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| **Title** of the subject: **Instrumental analytics MTBE7020A** | **ECTS Credit Points: 4** |
| **Type** of the subject: compulsory |
| **Ratio of theory and practice: 50-50%**  |
| **Type and number of classes per semester**: 2 hour(s) lecture and 2 hour(s) practice per **semester**  |
| **Type of exam**: exam mark |
| **Subject in the curriculum:** semester 4 |
| Preliminary requirements:- |

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| **Summary of content - theory**:  |
| Course objectives: The basic objective of the course is to acquaint students with the most important instrumental chemical analytical knowledge required to determine the quality and components of food, food raw materials and food ingredients.**Schedule:** 1: Introduction, history of analytical chemistry. 2: Basic concepts in analytical chemistry, the process of analysis, the accuracy and forms of the results, basic statistical concepts, validation of measurement methods. 3: Classical methods of qualitative analysis, typical reactions, flame colouring and other methods. 4: Basic physical measurements in analytical chemistry. Mass, volume, density, conductivity and pH. 5: Classical analytical measurement methods. Precipitation based on classical analytical methods, gravimetry. Titrations. 6: The volumetric methods of analysis and their groups. Acid-base titrations. Complexometric titrations. Redox titrations. 7: The UV/VIS photometry. Apparatuses, methods and applications. Infrared spectroscopy. 8: Flame photometry (FES). Flame atomic absorption spectrometry (AAS). Graphite furnace atomic absorption spectrometry (GF-AAS). 9: Inductively coupled plasma optical emission spectrometry (ICP-OES).10: Chromatographic methods principles, classification, fields of application.11: GC and HPLC methods, apparatuses, fields of application.12: Mass spectrometry, mass spectrometry coupled systems (GC-MS, HPLC-MS, ICP-MS)13: Comparing of analytical methods.14: Sample preparation methods. |
| **Summary of content - practice**: |
| Skills to be learnt: Learning to use the various instrumental chemical analytical techniques to determine the quality and components in various samples of food, food raw materials and food ingredients.**Schedule:**1: Calibration2 and 3: Performance characteristics4 and 5: UV-Vis spectrophotometric method6 and 7: Conductometry8: Thin layer chromatography9 and 10: High performance liquid chromatography10 and 11: Analysis of capsaicin and dihydrocapsaicin contents12: Sample preparation for elemental analysis13: Flame atomic absorption spectrometry14: Inductively coupled plasma optical emission spectrometry |
| **Literature, handbooks in English**  |
| 1. Boss, C. B. & Fredeen, K. J., 1997. Concepts, instrumentation, and techniques in inductively coupled plasma optical emission spectrometry. Perkin Elmer. USA.
2. Cresser, M. S., 1994. Flame spectrometry in environmental chemical analysis. The Royal Society of Chemistry. Cambridge.
3. Montaser, A. & Golightly, D. W., 1987. Inductively coupled plasmas in analytical atomic spectrometry. VCH Publishers. New York.
4. Montaser, A. 1998. Inductively coupled plasmas mass spectrometry. VCH Publishers. New York.
5. Pare J.R.J. and J.M.R. Belanger, 1997. Instrumental methods in food analysis. Environment Canada, Environmental Technology Centre, Ottawa, Ontario, Canada, Elsevier, Amsterdam - Lausanne - New York - Oxford - Shannon - Tokyo.
6. Heftmann E., 1992. Chromatography, fundamentals and applications of chromatography and related differential migration methods. Part A: fundamentals and techniques. Elsevier, Amsterdam - Oxford - New York - Tokyo.
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| **Competencies gained** *(acc. to the Regulation on training and outcome requirements)* |
| 1. **Knowledge:**
* Students know the basic principles of laboratory examination for food technology and food safety analysis.
1. **Skills:**
* Students have the ability to learn laboratory techniques, taking into account the environmental and health protection standards, and applying new methods in the whole area of food production.
1. **Attitude:**
* Students are committed to food quality, food safety and environmentally friendly solutions that support the health of the individual and society.
* Students are receptive to learn the needed theory, in order to understand how equipments and tools, used in food industry, function.
1. **Autonomy and responsibility:**
* Students areable to take responsibility for their own work and for the work of their colleagues under their supervision as well.
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| **Responsible lecturer: Prof. Dr. Béla Kovács, professor, PhD** |
| **Other lecturer(s): Dr. Éva Bacskainé Bódi, Áron Soós** |

