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**Department of Chemical – Petrochemical Engineering**

**College of Engineering**

**University of Salahaddin - Hawler**

**Subject: Heat Transfer**

**Course Book –Year – 3rd , Semester – 5th**

**Lecturer's name: Asst. Prof. Dr. Mohammed J. Barzanjy**

**Academic Year: 2022 - 2023**

**Course Book**

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| **1. Course name** | **Mass Transfer – I** | |
| **2. Lecturer in charge** | **Asst. Prof. Dr. Mohammed Jawdat Barzanjy** | |
| **3. Department/ College** | **Mechanical Engineering / Engineering** | |
| **4. Contact** | **e-mail: dr\_m.barzanjy@yahoo.com**  **Tel: (optional)** | |
| **5. Time (in hours) per week** | **Theory: 04 ( Theoretical : 04 )**  **Practical: 02** | |
| **6. Office hours** | **10 hours** | |
| **7. Course code** | **CPE3025** | |
| **8. Teacher's academic profile** | **B.Sc. Mechanical Engineering – 1991**  **B.Sc. Artillery and Rocket Mechanics – 1992**  **M.Sc. Applied Mechanics – 1997**  **Ph.D. Thermal Powers ( Heat and Mass Transfer, Aerodynamics ) – 2007**  **Worked as academic employment ( University lecture ) from 1991.** | |
| **9. Keywords** | **Concentration, Fluxes, Fick's Law, Diffusion, Stationary Media, equimolar** | |
| **10. Course overview:**  The course treats the advanced methods used in Mass Transfer and elucidates the deep information about the modelling of problem. Also treat the following general topics:   1. Covers an advanced method used to solve the engineering problems. 2. Modelling the engineering problem and solved it by new accurate methods of numerical analysis.   Mass Transfer – I, is a well established topic in chemical engineering, taught to the senior students in 3rd year ( 5th semester ) through as follows:  1. A **theoretical** weekly program of **four** hours.  2. A **practical** weekly program of **two** hours. | | |
| **11. Course objective:**   1. Acquire specialized knowledge in modelling the engineering problems and solve by new methods with good accuracy. 2. Use the update advanced numerical methods and compare the results with the engineering analysis methods results 3. Opportunity of deep analysis of advanced engineering and numerical methods. | | |
| **12. Student's obligation**  For the student to achieve a level of excellence in the subject, the following items should be given utmost consideration:   1. Class attendance on regular basis for the purpose of learning. 2. Active participation in class discussions. 3. Reviewing the lecture notes and topics on weekly basis, noting the ambiguous points, if any, and requesting clarification during instructor office hours. 4. Visiting the library on regular basis and checking the internet for other approaches or simplifications of topics and ideas. 5. Giving adequate and sufficient priority to preparing for weekly, monthly and final tests. | | |
| **13. Forms of teaching**  Due to very equations and rules driving, the essence of teaching program is presented on white board. Sometimes, some explanations of details are prepared on MS power point. There are also assignments and seasonal projects appointed to individual students or groups that help the evaluation process and also support team work effort. | | |
| **14. Assessment scheme**  Attaining the requirements set to succeed in Mass Transfer – I, requires developing an engineer sense, relating to this topic, based on an emergent analytical and problem solving skills and memorizing topics can't secure success. In education system, the maximum mark is ( 100 % ). The grading system is based on the summation of 2-categories of evaluations as:   1. First, ( 40 % ) of the mark is based on an academic semester effort of the student which includes but is not restricted to the following:   - One examination ( 25 % ), for which the study material is set for the topics reviewed in that particular semester.  - Quizzes ( 5 % multiple by 2 ) = 10 %, for which the study material is limited and assigned by the instructor.  Active participation of the student in the classroom attendance, activities and discussions may be rewarded by the instructor for up to a limit not exceeding ( 5 % ) as a general support margin, on the same basis for all of the students.   1. Second, ( 60 % ) of the mark is based on a final examination that is comprehensive for the whole of the study material reviewed during an academic semester and it usually occurs during the month of January of each year.   At the end of the evaluation process, if the students could not secure a minimum of ( 50 % ), they are given a chance to repeat the final examination after two weeks and they should be able by then to equal or exceed the ( 50 % ) limit otherwise they will have to repeat this subject during the next academic year if it did not contradict with the administrative regulations. ‌ | | |
