (2005) **Unit Operations of Chemical Engineering 7th Ed**. McGraw-Hill Companies, Inc., New York.
7. Serth, R. W. and Lestina, T. (2014). **Process Heat Transfer: Principles, Applications and Rules of Thumb 2nd Ed**. Academic Press, Massachusetts.
8. Towler, G. P. and Sinnott, R. (2013) **Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design**. Elsevier, Inc., Massachusetts.
9. Welty, J. R., et al. (2008) **Fundamentals of Momentum, Heat, and Mass Transfer 5th Ed**. John Wiley and Sons, Inc., New Jersey.

Course Assessment

Long examinations (4)	80%
Design project	15%
Classwork	5%

Grading System

1.0	1.25	1.5	1.75	2.0	2.25	2.5	2.75	3.0	5.0
[92,100]	[88,92)	[84,88)	[80,84)	[76,80)	[72,76)	[68,72)	[64,68)	[60,64)	[0,60)

Course Policies

1. **LONG EXAMINATIONS**
   a. Long examinations shall consist of an objective and a computational part.
   b. Answer sheets should be submitted at least one work day before the schedule exam. Failure to do so will merit a 10-point deduction from the long exam score. Answer sheets should be of legal size with the class number and student number written on the upper right corner of ALL sheets.
   c. A student who missed a long exam for valid reasons is entitled to a makeup exam. Only one missed long exam is allowed; a student shall automatically obtain a score of zero for any other missed exams or for any exams missed without valid reasons. The student must inform the instructor within the day of the long exam if he/she is going to miss the exam or had missed it. The supporting documents must be submitted the following working day or as agreed upon by the instructor and the student.

2. **DESIGN PROJECT**
   a. Groups of three or four students shall carry out the detailed design of the heat and mass transfer equipment in common industrial processes. Each group member will be tasked with the design of a specific equipment in the overall process.
   b. Each group is required to schedule four graded consultations with the instructor for progress monitoring.
   c. An oral presentation of the final design shall be delivered by the end of the semester.
   d. A ring-bound copy and an e-copy (burned in a CD) of the final report and all the pertinent calculations shall be submitted. Relevant program files should also be included in the submission.

3. **CLASSWORK**
   a. Classwork may be given in the form of short quiz, seatwork, problem set, homework, or case studies.
   b. For case studies, groups of two or three students are required to develop Excel®-based calculation sheets capable of performing basic design calculations for the equipment covered in the course.
   c. Late submissions shall not be accepted for whatever reason.
   d. There will be no make-up classwork; a missed classwork shall automatically be given a score of zero.

4. **OTHER MATTERS**
   a. Students are encouraged to actively participate in discussions and are expected to read any suggested readings.
   b. Aspen HYSYS® installers can be borrowed from the department. Students are highly encouraged to explore the software since it would be useful in equipment design.
   c. University rules on absences/cheating/dropping/LOA shall apply.
   d. **The instructor reserves the right to make changes in class policies when deemed necessary.**

Consultation

M. L. MOPON JR.		T. P. TUMOLVA	
Room	C303-304 Chem Engg Bldg	Room	C301-302 Chem Engg Bldg
Hours*	MTWThF 8:00 am – 10:00 am	Hours*	M 8:30 am – 11:30 am
			TTh 10:00 am – 11:30 am 4:00 pm – 6:00 pm

*Consultation beyond the specified schedules may be done by setting up appointments.