| INDBIOT-08 | **BIOPROCESS PLANT DESIGN** |
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| **GENERAL INFORMATION** | |
| Course Coordinator(s) | Darko Velić, PhD, full prof. |
| Associate(s) | Krunoslav Aladić, PhD, assist. prof. |
| Study Programme | Interdisciplinary Graduate Study Programme in English: Biotechnology |
| Course Status | Obligatory |
| Year of Study, Semester | 2nd Year / 4th Semester |
| Credits (ECTS) | 4 |
| Teaching Method (number of classes) | Lectures 20; Seminars 15; Exercises 15 |
| Expected Number of Students in the Course | 25-30 |

**COURSE DESCRIPTION**

**Course Aims**

The aim of this course is to get acquainted with the crucial stages of bioprocess plant design; from project design, procurement and installation of bioprocess equipment to production start-up. Furthermore, the goal is to introduce students to pre-design and design conditions of the bioprocess plant.

**Prerequisites for Enrolment and the Entry Competencies Required for the Course**

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**Learning Outcomes at the Programme Level Contributed by the Course**

INDBIOT-5; BIOTECH-7; BIOTECH-9

**Learning Outcomes at the Course Level**

After successful completion of this course students are expected to be able to:

1. Properly interpret, compare and differentiate the individual stages of bioprocess plant design.
2. Describe and analyse possible project solutions and define the project task.
3. Define and determine production standards, select optimal process solutions and estimate costs.
4. Analyse and optimise the heat exchanger network.
5. Properly interpret and differentiate legal provisions related to bioprocess plant design.
6. Compare, analyse and apply the acquired knowledge in the design of the bioprocess plant project.

**Course Content**

**Lectures.** Phases and hierarchy of bioprocess plant design. Bioprocess research and development. Scale-up of bioprocesses and bioprocess equipment. Bioprocess flowsheet - norms and standards. The material and energy balances, capacity selection. Specification of bioprocess equipment. Bioprocess measurement, regulation and automation. Simulation programs and models. Thermo-economic analysis and energy integration of bioprocesses. The pinch technology and optimisation of the heat exchanger network. Estimation of the cost of process equipment and total investment. Bioprocess security. Waste minimisation and management. Investment program. Bioprocess plant design and legislation.
**Seminars.** Calculate and analyse material and energy balances of for the selected bioprocess plant.
**Exercises.** Draw process diagrams and layout plans for the bioprocess plant using MS Visio® and CAD software.

Teaching Methods

Lectures; seminars and computer exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all

knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

**Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)***

| Class-related activity | ECTS | Learning outcome | Student activity | Evaluation method | Grade points | |
|---|---|---|---|---|---|---|
| | | | | | Min. | Max. |
| Attending classes (lectures, exercises) | 0.3 | 1-6 | Attendance at classes | Keeping records | 5 | 10 |
| Seminars | 1.2 | 3-4 | Seminar work | Oral presentation | 10 | 30 |
| Computer exercises | 0.5 | 6 | Attendance at exercises | Exercises report | 5 | 10 |
| Final exam | 2 | 1-8 | Studying for the final exam | Written exam | 30 | 50 |
| **Total** | **4** | | | | **50** | **100** |

Evaluation of the written part of the final exam

| Percentage of correct answers (%) | Grade |
|---|---|
| >95.00 | 50 |
| 90.00-94.99 | 47 |
| 85.00-89.99 | 45 |
| 80.00-84.99 | 40 |
| 75.00-79.99 | 38 |
| 70.00-74.99 | 35 |
| 65.00-69.99 | 33 |
| 60.00-64.99 | 30 |

*Forming the final grade:*
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

**Mandatory Literature (available in the library and via other media)**

| Title | Number of copies in the library | Availability via other media |
|---|---|---|
| Odum J, Flickinger MC: Process Architecture in Biomanufacturing Facility Design, Wiley, 2017. | - | - |

**Additional Literature**

1. Jacobs T, Signore AA: Good Design Practices for GMP Pharmaceutical Facilities, 2nd Ed., CRC Press, 2017.
2. Jagschies G, Lindskog E, Lacki K, Galliher P: Biopharmaceutical Processing: Development, Design, and Implementation of Manufacturing Processes, 1st Ed., Elsevier, 2017.

**Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies**

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| Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek. |
| **Note** |
| E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites. |