# POLYTECHNIC OF MEĐIMURJE IN ČAKOVEC

## COURSE SYLLABUS

ACADEMIC YEAR: 2020/2021

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| **1. GENERAL COURSE INFORMATION** | | | | |
| **1.1 Course name** | **Thermal networks** | | | |
| **1.2 Study program/s** | Undergraduate professional study Sustainable Development | | | |
| **1.3 Course status (O,E)** | Obligation | **1.6 Mode of instruction (number of hours)** | **Lectures** | 30 |
| **1.4 Course code** | | | **Exercises** | 30 |
| **1.5 Course abbreviation** | TM | | **Seminars** | |
| **1.6 Semester** | VI | | **E-learning** | |
| **1.7 ECTS** | 4 | **1.7 Place and time of instruction** | Premises of the Polytechnic of Međimurje in Čakovec, according to the schedule published on the website | |
| **2. TEACHING STAFF** | | | | |
| **2.1 Course leader/s-title** | prof. dr. sc. Budimir Mijović | **contact** | budimir.mijovic@mev.hr | |
| | - - - | **contact** | - - - | |
| **2.2 Assistant/s- title** | Dr. sc. Mario Šercer | **contact** | mario.sercer@mev.hr | |
| | - - - | **contact** | - - - | |
| **2.3 Instruction held by- title** | - - - | **contact** | - - - | |
| **3. COURSE DESCRIPTION** | | | | |
| **3.1 Course goals** | The aim of the course is the acquisition of basic knowledge and education of students of thermotechnical mechanical engineering in the professional field of thermal networks. | | | |
| **3.2 Prerequisites** | Passed the course Heating and air conditioning. | | | |
| **3.3 Course outcomes** | After successfully passing the course, the student will be able to:<br><br>1 Interpret and valorize the mode of operation of district heating and cooling systems.<br>2. Calculate the operating parameters of heating networks.<br>3. Identify and valorize the heating network system.<br>4. Explain and investigate the principle of selection of pipelines and pipe fittings in the heating network.<br>5. Identify, isolate and estimate heat losses from district heating and cooling.<br>6. Select and apply the mode of operation of the heating network system in project tasks.<br>7. Plan and apply the method of selection of equipment for the heating network.<br>8. Analyse, evaluate and develop the heat balance of the thermotechnical system of the heating network.<br>9. Predict and calculate the elements of room cooling.<br>10. Exhibit and manage activities related to the construction and maintenance of heating networks. | | | |
| **3.4 Course content** | The course presents the contents related to the selection of the required thermal comfort of the heating and air conditioning system with the | | | |

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| | assessment and implementation of the thermal balance of the thermotechnical system. |

**3.5 Types of coursework**

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|---|---|---|---|---|---|---|---|---|---|
| x | Lectures | x | Exercises | x | Blended e-learning | x | Individual activities | | Laboratory |
| x | Seminars and workshops | x | Distant learning | x | Field classes | x | Multimedia and network | x | Mentorship |
| | Other | | | | | | | | |

**3.6 Language of instruction**

Croatian / English

**3.7 Monitoring students' work (enter the number of ECTS credits for each activity so that the total number of ECTS credits is equal to the total ECTS value of the course, 1 ECTS = 30 hours)**

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| 2,0 | Class attendance | 0,3 | Seminars | | Essay |
| 0,3 | Class activity | 0,3 | Project | | Report/paper |
| | Midterm exams | 0,3 | Practical task | 0,3 | Continuous knowledge check |
| 1,0 | Written exam | | Experimental work | | |
| 0,5 | Oral exam | | Research | | |

**3.8 Assessment and evaluation of students' work during classes and at the final exam**

| Activity specification | Percent % | Points |
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| Assessment during instruction | | |
| Attendance | 5% | 5 |
| Class activity | 5% | 5 |
| Project / Practical work | 20% | 20 |
| Seminar / Colloquium I | 20% | 20 |
| Seminar / Colloquium II | 20% | 20 |
| Oral exam | 30% | 30 |
| *Exam assessment for the students who failed to fullfil all the obligatory requirements during the semester* | | |
| *Written exam* | *60%* | *60* |
| **Total:** | **100%** | **100** |

