GUJARAT TECHNOLOGICAL UNIVERSITY

CHEMICAL ENGINEERING (30)
ADVANCED HEAT TRANSFER
SUBJECT CODE: 2733005
M.E. 3rd SEMESTER

Type of course: Chemical Engineering (MAJOR ELECTIVE IV)

Prerequisite: The student should have basic understanding of Heat Transfer and heat exchange equipment.

Rationale: This subject involves the understanding of heat transfer and designing of heat exchange equipment used in chemical process industries. It also involves the fundamentals understanding of heat transport process viz. importance of various design consideration during the development and design of any process. With rapid rate of increase in the advancement of knowledge, it is important that the students should know the relevant importance and application of various process auxiliaries and utilities used in industries. This subject deals with the basics as well as advanced understanding of various process auxiliaries and utilities used in chemical plant.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks		Practical Marks				
L	T	P	C	ESE (E)	PA (M)	ESE (V)		PA (I)		
						ESE	OEP	PA	RP	
3	2#	2	5	70	30	20	10	10	10	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1.	Introduction to conductive, convective and radiation heat transfer. Revision of basic laws with emphasis on laws of radiation, natural convection between stationary fluid and solid and natural convection between moving fluid and solid.	02	3
2.	**Unsteady State Conduction:** Introduction, lumped heat capacity system, Transient heat flow in semi infinite solids, Convection boundary conditions, Multi dimensional systems, Thermal resistance and capacity formulations.	08	15
3.	**Heat Exchange equipment:** Designing of extended surface equipments – fin tube heat exchanger, spiral flow heat exchanger, heat transfer in solids.	08	15
4.	**Evaporators:** Introduction, Types of evaporators, Methods of feeding in multiple effect evaporator, Thermal / Process design considerations, designing of multiple effect evaporator.	08	15
5.	**Condensers:** Introduction, Types of Reboilers, Condensation on Vertical Surface and Horizontal tubes, Modification of Nusselt theory, Condensation inside horizontal tubes, Condensation on Finned tubes, Multi-component Condensation	08	15
6.	**Boiling Heat Transfer:**	08	15

	Introduction, Pool boiling, Correlation of Nucleate boiling in horizontal tubes, Two phase flow heat transfer, Convective boiling in Tubes, Film Boiling.		
7.	**Reboilers:** Introduction, Types of Reboilers, Design of Kettle reboilers, Design of Vertical and Horizontal reboilers.	06	11
8.	**Heat transfer in fluidized bed:** Designing of fluidized bed heating system, Designing of fluidized bed boilers.	06	11

Reference Books:

1. D. Q. Kern, Process Heat Transfer, McGraw Hill, 1997.
2. Holman, J. P., Heat Transfer, 9 ed., McGraw Hill, 2008.
3. R. K. Sinnott, Coulson & Richardsons Chemical Engineering Design, Vol. 6, Elsevier Butterworth-Heinemann.
4. Robert W. Serth, Process Heat Transfer: Principles and Applications, Elsevier Science & Technology Books.
5. John H. Lienhard IV, John H. Lienhard V, A Heat Transfer Textbook, Phlogiston Press.
6. McCabe W.L., Smith J.C., Harriot P., Unit Oerations of Chemical Engineering, 7th ed., McGraw Hill, 1993.
7. S.B.Thakore & B.I. Bhatt, Introduction to Process Engineering and design, Tata McGraw Hill Publishing Company.

Course Outcome:

After learning the course the students should be able to:

1. Learn about the overall knowledge about the heat transfer process in industry.
2. Understand the importance of heat transfer and designing of equipment in process industries.
3. Become familiar with equipments, used for heat transfer in industry.
4. Deal with most common types of steady as well as unsteady state operations of heat transfer.
5. Build a bridge between theoretical and practical concepts used for process auxiliaries and utilities in any process industry.

List of Experiments:

1 To determine thermal conductivity of given Metal Rod.
2 To determine thermal conductivity of the given composite walls.
3 To determine the thermal conductivity of lagging material, by heater input to be heat flow rate through the pipe
4 To Determine the heat flow rate through the lagged pipe and compare it with the heater input for known value of thermal conductivity of lagging material
5 To determine Stephan Boltzmann constant experimentally.
6 To determine the overall heat transfer co-efficient of shell and tube type heat exchangers.
7 To determine overall heat transfer co-efficient for finned tube type heat exchangers.
8 To determine outside and inside heat transfer for parallel plate type heat exchanger.
9 To Study Drop & Film Wise Condensation & Determine the Film Co-efficient
10 To Study the Boiling of Liquid by Submerged heated surface & Determine Critical Heat Flux.

Open Ended Projects:

The practical work at masters must be largely consisting of open ended projects. In each case a sample set may be provided and the faculty member may be empowered to select appropriate problems for practical work. At the end of semester before submission of marks of PA and term work, the faculty member will upload the three best problems done by the students during the practical hours.
After performance of practicals (minimum 5 Practicals) remaining time should be allotted to open-

ended projects / study reports / latest outcomes in technology study:

1. In the beginning of the academic term, faculties will have to allot their students at least one Open-ended Project / Study Report / Latest outcome in technology.
2. Literature survey including patents and research papers of fundamental process
   - Design based small project **or**
   - Study report based on latest scientific development **or**
   - Technology study report/ modeling/ simulation/collection report **or**
   - Computer based simulation/ web based application/ analysis presentations of basic concept field which may help them in chemical engineering.
3. These can be done in a group containing maximum **three** students in each.
4. Faculties should cultivate problem based project to enhance the basic mental and technical level of students.
5. Evaluation should be done on **approach of the student on his/her efforts** (not on completion) to study the design module of given task.
6. In the semester student should perform **minimum** 5 set of experiments and complete **one_small open ended dedicated project** based on engineering applications.

Open Ended Projects field:

Students are free to select any area of science and technology based on heat transfer and its applications in design to define Projects.

Some suggested projects are listed below:

1. Carry out detailed design of any heat exchange equipment which includes the concept of basic heat transfer with the help of softwares available.
2. Preparation of report of analysis on scientific development in design methodology.

Major Equipments:

Metal rod apparatus, composite wall apparatus, lagged pipe apparatus, shell and tube heat exchanger, finned tube exchanger, plate type heat exchanger, critical heat flux apparatus, dropwise and filmwise condensation apparatus.

List of Open Source Software/learning website:

1) Literature available for Advanced Heat Transfer in chemical plant / industry.
2) NPTEL Video Lectures.
3) MIT Open course lecture on Advanced Heat Transfer.

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. Every student or a group of students shall critically students shall critically study two paper, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.