**Name of the course:** Introduction to electron microscopy

**Department responsible for the course or** **equivalent:** Dpt. Nanotechnology and Microsystems Technology, Institute of Nanotechnologies, electronics and electronic equipment engineering

**Lecturer (name, academic title, e-mail): Dr. Alexey Kolomiytsev,** **askolomiytsev@sfedu.ru****, Dr. Oleg Ilin,** **oiilin@sefdu.ru**

**Semester when the course unit is delivered**: 7

**Teaching hours per week**: 3

**Level of course unit**: Bachelor level

**ECTS credits:** 5

**Admission requirements**: Course «Introduction to electron microscopy» requires the basic knowledge of higher mathematics (differential and integral calculus with several variables, probability calculation), digital and analogue circuit technology, electric and magnetic fields, design layout and functioning of electronic circuits, general and solid state physics, chemistry and material science.

**Course aims**: To obtain theoretical and practical knowledge and insight in transmission and scanning electron microscopy and X-ray microanalysis for the study of materials and nanodevices.

To make the students familiar with the basics of the electron microscopy techniques taught in the course and to illustrate some pratical aspects of these techniques.

The «Introduction to electron microscopy » course is taught in the 7th semester of Bachelor’s program.

**Course contents**:

The course is comprised of 3 units (and a UNIT 0). Each unit ends with a creative project worked by the students individually with guidance from the lecturer.

Unit 0: Basics of electron microscopy.

Introduction to electron-solid interactions. Energy loss. Electron sources. Principles of image formation. Electron Optics. Aberrations and Astigmatism.

Unit 1: Transmission electron microscopy.

TEM column. TEM image formation. Specimen preparation. Electron detectors. Electron diffraction. Instrumentation and software.

Unit 2: Scanning electron microscopy.

SEM column. SEM image formation. Resolution. Vacuum modes. Single beam and Dual beam systems. Image processing.

Unit 3: X-ray microanalysis in electron microscopy.

Energy dispersive and wavelength dispersive analysis. X-ray generation. X-ray detectors. Spectrum Collection. EDS mapping. Accuracy and Resolution of EDS.

**Learning outcomes**: Students will give an oral presentation on a current topic in area of electron microscopy technique.

**Planned learning activities and teaching methods:** Lectures, Lab Sessions and Project Work.

**Assessment methods and criteria**

Assignments for this course consists of: 4 projects, a midterm and final exams, and an end of term presentation.

1. Electron beam physics **Project**: one week from end of unit 10%

2. TEM **Project**: one week from end of unit 10%

3. SEM **Project** one week from end of unit 10%

4. In Class Mid term Exam 20%

5. X-ray microanalysis **Project** one week from end of unit 10%

6. Presentation in class 10 min pres. and 5 min Q&A 10%

7. Final Exam 30%

**Course literature (recommended or required):**

1. Microstructural Characterization of Materials, D. Brandon and W.D. Kaplan, Wiley & Sons.
2. Physical Methods for Materials Characterization, P.E.J. Flewitt and R.K. Wild, Institute of Physics Publishing.
3. Physical Principles of Electron Microscopy, R.F. Egerton, Springer Verlag.
4. Franssila S. Introduction to microfabrication. 2004. New Jersey: Wiley. 422 p.