**3.9 Assessment criteria – analysis per learning outcomes**

| Ways of evaluating learning outcomes | | | | | | | |
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| | **Atten-dance** | **Activity** | **Project** | **Mid-term exam 1** | **Mid-term exam 2** | **Practic work** | **Total** |
| Outcome 1 | | | 2 | 4 | | 3 | 9 |
| Outcome 2 | | | 2 | 4 | | 3 | 9 |
| Outcome 3 | | | 2 | 4 | | 3 | 9 |
| Outcome 4 | | | 2 | 4 | | 3 | 9 |
| Outcome 5 | | | 2 | 4 | | 3 | 9 |
| Outcome 6 | | | 2 | | 4 | 3 | 9 |
| Outcome 7 | | | 2 | | 4 | 3 | 9 |
| Outcome 8 | | | 2 | | 4 | 3 | 9 |
| Outcome 9 | | | 2 | | 4 | 3 | 9 |
| Outcome 10 | | | 2 | | 4 | 3 | 9 |
| Outcome not-related | 5 | 5 | | | | | 10 |
| **Total** | **5** | **5** | **20** | **20** | **20** | **30** | **100** |

The course has defined 10 learning outcomes, a system of scoring outcomes, in order to pass the exam the student must achieve at least 50% points for each learning outcome.

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| | The grade is calculated as follows:<br><br>• 87.51-100.00 points: rating Excellent (5)<br>• 75.01- 87.5 points: rating Very good (4)<br>• 62.51 -75.00 points: rating Good (3)<br>• 50.01- 62.5 points: rating Pass (2)<br>• 00.00- 50.00 points: rating Fail (1) | |
| **3.10 Specific features related with taking the course** | If the student collects 50% of the points of each outcome, he / she directly takes the exam, provided that he / she has done practical work (seminars / project). During the exam, it is possible to orally check the knowledge from practical work (seminars / project).<br>Once earned points for each learning outcome are no longer deleted unless the student, with the express approval of the course leader, decides to correct the result for each learning outcome, whereby the points won are deleted and newly earned points for that learning outcome are entered. The final grade is obtained on the exam period and is the sum of points earned during classes.<br>Students who did not take the colloquium access the written part of the exam where all learning outcomes are checked, and are required to have completed practical work (seminars / project) before taking the exam. | |
| **3.11 Students obligations** | Full-time students are required to attend at least 70% of the total number of hours of lectures and exercises in order to exercise the right to take the exam.<br>Part-time students are required to attend at least 30% of the total number of hours of lectures and exercises in order to exercise the right to take the exam.<br>If the student has not fulfilled all the obligations set by the course, he is obliged to attend the lectures again and meet the conditions for taking the exam.<br>Attendance can be offset by online tuition, organised webinars and added assignments given by teachers. One lesson lasts 45 minutes, and several hours form a teaching unit. Absence from one teaching unit is counted as one absence. Delays and apologies are recorded separately. In that case, if the student missed more than 50% of classes, and has a justifiable reason/apology, the request should be submitted to the Department Council, which then decides on the justification of student absences with the obligatory opinion of the course leader. | |
| **3.12 Written assignments** | Seminars / Projects | |
| **3.13 Required reading** | 1. | F. Bošnjaković: Nauka o toplini, 3 dio, Tehnička knjiga, Zagreb, 1986. ISBN 86-7059-017-4 |
| | 2. | I. Galaso: Određivanje toplinskog opterećenja prostorije, Zagreb, 1992 |
| | 3. | P. Donjerković: Osnove regulacije sustava grijanja, ventilacije i klimatizacije, Alfa Zagreb, 1996 |
| | 4. | Recknagel-Sprenger: Priručnik za grijanje i klimatizaciju, Oldenbourg 2004 |
| **3.14 Additional reading** | 1. | Propisi Hrvatske norme, pravilnici i smjernice za izvođenje, nadzor i puštanje u rad instalacija |
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| **4 ADDITIONAL COURSE INFORMATION** | | |
| **4.1 Quality control** | The quality of the program, teaching process, teaching skills and level of mastery of the material will be established by conducting a written evaluation based on questionnaires, and in other standardised ways and in accordance with the by-laws of the Polytechnic of Međimurje in Čakovec. | |
| **4.2 Contact the teacher** | Students can contact the teacher during the office hours and during classes, while for short questions and explanations they can contact him/her any day during working hours by coming in person or by landline. It is possible to ask questions and e-mail which will be answered as soon as possible. | |
| **4.3 Information about the course** | It is the obligation of each student to be regularly informed about the course. All relevant information and notices related to classes and exams, maintenance or any year, will be reported in a timely manner on the bulletin board and on the website of the Polytechnic of Međimurje in Čakovec. | |
| **4.4 Course contribution to the study program** | Course contribution to the study program in generic learning outcomes;<br><br>I1 - Interpret information, ideas, problems and solutions to professional and general public,<br>I2 - Use new technologies and techniques as part of a lifelong process learning,<br>I5 - Critically evaluate arguments, assumptions and data in order to create opinions and contributing to the solution of the problem.<br><br>The contribution of the course to the study program in specific learning outcomes;<br><br>I6 - Solve engineering problems of thermal networks using mathematics, physics, chemistry and biology,<br>I7 - Analyze the collected data in the field of heating networks,<br>I8 - Interdisciplinary solution of engineering problems of heating networks,<br>I11 - Apply basics of thermoenergetics, thermodynamics and hydromechanics in spatial design of thermal systems,<br>I12 - Develop a technical plan in the field of mechanical engineering design system,<br>I13 - Analyze the basic elements and networks in electrical engineering and justify use of non-renewable and renewable energy sources, applicable code thermal systems,<br>I14 - Apply and monitor conventional heating, cooling, and ventilation systems and devices,<br>I15 - Maintain thermotechnical systems and thermal networks at a distance,<br>I16 - Propose technical changes and upgrades to conventional ones heating systems in the direction of sustainable development. | |

