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| **Title and Code** of the subject:  **Unit operations in food processing II. MTBE7017A** | **ECTS Credit Points: 5** |
| **Type** of the subject: **compulsory** | |
| **Ratio of theory and practice: 50/50%** (credit%) | |
| **Type and number of classes per semester**: 28 hours lecture and 28 hours practice per **semester**  Number of teaching hours / week : 2+2 (lecture and practice) | |
| **Type of exam**: exam (written test) | |
| **Subject in the curriculum:** semester 4. | |
| Preliminary requirements:**Unit operations in food processing I. MTBE7013A** | |

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| **Summary of content - theory**: |
| Within the framework of Unit operations in food processing II subject mass transfer operations are educated. In the lectures mathematical description, equipment and conditions of the mass transfer operations are discussed. The application of fundamental laws and equations takes place in the seminars.  **Schedule:**   1. Introduction. Mass transfer operations in the food industry. 2. The purpose of mass transport. Introduction to mass transfer and diffusion. 3. Characterization of diffusion processes. 4. Gas absorption (processes, conditions, equipment). 5. Distillation (processes, conditions, equipment). 6. Rectification (processes, conditions, equipment). 7. Adsorption (processes, conditions, equipment). 8. Ion exchange (processes, conditions, equipment). 9. Extraction: liquid-liquid extraction, solid-liquid extraction (processes, conditions, equipment). 10. Supercritical extraction (processes, conditions, equipment). 11. Crystallization (processes, conditions, equipment). 12. Drying (processes, conditions, equipment). 13. Membrane separation (processes, conditions, equipment). 14. Classification operations |
| **Summary of content - practice**: |
| In the frame of the exercise classes equations and methods are described. The chemical industry has been present in the food industry for a long time, so the relationships that were originally designed for ideal gases and Newtonian fluids have a great role to play. In addition, many empirical rules and practices have been used that have been developed on the basis of experience, since food processing and manufacturing mainly do not deal with Newtonian fluids, but with semi-solid or solid materials.  **Schedule:**   1. Fick's 1st law of diffusion. Molecular diffusion in gases and liquids. 2. Estimation of diffusion coefficients in gases, liquids. 3. Molecular diffusion in solids. 4. Solubility of gases in liquids: application of Henry's law. 5. Determining of the number of equilibrium stages of countercurrent multistage absorption by graphical and analytical methods. 6. Calculation of steam-liquid equilibrium: application of the Dalton's and Rault's laws. Investigation of volatility of components, determination of relative volatility. 7. Graphical solution of the Rayleigh equation in case of simple batch distillation. 8. Determination of the number of theoretical stages of the rectification by McCabe-Thiele method and graphical determination of minimal reflux ratio. 9. Investigation of adsorption equilibrium: use of Freundlich isotherm and Langmuir isotherm. 10. Graphical determination of the number of multistage countercurrent extractions by Ponchon-Savarit method. 11. Determination of solubility and size of crystals using the Kelvin equation. 12. Determination of the absolute humidity, humidity and dew point of the air. Interpretation of psychometric diagram. 13. Setting the drying conditions: time required for drying, applied air speed. 14. Hydraulic permeability of membranes. Determining the amount of permeate during reverse osmosis. |
| **Literature, handbooks in English** |
| 1. Christie John Geankoplis: Transport Processes and Unit Operations (3rd Edition), Prentice Hall PTR, New Jersey, 1993. ISBN-13: 978-0139304392 ISBN-10: 0139304398 2. George D. Saravacos, Zacharias B. Maroulis: Food Process Engineering Operations, CRC Press, 2011. ISBN 9781420083538 3. Zeki Berk: Food Process Engineering and Technology, 2nd Edition, Academic Press, 2013. ISBN 9780124159235 |
| **Competencies gained** *(acc. to the Regulation on training and outcome requirements)* |
| 1. **Knowledge:**   The student knows and understands the principles, machines, equipment and instruments of widely understood food industry operations, as well as their operation in practice.   1. **Skills:**   The student is able to perform sub-tasks in the development, design of technological systems, and in the development of new processes and products.   1. **Attitude:**   The student is susceptible to acquire the knowledge needed to work with devices and equipment related to food processing.   1. **Autonomy and responsibility:**   The student solves professional problems in the field of food industry independently or in cooperation with others, with individual responsibility and the observance of the ethical standards of the profession. |

