Module (Course Syllabus) Catalogue

2022-2023

College/ Institute	**Koya Technical Institute**	
Department	**Petroleum Technology**	
Module Name	**Heat and Mass Transfer**	
Module Code		
Degree	**Technical Diploma** [•] **Bachler** [ ] **High Diploma** [ ] **Master** [ ] **PhD** [ ]	
Semester	**4th**	
Qualification	**PhD**	
Scientific Title	**Lecturer**	
ECTS (Credits)		
Module type	**Prerequisite** [ ] **Core** [•] **Assist.** [ ]	
Weekly hours		
Weekly hours (Theory)	**(2)hr Class**	**( )Total hrs Workload**
Weekly hours (Practical)	**(2)hr Class**	**( )Total hrs Workload**
Number of Weeks	**12**	
Lecturer (Theory)	**Dr. Barhm Abdullah Mohamad**	
E-Mail & Mobile NO.	**barhm.mohamad@epu.edu.iq 07512209152**	
Lecturer (Practical)		
E-Mail & Mobile NO.		
Websites		

Course Book

<table>
<tr><td>Course Description</td><td colspan="5">This course will focus on the Demonstrating the basic concepts of heat and mass transfer and covering process related to heat and mass transfer such as the methods of heat transfer, heat and mass transfer equipment's such as heat exchangers, cooling towers, distillation, absorption, extraction.</td></tr>
<tr><td>Course objectives</td><td colspan="5">• Providing knowledge about fundamentals of heat and mass transfer.
• Analysing how heat and mass transfer occur.
• Educating students to solve problems.</td></tr>
<tr><td>Student's obligation</td><td colspan="5">• Attending classes and participate in the lecture.
• Make reports and studies on different topics.
• Assignment preparations.
• Make quizzes and exams to make sure they got necessary knowledges.</td></tr>
<tr><td>Required Learning Materials</td><td colspan="5">• Handouts, notes and references.
• Showing necessary videos and reports.
• Showing equipment on different sites if possible.</td></tr>
<tr><td rowspan="13">Evaluation</td><td colspan="2">Task</td><td>Weight (Marks)</td><td>Due Week</td><td>Relevant Learning Outcome</td></tr>
<tr><td colspan="2">Paper Review</td><td></td><td></td><td></td></tr>
<tr><td rowspan="6">Assignments</td><td>Homework</td><td>5</td><td></td><td></td></tr>
<tr><td>Class Activity</td><td>2</td><td></td><td></td></tr>
<tr><td>Report</td><td>10</td><td></td><td></td></tr>
<tr><td>Seminar</td><td>10</td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td></td></tr>
<tr><td>Project</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Quiz</td><td>8</td><td></td><td></td></tr>
<tr><td colspan="2">Lab.</td><td>15</td><td></td><td></td></tr>
<tr><td colspan="2">Midterm Exam</td><td>10</td><td></td><td></td></tr>
<tr><td colspan="2">Final Exam</td><td>40</td><td></td><td></td></tr>
<tr><td colspan="2">Total</td><td>100</td><td></td><td></td></tr>
<tr><td>Specific learning outcome:</td><td colspan="5">1- Theory of heat and mass transfer.
2- Analyzing problems.
3- Solving heat and mass transfer problems.</td></tr>
</table>

Course References:	1. Bejan, A. and Kraus, A.D. (2003) Heat and Mass Transfer Handbook. John Wiley and Sons, Hoboken. 2. Cengel, Y. A., & Ghajar, A. J. (2014). Heat and mass transfer: Fundamentals and applications (5th ed.). McGraw-Hill Professional.

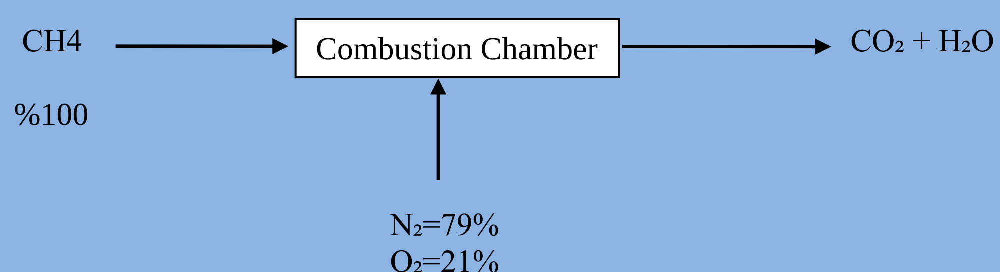
Course topics (Theory)	**Week**	**Learning Outcome**
Introduction	1	General information about heat and mass transfer
Conduction, convection and radiation	2	Importance of types of heat transfer
Heat exchanger concepts	3	The selection of heat exchanger
Cooling tower	4	Cooling tower types
Psychrometric Chart	5	Psychrometric Chart Principle and usages
Steam boiler	6	Steam generation types and its approaches
Furnace (Heater)	7	Basics design of heater
Combustion	8	The combustion phenomena
Absorption/desorption	9	Importance of absorption/desorption
Distillation	10	Distillation types and columns
Extraction	11	Extraction basics
Drying	12	Basics of drying and application
Practical Topics	**Week**	**Learning Outcome**
Temperature Measurements and Calibration	1	Thermometer readings and calibration technique
Thermal conductivity	2	Measuring thermal conductivity of materials