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**5. ANALYSIS OF COURSE TOPICS (the number of hours is equal to the number of lectures and exercises of the course)**

**LECTURES**

| Hours | Topic and description | Method<br>• Direct teaching (lecture, instruction, pp presentation)<br>• Discovery learning (individual, lead, discussion)<br>• Group learning<br>• Case study<br>• Field classes… | Learning outcomes | Course outcome |
|---|---|---|---|---|
| **1.** | Introduce students to the lecture program, teaching conditions, literature and criteria for evaluating knowledge. Development and perspective, a historical overview of the development of heating with an impact on the development of society | Lecture, Discovery learning, Presentation | Use knowledge of historical development and future perspective projections of technical systems of ventilation, heating, cooling and air conditioning | I1 |
| **2.** | Types of systems and characteristics of the heating network, Example of the heating system, Parameters of the heating network. | Lecture, Discovery learning, Presentation | Distinguish system models and heat network features. | I1 |
| **3.** | Heating network elements. | Lecture, Discovery learning, Presentation | Distinguish the elements of the heating network | I2 |
| **4.** | The principle of heat required for the heating network. | Lecture, Discovery learning, Presentation | Use the heat principles required for the heating network | I3 |
| **5.** | The principle of heat losses in the heat network. | Lecture, Discovery learning, Presentation | Use the principles of heat loss in the heat network | I4 |
| **6.** | Basic concepts of monitoring and measuring the process of thermal network. | Lecture, Discovery learning, Presentation | Distinguish the basic concepts of monitoring and measuring the process of the thermal network | I5 |
| **7.** | Thermotechnical characteristics of the heating network. | Lecture, Discovery learning, Presentation | Apply and distinguish the input and output | I5 |