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| **Terms of course completion:** |
| 1. Completing laboratory exercises
2. Written exam (minimum marks when percentage is 60%)
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| **Form of examination:** |
| Written exam |
| **Requirement(s) to get signature:** |
| Participate in the practices and successful practice tests |

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| **Exam questions:** |
| 1. Please calculate! eg.:

mg/kg=............% (1 point)ug/g=............ ng/g (1 point)%=............ μg/g (1 point)ppb=............ μg/kg (1 point)ppt=............ ppq (1 point)1. Write down the definition of these concepts!

- Selectivity (2 points)- Robustness/ruggedness (2 points)- Range of measurement (2 points)- Linearity (2 points)- Sensitivity (Fig.) (2+2 points)- Detection limit (Equations) (2+2+2 points)- Quantitation limit (Equations) (2+2+2 points)- Accuracy (2 points)- Precision (2 points)- Repeatability (2 points)- Reproducibility (2 points)- Calibration method (4 points)- Standard addition method (4 points)- Internal standard method (4 points)- Isotope-dilution process (2 points)- The retention time (2 points)1. Describe the main steps of inorganic environmental analysis and estimation of the level of errors for the various steps (10 points)
2. Write down each step of the sample preparation of the inorganic environmental analysis. (7 points)
3. Please explain what chromatography means! (2 points)
4. Please explain the supercritical fluid chromatography (fig. also)? (5+4 points)
5. Please write down the mass of molecules to be analyzed in organic analysis? (6 points)
6. Please write down the types of chromatography (tree structure)? (12 points)
7. The two most important information on the chromatogram and their explanation. (4 points)
8. Write down the formulas needed to determine the terms and explain the meaning of the letters contained therein!

- retention factor (2 points)- theoretical plate number (2 points)- separation factor (2 points)- HETP (2 points)- resolution (2 points)1. The structure of the gas chromatograph (schematically). (8 points)
2. Write down the four kinds of carrier gas most commonly used in gas chromatographs. (4 points)
3. Please list some examples of measured components by gas chromatography? (5 points)
4. Types of gas chromatography detectors (4 points)
5. Schematic representation of a system for HPLC, furthermore, please give me some details of the parts also (5+10 points)
6. A list of at least eight detectors in LC. (8 points)
7. Fields in which High Performance Liquid Chromatography is used! (5+5 points)
8. The structure of atomic absorption spectrometers (schematically). (7 points)
9. Please write the Planck and Lambert-Beer equations and the meanings of the letters! (4+4 points)
10. Electrothermal atomization process (Figure+detailes). (5+5 points)
11. Flames and their combustion rate, moreover, the flame temperature. (5+5+5 points)
12. The ICP-OES design (schematic). (7 points)
13. Type of sample introduction technics in ICP-OES technology. (5 points)
14. The different plasma view in ICP-OES. (2 points)
15. The excitation process in ICP-OES method. (8 points)
16. Different characteristics in ICP-OES: application areas, the range of detection limits, sample throughput, sample volume, dynamic range, precision, number of elements (7 points)
17. Different characteristics in FAAS: application areas, the range of detection limits, sample throughput, sample volume, dynamic range, precision, number of elements (7 points)
18. Different characteristics in GF-AAS: application areas, the range of detection limits, sample throughput, sample volume, dynamic range, precision, number of elements (7 points)
19. Different characteristics in ICP-MS: application areas, the range of detection limits, sample throughput, sample volume, dynamic range, precision, number of elements (7 points)
20. The main parts of ICP-MS equipment and the operating principle. (6+2 points)
21. Various pressure values in different parts of the ICP-MS apparatus. (3 points)
22. Types of mass spectrometers. (3 points)
23. Please list the electromagnetic radiations and their wavelength ranges (8 + 8 points)
24. Please list at least four cations and four anions that can be measured by ultraviolet-visible absorption spectrophotometry. (8 points)
25. Please draw and explain the principle of spectrophotometer operation? (8 points = 6 points for drawing + 2 points for explanation)
26. Please list the types of lightsources in an UV-VIS spectrophotometer, at what wavelength ranges can they operate? (2+2 points)
27. Please list the various types of UV-VIS spectrophotometers? (12 points)
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