MSc Mechatronics Engineering

MECHATRONICS ENGINEERING MSc

Viti i Parë: 60 ECTS **Year One: 60 ECTS**		
Semester I: 30 ECTS		
nr	**Subject**	**ECTS**
1	Advanced Electrical and Electronics Engineering	6
2	Complex Software Modeling and Design	5
3	Automation and Industrial Communication	5
4	Advanced Material Sciences and Engineering	5
5	Management and Organisational Culture	4
6	Modeling and Simulation for Advanced Mechatronics	5
		30
Semester II: 30 ECTS		
7	Advanced Mechatronics Systems	5
8	Advanced Design and Control Engineering	5
9	Robotics and Automation Systems	4
10	Complex System Engineering	4
11	Micro-Mechatronics	4
12	Digital Signal Processing	4
13	Embedded System Design	4
		30
Viti i Dytë: 60 ECTS **Year Two: 60 ECTS**		
Semester III: 30 ECTS		
nr Rendor	**Subject**	**ECTS**
14	Research Methods	5
15	Operations and Project Management	5
		10

Concentration: Students must select one of the concentrations in the second year		
Concentration: Artificial Intelligence and Robotics		
16	Motion Planning	20
17	Neural Networks and Deep Learning	
18	Robotic Vision	
19	Special Topics in Robotics	
Concentration: Biomedical Engineering		
16	Biomedical Signal Processing	20
17	Biomimetics	
18	Biomedical Instrumentation and Signals	
19	Biomechanics	
Concentration: Industrial Product Design		
16	Product Development and Management	20
17	Finite Element Method	
18	Design Optimisation	
19	Design for Advanced Manufacturing	
Concentration: Production Process Engineering and Technology		
16	Advanced Manufacture Processes	20
17	Machine and System Dynamics	
18	Design for Advanced Manufacturing	
19	Finite Element Method	
Concentration: Energy Engineering		
16	Renewable Energy Resource	20
17	Smart Grid Technology	
18	Advanced Power Systems	

19	Special Topic in Energy Engineering	
Concentration: Mechatronics Management		
16	Engineering Economics and Management	20
17	Management Information Systems	
18	Decision Analysis	
19	Marketing Management	
		30
Semester IV: 30 ECTS		
20	Applied Mechatronics/Laboratory Project	6
21	Thesis	24
		30
		Total 120 ECTS

Course description

Course	Advanced Electronic and Electric Engineering
ECTS	**6**
Description	The course discusses advanced topics in electronic and electrical engineering. The core material includes the electronic properties of materials, diodes, logic families ad storage elements. Towards the end of the course students are provided with more advanced topics in design parameters, interfacing ad buses, circuit modelling and simulation and operational amplifiers. Key introductory topics include: electronic properties of materials, Diodes, MOS Transistors, MOS logic families, Bipolar transistors, Design parameters, Storage elements, Interfacing logic families, operational amplifiers.
Learning Outcomes	Upon successful completion of the course, the student is expected to: • Analyze the electronic properties of materials, diodes, and transistors. • Evaluate design parameters for logic families and storage elements. • Develop interfacing and bus systems for advanced electronic circuits. • Apply circuit modeling and simulation for performance optimization. • Design and implement operational amplifier-based systems. • Synthesize advanced concepts to solve complex engineering problems.
Teaching/Learning methods	Lectures Exercises Laboratory E-Learning
Assessment methods	The course is based on several assignements: Assignments 1 – Individual Reports on each topic (20%) Mid-Term Exam: 20% Participation: 10%

	Final Exam: 50%
Equipment	PC, Project, Lab, Moodle
Theoretical/practical ratio	The course is equivalent with 180 nominal teaching hours. The course load is divided as follows: 1. Lectures : 30 2. Exercises: 15 3. Laboratory: 15 4. Self-study: 120
Literature	• Advanced Electronic Circuit Design, Authors: David J. Comer and Donald T. Comer Published: 2020, ISBN: 978-0471228288 • Power Electronics: Devices, Drivers, Applications, and Passive Components, Author: Barry W. Williams, Published: 2019ISBN: 9, 78-0993368631 • CMOS Analog Design Using All-Region MOSFET Modeling, Authors: Márcio Cherem Schneider and Carlos Galup-Montoro, Published: 2019, ISBN: 978-1108494934

Course	**Complex Software Modelling and Design**
ECTS	**5**
Description	The Software Systems must be carefully analysed, designed and modelled before they are constructed. This subject delivers the knowledge and skills needed for the design of medium to large-scale software systems. The subject also teaches students how off-the-shelf development frameworks can be utilized for designing large-scale software systems. The emphasis will be on techniques appropriate for object-oriented design and development. Topics covered include: modeling software systems using the UML, software design processes and principles, common design patterns and software architectures, tools for design and development.