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| | | | features of the heating network | |
| **8.** | Thermotechnical characteristics of heat for the heating network. | Lecture, Discovery learning, Presentation | Apply and distinguish heat input and output characteristics for the heating network | I5 |
| **9.** | Thermotechnical characteristics of individual thermal networks. | Lecture, Discovery learning, Presentation | Apply and distinguish input and output features of heating networks | I5 |
| **10.** | Features and examples of different heat networks. | Lecture, Discovery learning, Presentation | Apply and distinguish the features of heating network systems | I6 |
| **11.** | Thermal systems, Examples. | Lecture, Discovery learning, Presentation | Exemplary differentiation of thermal systems | I7 |
| **12.** | Pipelines and fittings. | Lecture, Discovery learning, Presentation | Explain piping and fittings | I7 |
| **13.** | District cooling | Lecture, Discovery learning, Presentation | Explain the elements of district cooling | I8 |
| **14.** | Structural elements of thermal plants. | Lecture, Discovery learning, Presentation | Explain the structural elements of thermal plants | I9 |
| **15.** | District cooling systems. | Lecture, Discovery learning, Presentation | Apply engineering of thermotechnical cooling systems | I10 |
| **EXERCISES/ SEMINARS** | | | | |
| **Hours** | **Topic and description** | **Method**<br>• Direct teaching (lecture, instruction, pp presentation)<br>• Discovery learning (individual, lead, discussion)<br>• Group learning<br>• Case study<br>• Field classes… | **Learning outcomes** | **Course outcome** |
| **1.** | Introduce students to the lecture program, teaching conditions, literature and criteria for evaluating knowledge. Development and perspective, a historical overview of the development of heating networks with an impact on the development of society | Lecture, Discovery learning, Presentation | Apply knowledge of historical development and future perspective projections of technical systems of heating networks | I1 |

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| **2.** | Types of heating network systems and features, Example of heating network. | Lecture, Discovery learning, Presentation | Explain system models and heat network features. | I1 |
| **3.** | Remote heating network. | Lecture, Discovery learning, Presentation | Explain the principles and operating parameters of a remote heating network | I2 |
| **4.** | The principle of heat transfer required for district heating. | Lecture, Discovery learning, Presentation | Apply the principles of heat required for district heating | I3 |
| **5.** | The principle of heat loss in a heating network. | Lecture, Discovery learning, Presentation | Explain the principles of heat loss in district heating network | I4 |
| **6.** | Basic concepts of thermal network system process monitoring. | Lecture, Discovery learning, Presentation | Derive the basic concepts of monitoring and measuring the process of technical heating system at a distance | I5 |
| **7.** | Thermotechnical features of thermal heating. | Lecture, Discovery learning, Presentation | Apply and distinguish the input and output features of thermal heating | I5 |
| **8.** | Thermotechnical characteristics of heat for the heating network. | Lecture, Discovery learning, Presentation | Apply and distinguish heat input and output characteristics for the heating network | I5 |
| **9.** | Thermotechnical characteristics of heating bodies in the heating network. | Lecture, Discovery learning, Presentation | Apply and distinguish input and output features of heating bodies in the heating network | I5 |
| **10.** | Features and examples of expansion systems in the heating network. | Lecture, Discovery learning, Presentation | Apply and distinguish the features of expansion systems in the heating network | I6 |
| **11.** | Pipelines and pipe fittings, Examples. | Lecture, Discovery learning, Presentation | Explain the differences between pipes and pipe fittings | I7 |
| **12.** | Thermal balance of thermotechnical system of thermal network. | Lecture, Discovery learning, Presentation | Explain the heat balance of a | I7 |

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| | | | heating network system | |
| **13.** | Thermotechnical preparation and air distribution in cooling systems. | Lecture, Discovery learning, Presentation | Explain the preparation and distribution of air in cooling systems | I8 |
| **14.** | Structural elements of air conditioning systems in refrigeration systems. | Lecture, Discovery learning, Presentation | Apply the building elements of air conditioning systems in cooling systems | I9 |
| **15.** | Thermotechnical air conditioning systems in the cooling system. | Lecture, Discovery learning, Presentation | Apply the engineering of thermotechnical air conditioning systems in a cooling system | I10 |