**3.2. Course description**

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| **Generic information** |
| Head of Course | Dr. sc. Sanjin Valčić |
| Course | Application of mathematical tools in electrical engineering |
| Study Programme | Marine Electronic Engineering and Information Technology |
| Level | Graduate degree |
| Type of Course | mandatory |
| Year of Study | 1st |  |
| Estimated Student Workload and Methods of Instruction | ECTS coefficient of Student Workload | 5 |
| Number of Hours (L+E+S) | 2+2+0 |

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| **1. GENERAL COURSE DESCRIPTION** |
| *1.1. Course Objectives*  |
| *The main objective of the course is to enable students to understand and solve problems in line and surface integrals, ordinary differential equations, Laplace transform and Fourier series and transform with emphasis on application in electrical engineering.* |
| *1.2. Prerequisites for Course Registration*  |
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| *1.3. Expected Learning Outcomes*  |
| 1. Understand, set and calculate various line and surface integrals of scalar and vector fields.
2. Apply Stokes' and divergence theorem in the theory of electromagnetism, i.e. in Maxwell' s equations.
3. Find general and singular solutions of various ordinary first and second order differential equations.
4. Apply ordinary differential equations in the modeling of electrical RLC circuits.
5. Understand, interpret, and apply the properties of the Laplace transform to time dependent signals.
6. Apply the Laplace transform to solving differential equations and use the Laplace transform in the analysis of electrical RLC circuits.
7. Define and explain the orthogonality of trigonometric functions and expand periodic functions in form of trigonometric Fourier series.
8. Apply the Fourier transform in signal analysis theory, i.e., determine the amplitude and phase spectrum of a signal.
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| *1.4. Course Outline*  |
| Double integrals in a rectangular and polar coordinate system. Triple integrals in a rectangular, cylindrical and spherical coordinate system. Line integrals of scalar and vector fields. Surface integrals of scalar and vector fields. Stokes and Divergence Theorem. Application of integral calculus in theory of electromagnetism (Maxwell equations and wave equation). Ordinary first and second order differential equations. Application of ordinary differential equations in electrical RLC circuits. Laplace transform. Analysis of transient phenomena in electrical RLC circuits using Laplace transform. The excitation, response and transfer function (in the Laplace domain) of electrical systems. Trigonometric and complex exponential Fourier series. Analysis of harmonics by the development of periodic functions in Fourier series. Fourier transform and integral. |
| *1.5. Modes of* *Instruction*  | [x] Lectures[ ]  Seminars and workshops [x]  Exercises [ ]  E-learning[ ]  Field work | [ ]  Practical work [ ]  Multimedia and Network [ ]  Laboratory[ ]  Mentorship[ ]  Other \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| *1.6. Comments*  |       |
| *1.7. Student Obligations*  |
| Regular class attendance (lectures and exercises), midterms with numerical assignments, and oral examination. |
| *1.8. Assessment1 of Learning Outcomes*  |
| Course attendance | 2 | Class participation |     | Seminar paper |     | Experiment |     |
| Written exam |     | Oral exam | 1 | Essay |     | Research |     |
| Project |     | Continuous Assessment | 2 | Presentation |     | Practical work |  |
| Portfolio |     |  |     |  |     |  |     |

1 **NOTE:** Name the proportion of ECTS credits for each activity so that the total number of ECTS credits is equal to the ECTS value of the course. Use empty fields for additional activities.

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| *1.9. Assessment of Learning Outcomes and Examples of Evaluation during Classes and on the Final Exam*  |
| The procedure for evaluating the acquired learning outcomes is carried out according to the Regulations on Studies of the University of Rijeka and the Regulations on Studies at the Faculty of Maritime Studies in Rijeka as follows:* *through continuous assessment during the course the 70% of the acquired learning outcomes are evaluated: through 1st midterm - learning outcomes 1-4 (35%), 2nd midterm - learning outcomes 5-8 (35%); the student must have completed at least 50% of points in each midterm,*
* *at the final part of the exam 30% of the acquired learning outcomes (1-8) are evaluated, with the student having to pass a minimum of 50% of points for passing the final exam.*

Examples of evaluating learning outcomes in relation to set learning outcomes are:1. Calculate the electric field flow vec{E} (x, y, z) = x vec{i} + y vec{j} + z3 vec{k} through the outside of the surface x2 + y2 = z2, for which 0 < = z <= 1.
2. Using the appropriate theorem, explain Faraday's law of electromagnetic induction and write it in integral and differential form.
3. Solve the differential equation y'-y / x = x2.
4. A variable resistance resistor r (t) = t Ω and a constant capacitor C = 1 F are connected to the series with variable voltage source u (t) = et V in series. Set and solve the differential equation for the voltage across the capacitor as a function of time *t*, with the initial condition uC (0) = 0 V.
5. Calculate the Laplace transform of the function g (t) = t2u (t-2).
6. Determine the transfer function of the serial RLC circuit if the output is the voltage across the resistor. Then, with the parameters R = 4 Ω, L = 2 H and C = 1/2 F, determine the response of the circuit if the excitation e (t) = u (t) V.
7. Expand the periodic function f (x) = x, given at the interval [-π, π], in a form of a trigonometric Fourier series.
8. Determine the Fourier transform and the Fourier integral of the function f (t) = sin (3t), given at the interval [-π, π].
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| *1.10. Main Reading*  |  |  |
| * Teaching material on the e-learning system Merlin (<https://moodle.srce.hr>)
* Brnetić, I., Županović, V.: Matematika 3 – višestruki integrali, Element, Zagreb, 2009.
* Elezović, N.: Matematika 2 – diferencijalne jednadžbe, Element, Zagreb, 2010.
* Elezović, N.: Matematika 3 – Fourierov red i integral, Laplaceova transformacija, Element, Zagreb, 2010.
* Korkut, L., Krnić, M., Pašić, M.: Matematika 3 – vektorska analiza, Element, Zagreb, 2009.
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| *1.11. Recommended Reading*  |  |  |
| * https://www.wolframalpha.com/about/
* https://www.geogebra.org/
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| *1.12. Number of Main Reading Examples*  |  |  |
| *Title*  | *Number of examples*  | *Number of students*  |
| Teaching material on the e-learning system Merlin | - | 30 |
| Brnetić, I., Županović, V.: Matematika 3 – višestruki integrali, Element, Zagreb, 2009. | 3 | 30 |
| Elezović, N.: Matematika 2 – diferencijalne jednadžbe, Element, Zagreb, 2010. | 3 | 30 |
| Elezović, N.: Matematika 3 – Fourierov red i integral: Laplaceova transformacija, Element, Zagreb, 2010. | 2 | 30 |
| Korkut, L., Krnić, M., Pašić, M.: Matematika 3 – vektorska analiza, Element, Zagreb, 2009. | 3 | 30 |
| *1.13. Quality Assurance*  |
| The quality of study is constantly monitored in accordance with the ISO 9001 system implemented at the Faculty of Maritime Studies in Rijeka. An analysis of the exams is made annually and a student survey is conducted once a semester. |