Learning outcomes	On completion of this subject the student is expected to be able to: • Analyze software requirements for medium to large-scale systems. • Model software systems using UML effectively. • Apply design principles, patterns, and architectures in software development. • Utilize development frameworks for large-scale software design. • Use tools for modeling and developing complex software systems.
Teaching/Learning methods	**LEARNING AND TEACHING METHODS** The subject comprises lectures and seminars each week. Weekly readings are assigned from the textbook. The subject also includes a design/implementation project, which involves analysis, design, implementation and delivery. **INDICATIVE KEY LEARNING RESOURCES** At the beginning of the year, the coordinator will propose a textbook that will be made available through library. Additional learning material will be made available on the learning management system (LMS) site for the subject. **CAREERS / INDUSTRY LINKS** The software industry is a large and steadily growing industry, and is constantly looking for competent software engineers. This subject teaches the software engineering design principles and core software design skills required by industry practitioners. subject is valued by employers and are often seen as a necessary grounding for a career in software and technology related industries. The subject provides students with a realistic environment in which to apply and learn the theory and practice of requirements engineering. Projects are chosen to reflect real-world considerations. Industry guest speakers are invited to provide lectures in relation to specialised project requirements.

Assessment methods	• A single team based project will be undertaken in teams of 3 during the semester. The project work is expected to take approximately 35 – 40 hours of work (40%) per student. The project requires the analysis, design and implementation of a small application. The project will be assessed in three stages and due at the end of week 4, requiring approximately 15 - 20 hours of work per student and due at the start of week 8, and due at the end of week 11. The project is a hurdle and must be passed to pass the subject • One two hour written closed book end-of-semester written examination (60%). The examination is a hurdle and must be passed, to pass the subject.
Equipment	Laboratory, Dashboards/Other related equipment
Theoretical/practical ratio	Total hours: 150 Lectures: 30 Seminars: 30 Laboratory: 15 Self-study: 75
Literature	• Software Architecture: The Hard Parts Authors: Neal Ford, Mark Richards, Pramod Sadalage, Zhamak Dehghani, 2021, ISBN: 978-1492086890 • Fundamentals of Software Architecture: An Engineering Approach, Authors: Mark Richards, Neal Ford, Published: 2020, ISBN: 978-1492043459 • Designing Data-Intensive Applications, Author: Martin Kleppmann, Published: 2021 (Revised Edition), ISBN: 978-1449373320 • Clean Agile: Back to Basics, Author: Robert C. Martin, Published: 2019, ISBN: 978-0135781866 • Software Design X-Rays: Fix Technical Debt with Behavioral Code Analysis, Author: Adam Tornhill, Published: 2020, ISBN: 978-0136624728

Course	**Automation and Industrial Communication**
ECTS	**5**
Description	This course provides a comprehensive understanding of automation systems and industrial communication technologies. Students will explore key concepts such as programmable logic controllers (PLCs), sensors, actuators, and industrial communication protocols, including Ethernet/IP, Modbus, and Profibus. The course emphasizes analyzing and explaining various practices and theories in automation and communication, selecting appropriate methods and technologies for system design and integration. Learners will gain practical experience in implementing real-time communication solutions, integrating automation components, and troubleshooting system issues. Through laboratory exercises, case studies, and team-based projects, students will develop the ability to document and present automation solutions effectively. The course prepares students to address the challenges of designing and managing reliable, efficient, and scalable automation systems for industrial applications.
Learning outcomes	On completion of this subject the student is expected to be able to: • Analyze and explain key practices and theories in industrial automation, including PLCs, sensors, and actuators, selecting appropriate methods for system design. • Evaluate various industrial communication standards (e.g., Ethernet/IP, Modbus, Profibus) and select the most suitable protocol based on system requirements. • Implement and integrate automation systems by combining hardware and software technologies to address specific industrial challenges. • Describe the requirements and principles of real-time communication in industrial networks, selecting appropriate solutions for reliable operation. • Clearly communicate and document the design, implementation, and integration of automation and communication systems to diverse stakeholders.
Teaching/Learning methods	Lectures Seminars and Discussions Laboratory Exercises Case Studies

	Team Projects Self-Study Presentations
Assessment methods	Final Project Report (40%) Midterm Exam (20%) Laboratory Performance (20%) Oral Presentation (10%) Participation and Peer Review (10%)
Equipment	Laboratory, Dashboards/Other related equipment
Theoretical/practical ratio	**Total Hours: 150** Lectures: 30 hours Seminars: 30 hours Laboratory: 15 hours Self-study: 75 hours
Literature	• Kissell, Thomas S. (2020). Industrial Automation and Process Control, 2nd Edition. Pearson. ISBN 978-0135175385 • Bolton, W. (2021). Programmable Logic Controllers, 7th Edition. Newnes. ISBN 978-0128238668 • Goossens, Joel. (2022). Real-Time Systems: Design Principles for Distributed Embedded Applications. Springer. ISBN 978-3030917006

