Level of education: **Master**
Field of study: **16.04.01 Technical Physics**

Advanced Quantum and Nanophotonic Systems

MICROFLUIDICS

Credits: 3 ECTS		
Semester		**Assessment**
2nd semester	3 ECTS	Exam

Course developers: **Anatolii Otroshchenko**

Microfluidics is an interdisciplinary science that studies the behavior of liquids at microscale, and is closely related to the development of micro- and nanotechnologies. Modern trends in microfluidics are aimed at modeling the processes of natural systems, analysis of biological objects, study of the toxicity of substances and mechanisms of affecting on living organisms, development of optical biosensors, etc. As part of the course, students are invited to familiarize themselves with microfluidic technology as a modern interdisciplinary tool for solving a wide range of problems in physics, hydraulics, dynamics, chemistry and biology. As part of the course, students will get acquainted with current trends, achievements of microfluidic technologies, develop skills and abilities in conducting research in miniaturized microfluidic systems. Additionally, within the course students will gain experience in designing and fabricating the microfluidic chips, and performing a study on a microfluidic platform.

Requirements

General Physics
Chemistry
3D-Modeling of Objects

Course structure

1. HISTORY OF MICROELECTROMECHANICAL SYSTEMS AND MICROFLUIDIC DEVICES
    1.1. History of microfluidic technologies.
2. THEORETICAL FOUNDATIONS OF PHYSICAL AND CHEMICAL PROCESSES IN MICROFLUIDIC DEVICES
    2.1. Features of fluid motion at small Reynolds numbers.

2.2. Diffusion in microsystems.
2.3. Capillary phenomena, multiphase fluid flows in microfluidic devices.
2.4. Magnetophoresis and magnetic methods of sorting micro and nanoparticles theory, examples.
2.5. Pneumonics. Streaming logistics.

3. MODELING OF PHYSICO-CHEMICAL PROCESSES IN MICROCHIPS

3.1. Basic methods of numerical solution of a system of partial differential equations. Application of software packages. Comsol Multiphysics for solving systems of differential equations describing physicochemical processes in microfluidic devices.

4. MICROFLUIDIC DEVICE MANUFACTURING TECHNOLOGIES

4.1. Introduction to the basic materials and their properties for the manufacture of microfluidic chips. Criteria for the selection of materials.
4.2. Methods of manufacturing microfluidic chips from polymer materials: familiarity with the technological route, its features and limitations. "Soft" lithography.
4.3. "Simple" microfluidic devices. Multilayer microfluidic devices, design and manufacturing features. Applications of multilayer microfluidic chips.
4.4. Methods of manufacturing microfluidic chips from various materials (polymers, glass, ceramics, metal).
4.5. Methods and features of integration of microfluidic chips, valves, microelectrodes, optical elements and control electronics into a microfluidic device.

5. METHODS OF CHEMICAL, BIOLOGICAL AND MEDICAL RESEARCH IN MICROFLUIDIC DEVICES

5.1. Isolation and sorting of biological objects (cells, bacteria and biomolecules) in microfluidic devices.
5.2. Organ-on-a-chip devices and methods of screening drugs on cell cultures in microfluidic devices.
5.3. Conducting biochemical reactions in microemulsions.
5.4. Personal medicine devices based on microfluidic technologies. POC.
5.5. Features of chemical processes (synthesis) in a microfluidic chip.

Assessment

Grading policy:

1. Presentation (an analysis of a specific research paper) - max. 40 points.
2. Research work – max. 60 points.

≥ 80 % – excellent,
≥ 60 % – good,
≥ 50 % – satisfactory,
≤ 50 % – unsatisfactory.

Faculty: **Faculty of Physics**

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Tags: **Microfluidics, microfluidic devices, diffusion in microsystems, capillary phenomena, magnetophoresis methods, magnetic methods, pneumonics, microfluidic chips**