**Unit Operations II.**

**Code:**  **MFKVM32K04\_EN**

**ECTS Credit Points: 4**

Year, Semester: 2nd year/2nd semester

Number of teaching hours/week:

Lecture: **2**

Practice: **4**

**Prerequisites: Unit Operations I.**

**Topics**:

General characterization of transfer processes. Classification of transfer processes.

Heat transfer. General characterization of heat transfer. Heat transfer by convection, conduction and radiation. Application of dimensional analysis to heat-transfer by convection. Heating and cooling. Heat transfer at standard- and changeable temperature difference. Unsteady- and steady state transfer of heat. The logarithmic mean temperature difference. Heat exchangers.

Evaporation and crystallization. Mass transfer processes. Mass transfer across a phase boundary, the two-film theory. Common interpretation of the operating line and the equilibrium curve. Mass transfer in the columns, the transfer units. Mass transfer in the cascades, the equilibrium units.

Seminars/Practice: Problem-solving technique. Examples- and problems-solving in Unit operations II.

**Literature:**

Required:

Waren L. McCabe; Julian C. Smith; Peter Harriott: Unit Operation of Chemical Engineering. Seventh Edition, McGraw Hill Higher Education. 2005. ISBN 007-124710-6

Recommended:

1. Christie J. Geonkoplis: Transport Processes and Separation Processes Principles. (Includes Unit Operations). Fourth Edition, 2008. ISBN 0-13-101367-X
2. D. W. Green – R. H. Perry: Perry’s Chemical Engineers’ Handbook. 8th Edition, McGraw-Hill 2008. ISBN 978-0-07-142294-9

**Schedule**

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| **1th week:**  **Lecture/Seminar:** Introduction and mechanisms of heat transfer**.** General characterization of transfer processes.  **2nd week:**  **Lecture/Seminar:** Introduction to steady-state heat transfer. Basic mechanisms of heat transfer. Conduction, convection, transfer stream and radiation.  **3th week:**  **Lecture/ Seminar:** Heat stream by bulk flow. Fourier’s law of heat conduction. Thermal conductivity. Heat transfer. Newton’s law of cooling. Convective heat transfer coefficient.  **4th week:**  **Lecture/Seminar:** Conduction heat transfer. Conduction through a flat slab or wall. Conduction through a hollow cylinder. | **5th week:**  **Lecture/ Seminar:** Conduction through solids in series. Plane walls in series. Multilayer cylinders. Conduction through materials in parallel.  **6th week:**  **Lecture/ Seminar:** Combined convection and conduction and overall heat transfer coefficient.    **7th week:**  **Lecture Seminar /:** Conduction with internal heat generation.  **8th week:**  **Lecture/ Seminar:** **Mid-term test**  **9th week:**  **Lecture/ Seminar:** Heat exchangers. Types of heat exchangers. Log-mean temperature. |
| **10th week:**  **Lecture/ Seminar:** Introduction to radiation heat transfer. Basic equation of radiation. Radiation to a small object from surroundings.  **11th week:**  **Lecture/ Seminar:** Combined convection and radiation heat transfer.  **12th week:**  **Lecture/ Seminar:** Dimensional analysis in heat transfer. Buckingham method. | **13th week:**  **Lecture/ Seminar:** Evaporation and crystallization  **14th week:**  **Lecture/ Seminar:** Introduction to mass transfer processes. Equilibrium of mass transfer processes. Classification of mass transfer processes.  **15th week:**  **End-term test** |

**Requirements**

**A, for signature:**

Participation at **seminar** is compulsory. Student must attend the seminars and my not miss more than three seminar during the semester. In case a student misses more than three, the subject will not be signed and the student must repeat the course. The attendance on seminar will be recorded by the seminar leader. In case of further absences, a medical certificate needs to be presented. During the semester there are two tests: the mid-term test is in the 8th week and the end-term test in the 15th week. Students have to sit for the tests.

**B, for grade:**

The course ends in **mid-semester grade**. The mid-semester grade is calculated as an average of the two tests’ results. The minimum requirement for the mid-term and end-term tests is 60%. Based on the score of the tests separately, the grade for the tests is given according to the following table:

Score Grade

0-59 fail (1)

60-69 pass (2)

70-79 satisfactory (3)

80-89 good (4)

90-100 excellent (5)

If the score of any test is below 60, the student once can take a retake test covering the whole semester material.