| **15. Student learning outcome:**  Upon completion of the subject, students will be able to:  a. Obtain fundamental knowledge in the area of modes of Mass Transfer.  b. Apply their knowledge, skills and hand-on experience to the analysis of Diffusion Mass Transfer.  c. Extend their knowledge of chemical engineering to different situations of engineering context and professional practice in Transforming Phenomenon.  d. Recognize the need for and an ability to engage in life-long learning. | | |
| **16. Course Reading List and References‌:**   1. - Chemical Engineering, Volume 1, Sixth edition   Fluid Flow, Heat Transfer and Mass Transfer  J. M. Coulson and J. F. Richardson with J. R. Backhurst and J. H. Harker   1. Chemical Engineering, Volume 2, Fourth edition   Particle Technology and Separation Processes  J. M. Coulson and J. F. Richardson with J. R. Backhurst and J. H. Harker   1. Chemical Engineering, Volume 6, Third edition   Chemical Engineering Design  R. K. Sinnott | | |
| **17. The Topics:** | | **Lecturer's name** |
| Chapter One – **Mass transfer** | | Asst. Prof. Dr. Mohammed Jawdat Barzanjy |
| 1.1 Introduction | |
| 1.2 Modes of mass transfer | |
| 1.3 Concentration difference | |
| Chapter Two – **Diffusion** | |
| 2.1 Introduction | |
| 2.2 Diffusion in binary gas mixtures | |
| 2.3 Properties of binary mixtures | |
| 2.4 Equimolecular counter diffusion | |
| 2.5 Mass transfer through a stationary second component | |
| 2.6 Mass transfer velocities | |
| 2.7 General case for gas-phase mass transfer in a binary mixture | |
| 2.8 Diffusion as a mass flux | |
| 2.9 Thermal diffusion | |
| 2.10 Unsteady-state mass transfer | |
| 2.11 Equimolecular counter diffusion | |
| 2.12 Gas absorption | |
| Chapter Three – **Multi component gas - phase systems** | |
| 3.1 Molar flux in terms of effective diffusivity | |
| 3.2 Maxwell's law for a binary system | |
| 3.3 Equimolecular counter diffusion | |
| 3.4 Transfer of A through stationary B | |
| 3.5 Maxwell's Law for multi component mass transfer | |
| Chapter Four – **Diffusion in liquids** | |
| 4.1 Introduction | |
| 4.2 Liquid phase diffusivities | |
| Chapter Five – **Mass transfer across a phase boundary** | |
| 5.1 Introduction | |  |
| 5.2 The two-film theory | |  |
| 5.3 The Penetration Theory | |  |
| 5.4 Mass transfer to a sphere in a homogenous fluid | |  |
| 5.5 Other theories of mass transfer | |  |
| 5.6 Mass transfer coefficients | |  |
| **19. Examinations:**   1. A vessel contains a binary mixture of ( O2 and N2 ) with partial pressures in the ratio ( 0.21 and 0.79 ) respectively, at temperature of ( 15 oC ). The total pressure of the mixture is ( 1.1 bar ). Calculate the following for each species:  * Molar concentrations * Mass densities * Mass fractions * Molar fractions  1. The tyre tube of a vehicle has a surface area of ( 0.62 m2 ) and the wall thickness of ( 10 mm ). The tube has air filled in it at a pressure of ( 2.2 bar ). The air pressure drops to ( 2.18 bar ) in the period of ( 6 days ). The solubility of air in the rubber is ( 0.075 m3 ) of air / m3 of rubber at ( 1.0 bar ). The volume of air in the tube is ( 0.034 m3 ) and operating temperature is ( 300 K ). Calculate diffusivity of air in the rubber.   Assumptions:   * Steady diffusion of air in a tube * Gas constant of air = 0.287 kJ/kg.K * Constant properties * Atmospheric pressure = 1.0 bar   Notes:   * Δ m = m1 – m2 * Pm = 0.5 ( P1 + P2 ) * S = 0.075 Pm | | |
| **20. Extra notes:**  Due to a number of unforeseen reasons that may lead to shifting of the academic year program, it may be subjected to modifications. Also extra curriculum hours may be needed to cover all the topics. The students shall be notified of the changes if and when they may occur. | | |
| **21. Peer reviewپێداچوونه‌وه‌ی هاوه‌ڵ** | | |