

## SYLLABUS OF A MODULE

|                                                                                                       |                                        |
|-------------------------------------------------------------------------------------------------------|----------------------------------------|
| Polish name of a module                                                                               | <b>Równania różniczkowe zwyczajne</b>  |
| English name of a module                                                                              | <b>Ordinary Differential Equations</b> |
| ISCED classification - Code                                                                           | 0541                                   |
| ISCED classification - Field of study                                                                 | <i>Mathematics</i>                     |
| Languages of instruction                                                                              | <i>English</i>                         |
| Level of qualification:<br><i>1 – BSc (EQF 6)</i><br><i>2 – MSc (EQF 7)</i><br><i>3 – PhD (EQF 8)</i> | <i>1</i>                               |
| Number of ECTS credit points                                                                          | <i>6</i>                               |
| Examination:<br><i>EO – exam oral</i><br><i>EW – exam written</i><br><i>A - assignment</i>            | <i>EW</i>                              |
| Available in semester:<br><i>S – Spring only</i><br><i>A – autumn only</i><br><i>Y - both</i>         | <i>Y</i>                               |

### Number of hours per semester:

| Lecture | Exercises | Laboratory | Seminar | E-learning | Project |
|---------|-----------|------------|---------|------------|---------|
| 30 E    | 30        | 0          | 0       | 0          | 0       |

## **MODULE DESCRIPTION**

### **Module objectives**

- O1. Making the students familiar with the methods to solve certain types of differential equations and systems of differential equations
- O2. Acquainting the students with theorems to existence and uniqueness of solutions of differential equations
- O3. Developing skill in formulating differential equation models which are found in applications within engineering, physics, biology and economics

### **PRELIMINARY REQUIREMENTS FOR KNOWLEDGE, SKILLS AND OTHER COMPETENCES**

1. Knowledge of linear algebra and calculus of one and several variables
2. Ability to use different sources of information
3. Ability to work both independently and in a group
4. Ability to correctly interpret and present student's own activities

### **LEARNING OUTCOMES**

- LO 1 – student is able to solve the selected differential equations and systems of linear differential equations and is able to give the proper interpretation of the solutions
- LO 2 – student is able to formulate and sketch the proof of the selected theorems on existence and uniqueness of solutions of differential equations
- LO 3 – student is familiar with applications of differential equations

## MODULE CONTENT

| Type of classes – Lectures                                                                                                                  | Number of hours |
|---------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| <b>Lec 1</b> – Introduction to differential equations. Definitions and terminology. Direction fields. Modeling with differential equations. | <b>3</b>        |
| <b>Lec 2</b> – First order differential equations: separable equations, homogeneous equations.                                              | <b>3</b>        |
| <b>Lec 3</b> – First order linear differential equations. Bernoulli equation.                                                               | <b>3</b>        |
| <b>Lec 4</b> – Exact equations – definitions, method of solution. Integrating factor.                                                       | <b>3</b>        |
| <b>Lec 5</b> – Second order differential equations. Basic concepts. Linear second order differential equations with constant coefficients.  | <b>3</b>        |
| <b>Lec 6</b> – Nonhomogeneous second order DE. Variation of parameters technique.                                                           | <b>3</b>        |
| <b>Lec 7</b> – Method of undetermined coefficients. Second order linear differential equation with variable coefficients - Euler equation.  | <b>3</b>        |
| <b>Lec 8</b> – Systems of linear first-order differential equations. Basic theory.                                                          | <b>3</b>        |
| <b>Lec 9</b> – Homogenous linear systems. Method of solution.                                                                               | <b>3</b>        |
| <b>Lec 10</b> – Non-homogeneous linear systems. Solutions to the nonhomogeneous systems.                                                    | <b>3</b>        |
| Type of classes – Tutorials                                                                                                                 | Number of hours |
| <b>T1</b> – Classification of differential equations. Basic concepts and examples. Direction fields, isoclines, integral curves.            | <b>3</b>        |
| <b>T2</b> – Solving separable and homogeneous differential equations.                                                                       | <b>3</b>        |
| <b>T3</b> – Solving first order linear differential equations and Bernoulli equations.                                                      | <b>3</b>        |
| <b>T4</b> – Solving exact differential equations. Integrating factor.                                                                       | <b>3</b>        |
| <b>T5</b> – Solving second order differential equations.                                                                                    | <b>3</b>        |
| <b>T6</b> – Solving nonhomogeneous second order DE. Variation of parameters technique.                                                      | <b>3</b>        |
| <b>T7</b> – Solving nonhomogeneous second order DE. Method of undetermined coefficients. Euler equation.                                    | <b>3</b>        |
| <b>T8</b> – Solving systems of linear first-order differential equations with real and complex eigenvalues.                                 | <b>3</b>        |
| <b>T9</b> – Solving nonhomogeneous systems of differential equations using undermined coefficients and variation of parameters.             | <b>4</b>        |
| <b>T10</b> – Test                                                                                                                           | <b>2</b>        |

