# COURSE DESCRIPTION CARD - SYLLABUS

Course name
MOLECULAR ELECTRONICS

## Course

Proposed by Discipline
Materials Engineering

Year/Semester
II/4, III/6

Type of studies
Doctoral School

Course offered in
English

Form of study
full-time

Requirements
elective

## Number of hours

Lecture
4

Tutorials

Projects/seminars

## Number of credit points

1

## Lecturers

Responsible for the course/lecturer:
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Faculty of Materials Engineering and Technical Physics
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Responsible for the course/lecturer:

## Prerequisites

Knowledge: basic knowledge in modern physics (primarily solid state physics), and electronics. Basic chemistry is useful but not a formal requirement. Molecular Physics is recommended, especially for students who also intend to follow Organic Electronics.

Skills: student should have ability to find a solution to basic scientific and technological problems. Student should be able to read and understand the scientific papers. Student should be able to self-education.

Social competencies: understanding the need of self-education in terms of reading literature in field of molecular physics and teamwork.

## Course objective

Course lectures will cover topics such as: introduction to organic electronic materials and their basic properties; charge transport and energy structure of organic electronics; case studies on specific materials used in current research; optical properties (energy levels, color changes, light emission and absorption); organic electronic circuit components (diodes, transistors); structural properties of organic electronic materials, and applications of organic materials in inorganic electronic devices; techniques used in preparation of nano-electronics elements: self-assembly monolayers (SAM), Langmuir-Blodgett monomolecular films, printed and painted electronics, organic photovoltaics (solar cells); an overview of current applications and commercialization.

## Course-related learning outcomes

### Knowledge

A PhD student who graduated from doctoral school knows and understands:
1) charge transport, energy levels in organic electronic materials, and how they compare to metals and inorganic semiconductors, [P8S_WG/SzD_W01]
2) specific organic electronics materials, their properties, and applications, [P8S_WG/SzD_W02]
3) the optical properties and applications of organic electronic materials, such as in displays exemplify the architecture, characterization, and utilization of electronic components based on organic electronic materials (such as diodes, transistors), [P8S_WG/SzD_W03]
4) the use of organic electronic materials in applications summarize device fabrication techniques. [P8S_WK/SzD_W05]

### Skills

A PhD student who graduated from doctoral school can:
1) explain the fundamentals of nano-science, its applications for various fields of technology, [P8S_UW/SzD_U05]
2) describe new developments, including new optoelectronic devices, new materials and new applications in commercial devices, [P8S_UW/SzD_U05]
3) use the English language to allow active participation in the international scientific community. [P8S_UK/SzD_U08]

### Social competences

A PhD student who graduated from doctoral school is ready to:
1) critically assess the achievements within a given scientific discipline, [P8S_KK/SzD_K01]
2) fulfilling the social obligations of researchers and creators. [P8S_KO/SzD_K04]

## Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

| PQF code | Methods for verification of learning outcomes | Assessment criteria |
|---|---|---|
| W01, W02, W03, W05 | Individual rating with a presentation of general subjects related to the lecture and discussion | 50.1% - 70.0% - (3.0)<br>70.1% - 90.0% - (4.0)<br>90.1% - 100.0% - (5.0) |
| U 05, U08 | Individual rating with a presentation of general subjects related to the lecture and discussion | 50.1% - 70.0% - (3.0)<br>70.1% - 90.0% - (4.0)<br>90.1% - 100.0% - (5.0) |
| K01, K04 | Individual rating with a presentation and discussion | 50.1% - 70.0% - (3.0)<br>70.1% - 90.0% - (4.0)<br>90.1% - 100.0% - (5.0) |

## Programme content

1. Introduction to organic electronics (What is organic electronics? - brief history, properties of individual organic molecules).
2. Electron properties (from single monomolecular layers to bulk - structures, textures and optical properties).
3. Fundamentals of surface and interfacial physics (monolayers and self-assembly, micelles (structure and properties)).
4. Fabrication techniques (SAM, spin-coating (lithography), layer-by-layer, Langmuir-Blodgett films, printing, chemical functionalization).
5. Applications (application of organic molecules in nano-electronics and sensors).

## Teaching methods

Lecture: multimedia presentation including illustrations and examples.

## Bibliography

Basic

1. Encyclopedia of nanoscience and nanotechnology, Edited by H.S. Nalwa, American Scientific Publishers, 2007.

2. Nanostructures and Nanomaterials: synthesis, properties and applications, G. Cao and Y. Wang, World Scientific, 2nd edition, 2011.

3. Introduction to Molecular Electronics, Edited by M. C. Petty, M. R. Bryce, and D. Bloor (University of Durham, U.K.). Oxford University Press: New York. 1995.

Additional

1. Nanoelectronics- principles and devices, M. Dragoman and D. Dragoman, Artech House publishers, 2005.

## Breakdown of average student's workload

| | Hours | ECTS |
|---|---|---|
| Total workload | 18 | 1.0 |
| Classes requiring direct contact with the teacher | 8 | 0.5 |
| Student's own work (literature studies, preparation for tutorials, project preparation) [1] | 10 | 0.5 |

[1] delete or add other activities as appropriate