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| **Responsible lecturer: : Prof. Dr. Kovács Béla Róbert, professor, PhD** |
| **Other lecturer(s): Dr. Bérczesné Szojka Anikó, assistant lecturer** |

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| **Terms of course completion:** |
| During the semester, the student may write 2 tests containing theoretical questions, based on which he may get an offered mark for the exam. In addition, students have to write 2 tests containing questions connected to the topics of the seminar, and they will get the mark for the seminar based on these tests. |
| **Form of examination:** |
| Written exam |
| **Requirement(s) to get signature:** |
| Participate in the practices and successful practice tests (min 60%). |

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| **Exam questions:** |
| 1. What is diffusion? 2. What is the purpose of mass transport? 3. Describe molecular diffusion and bulk flow! 4. What is Fick's law? + formula 5. Describe the equimolar counter diffusion of gases! 6. A diffusing through stagnant, nondiffusing B in gases. 7. What are the characteristics of molecular diffusion in liquids? 8. What factors influence the diffusion of proteins in solution? 9. Describe of the diffusion in gels! 10. Describe the diffusion in solids! 11. What is absorption? 12. What are the requirements of the solvent (in absorption processes)? 13. What Is Henry's law? + formula 14. How can we determine the number of the stages of a countercurrant multiple absorber? (the presentation of the graphical method, the name of the analytical equation) 15. What kinds of equipment are used for absorption? (listing) 16. What is distillation? 17. What is equilibrium vapor pressure? 18. How does the boiling point depend on pressure? 19. Which laws characterize the vapor-liquid balance? + formula 20. What is volatility? + formula 21. What is relative volatility? + formula 22. What are the differences between batch and continuous distillation? 23. Continuous distillation under constant pressure. 24. Flash distillation with pressure reduction. 25. Continuous distillation by partial condensation. 26. What is rectification? 27. What is reflux (in rectification process)? 28. What kinds of tray columns are used for rectification? 29. What are the properties of the random packed columns? 30. What are the properties of the structured packing columns? 31. What are the advantages and the disadvantages of the rectifying towers? 32. What is adsorption? 33. What are the applications of adsorption? 34. What are the properties of the adsorbents? 35. Which are the main adsorbents? 36. What kinds of adsorption isotherms are used to determine equilibrium conditions during adsorption? (listing) 37. What is ion exchange? 38. What kinds of resins isotherms are used for ion exchange? 39. What are the main technological objectives of food dehydration? 40. What are the main drying methods? 41. What is humidity? 42. What is saturation humidity? 43. What is relative humidity? 44. How does the psychrometer work? 45. What information can be read from the psychrometric chart? 46. How does the experimental determination of the drying rate happen? 47. What are the pressure-driven membrane processes? 48. What kind of membrane materials do you know (+ an example)? 49. How are asymmetric membranes made up? (4) 50. Characterize the plate- and frame membrane module! 51. Characterize the plate- and frame membrane module! 52. Characterize the tubular membrane module! 53. What are the differences between cross-flow and dead-end filtration? 54. What is gel polarization? 55. What is osmosis? 56. What is osmotic balance? 57. What is reverse osmosis? 58. What are the applications of microfiltration in the food industry (two examples)? 59. What are the applications of ultrafiltration in the food industry (two examples)? 60. What are the applications of reverse osmosis and nanofiltration in the food industry (two examples)? 61. List the main steps of extraction! 62. What factors influence extraction? 63. Which are the characteristics of the extraction solvent? 64. In which case is the use of extraction instead of distillation justified? 65. Describe the mechanism of solid–liquid extraction! 66. Write four examples for the applications of solid–liquid extraction! 67. How does the Carussel extractor work? 68. How Does The Belt Extractor Work? 69. What is Critical Temperature? 70. In which cases is supercritical fluid extraction applied? 71. Characterize carbon dioxide as a solvent for supercritical fluid extraction? 72. Write three differences between crystalline and amorphous materials! 73. Which parameters affect the balance of the two-component systems? 74. What is saturation and supersaturation? 75. What processes are happening in the following zone: unsaturated zone, metastable zone, supersaturation zone? 76. Characterize the solubility graph! 77. What is nucleation? 78. What is the difference between the homogeneous and the heterogeneous nucleation? 79. Describe the crystal growth! 80. Characterize the vacuum crystallizer! 81. Characterize the Swenson-walker continuous crystallizer! |