## TEACHING TOOLS

|                                                  |
|--------------------------------------------------|
| 1. – lecture with using multimedia presentations |
| 2. – tutorials                                   |

## WAYS OF ASSESSMENT ( F – FORMATIVE, S – SUMMATIVE

|                                                      |
|------------------------------------------------------|
| <b>F1.</b> - assessment of preparation for exercises |
|------------------------------------------------------|

|                                                                                                     |
|-----------------------------------------------------------------------------------------------------|
| <b>F2.</b> - assessment of the ability to apply the acquired knowledge while doing the exercises    |
| <b>F3.</b> - assessment of activity during classes                                                  |
| <b>S1.</b> - assessment of the ability to solve the problems posed                                  |
| <b>S2.</b> - assessment of mastery of the teaching material being the subject of the lecture - exam |

\*) in order to receive a credit for the module, the student is obliged to attain a passing grade in all laboratory classes as well as in achievement tests.

## STUDENT'S WORKLOAD

| L.p.                                                                                                          | Forms of activity                                                     | Average number of hours required for realization of activity |
|---------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|--------------------------------------------------------------|
| <b>1. Contact hours with teacher</b>                                                                          |                                                                       |                                                              |
| 1.1                                                                                                           | Lectures                                                              | 30                                                           |
| 1.2                                                                                                           | Tutorials                                                             | 30                                                           |
| 1.3                                                                                                           | Laboratory                                                            |                                                              |
| 1.4                                                                                                           | Seminar                                                               |                                                              |
| 1.5                                                                                                           | Project                                                               |                                                              |
| 1.7                                                                                                           | Examination                                                           | 5                                                            |
| Total number of contact hours with teacher:                                                                   |                                                                       | 65                                                           |
| <b>2. Student's individual work</b>                                                                           |                                                                       |                                                              |
| 2.1                                                                                                           | Preparation for tutorials and tests                                   | 40                                                           |
| 2.2                                                                                                           | Preparation for laboratory exercises, writing reports on laboratories |                                                              |
| 2.3                                                                                                           | Preparation of project                                                |                                                              |
| 2.4                                                                                                           | Preparation for final lecture assessment                              |                                                              |
| 2.5                                                                                                           | Preparation for examination                                           | 20                                                           |
| 2.6                                                                                                           | Individual study of literature                                        | 15                                                           |
| Total number of hours of student's individual work:                                                           |                                                                       | 75                                                           |
| Overall student's workload:                                                                                   |                                                                       | 140                                                          |
| <b>Overall number of ECTS credits for the module</b>                                                          |                                                                       | 6                                                            |
| Number of ECTS points that student receives in classes requiring teacher's supervision:                       |                                                                       | 2,6                                                          |
| Number of <b>ECTS</b> credits acquired during practical classes including laboratory exercises and projects : |                                                                       | 1                                                            |

## BASIC AND SUPPLEMENTARY RESOURCE MATERIALS

|                                                                                                             |
|-------------------------------------------------------------------------------------------------------------|
| 1. Lecture notes                                                                                            |
| 2. Zill D. G., Cullen M. R., Differential equations with boundary-value problems, Thompson Brooks/Cole 2005 |
| 3. Trench William F., Elementary differential equations with boundary – value problems, 2013                |
| 4. Polyanin A. D., Manzhirow A., V., Mathematics for engineers and scientists, Chapman & Hall/CRC, 2007     |

**MODULE COORDINATOR ( NAME, SURNAME, DEPARTMENT, E-MAIL ADDRESS)**

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