Free and Forced Convection	3	Concepts of convection heat transfer
The effect of varying flow rate-parallel flow double pipe heat exchanger	4	Basic design of heat exchanger
The effect of varying flow rate-counter flow double pipe heat exchanger	5	Basic design of heat exchanger
The effect of varying flow rate-parallel flow shell and tube heat exchanger	6	Basic design of heat exchanger
The effect of varying flow rate-counter flow shell and tube heat exchanger	7	Basic design of heat exchanger
The effect of varying water flow rate on the performance of mechanical draught cooling tower	8	The approaches of mechanical draught cooling tower
Estimate the evaporation rate of water (water loss) for the cooling tower	9	Factors affecting Water evaporations
Gas absorption in packed tower with Raschig rings packings	10	Absorption process and the function of packings
Rotary dryer	11	Study and analysing the rate of drying

Questions Example Design

Ex. 1: Calculate the equivalence ratio for the following system, if you know the A/F Actual = 12: 1 :

Solution:



Let complete combustion:

$$CH_4 + 2O_2 + 3.76N_2 \longrightarrow CO_2 + 2\,H_2O + 3.76N_2$$

$$\text{A/F Stoic.} = \frac{\text{M.weight[air]}}{\text{M.weight[fuel]}}$$

$= \frac{10.58}{12} = 0.88$A/F Stoic. $= \frac{[2\times32]+[3.76\times28]}{[16]} = 10.58$

Equivalence Ratio [θ] $= \frac{\text{A/F stoic.}}{\text{A/F actual}}$

θ<1 The mixture is lean.

Ex. 2: 20 kg of (C_3H_8)fuel burned with 400kg of air to product CO_2 and H_2O, what is the equivalence ratio for the following system, if you know the A/F Actual = 11 : 1 ?

Solution:

$C_3H_8 + 5O_2 + 3.76\ N_2 \longrightarrow 3CO_2 + 4H_2O + 3.76\ N_2$

Basis: 20 kg of C_3H_8 and 400kg of air [O_2, N_2]

A/F Stoic. $= \frac{\text{M.weight[air]}}{\text{M.weight[fuel]}}$

$$\frac{A}{F}\text{Stoic.} = \frac{\frac{400}{160} + \frac{400}{105.28}}{\frac{20}{44}} = 13.85$$

Equivalence Ratio [θ] $= \frac{\text{A/F stoic.}}{\text{A/F actual}} = \frac{13.85}{11} = 1.25$

Ex.2: In an air-carbon dioxide mixture at 298 K and 202.6 kPa, the concentration of CO_2 at two planes (3 mm) apart are 25 vol.% and 15 vol.% respectively. The diffusivity of CO_2 in air at 298 K and 202.6 kPa is 8.2×10^{-6} m^2/s. Calculate the rate of transfer of CO_2 across the two planes, assuming:

a. Equimolecular counter diffusion.

b. Diffusion of CO_2 through a stagnant air layer.

Solution:

$P_{A1} = y_{A1} . P_T = (0.25)\ 202.6 = 50.65$ kPa

$P_{A2} = y_{A2} . P_T = (0.15)\ 202.6 = 30.39$ kPa

a. Equimolecular counter diffusion:

$$N_A = \frac{D_{AB}}{RT}\left[\frac{P_{A_1} - P_{A_2}}{z_2 - z_1}\right]$$

$$N_A = \frac{8.2\ X\ 10^{-6}}{8.314\ (298)}\left[\frac{50.65 - 30.39}{3\ X\ 10^{-3}}\right] = 2.23X10^{-5}\ \frac{\text{kmol}}{m^2.s}$$

b. Stagnant diffusion.

$$N_A = \frac{D_{AB}}{RT} \frac{P_T}{d_z} \, Ln\left[\frac{P_T - P_{A_2}}{P_T - P_{A_1}}\right]$$

$$N_A = \frac{8.2 \, X \, 10^{-6}}{(8.314)(298)} \frac{202.6}{3 \, X \, 10^{-3}} \, Ln\left[\frac{202.6 - 30.39}{202.6 - 50.65}\right] = 2.79 \, X \, 10^{-5} \frac{kmol}{m^2.s}$$

Extra notes:

External Evaluator