Course	**Advanced Materials Science Engineering**
ECTS	**5**

Description	This subject focuses on advanced materials and their engineering applications. Selected metallic, ceramic and polymer materials and their composites are analysed in the context of applications. When relevant, the topics will be reinforced by introducing the latest development in research. The selected advanced materials may include light alloys, ferrous alloys, superalloys, intermetallic alloys, ultrafine and nano structured alloys, amorphous alloys, metal matrix composites, structural and functional ceramics, and/or structural and functional polymers. Students may be required to study engineering cases or research papers and/or conducting experiments in a laboratory. The selected advanced materials may include light alloys, ferrous alloys, superalloys, intermetallic alloys, ultrafine and nano structured alloys, amorphous alloys, metal matrix composites, structural and functional ceramics, and/or structural and functional polymers.
Learning outcomes	Having completed this subject, the student is expected to be able to - • Analyze the properties and assess the potential applications of advanced materials in engineering. • Evaluate the use of alloys, ceramics, and polymers in engineering. • Apply knowledge of advanced material systems to solve problems. • Review research and case studies on advanced materials. • Conduct experiments to assess material behavior in engineering.
Teaching/Learning methods	The subject is delivered through a combination of lectures and projects. For e-learning, the lectures are recorded and made available to students through the University's online learning system
Assessment methods	• Two project reports of up to 3500 words each, in addition to supporting material such as figures and tables, to be submitted at the end of semester – Unit 1 report requiring approximately 40 to 50 hours work (40%); Unit 2 report requiring approximately 35 to 40 hours work (35%). • A one hour in class test (10%). • Oral presentation requiring approximately 20 hours work (15%).
Equipment	Laboratory, Dashboards/Other related equipment
Theoretical/practical ratio	Total hours: 150 Lectures: 30

	Seminars: 30 Laboratory: 15 Self-study: 75
Literature	• Materials Science and Engineering: An Introduction, Authors: William D. Callister Jr., David G. Rethwisch, Published: 2020, ISBN: 978-1119405498 • Advanced Materials and Design: Mechanical, Manufacturing, and Modeling, Authors: Ashutosh Tiwari, Rajeev Ahuja, Published: 2014, ISBN: 978-1118686232 • Engineering Materials 1: An Introduction to Properties, Applications, and Design, Authors: Michael F. Ashby, David R.H. Jones, Published: 2012 (4th Edition), ISBN: 978-0080966656

Course	Management and Organizational Culture
ECTS	**4**
Description	Leadership and Motivation are twin concepts which ensure that organizations can operate effectively according to a well-designed strategy. The course will review the development of vision, mission and strategy and demonstrate techniques for imbuing the organization with the underlying values associated with strategy, mission and vision. This course takes approaches recently developed in management research which advocate that leadership, including technology leadership, and motivation are informed by human value systems and concepts. This course represents an advanced management course in leadership and motivation. Leadership in technology management is demonstrated to be a key issue in the successful implementation of advanced technologies in pursuit of organizational excellence.
Learning outcomes	• Prepare and present strategic management analyses and organizational culture reports to diverse audiences. • Communicate project outcomes in written and oral formats, meeting professional and academic standards. • Critically assess management strategies and propose innovative solutions for organizational challenges. • Develop lifelong learning skills by following and applying the latest trends in management and leadership practices.
	opportunities and threats
Teaching/Learning methods	Lecture - Tutorial, using hands-on student exercises with BPM Tools - Case Studies - Guest speakers from industry (if available) - Student individual assignments based on Tutorial material - Team assignment (week 13) - Readings from texts and selected relevant articles and publications
Assessment methods	Individual Assignments 20%/Team Project 20%/Final exam 60 %
Equipment	– Dashboard, Adequate Software /Other related equipment
Theoretical/practical ratio	35/65

Literature	• Griffin, Ricky W. and Jean M. Phillips: Organizational Behavior: Managing People and Organizations (14th Edition). Cengage Learning, 2024. • Hellreigel, Don and John W. Slocum, Jr.: Organizational Behavior (14th Edition). Cengage Learning, 2010. • Ivancevich, John M. and Robert Konopaske: Organizational Behavior and Management (11th Edition). McGraw-Hill Education, 2012. • Koontz, Harold and Heinz Weihrich: Management: A Global Perspective (14th Edition). McGraw-Hill Education, 2010. • Steers, Richard M., Lyman W. Porter, and Gregory A. Bigley: Motivation and Work Behavior (8th Edition). McGraw-Hill Education, 2010. • Nelson, Debra L. and James Campbell Quick: Organizational Behavior: Foundations, Realities, and Challenges (5th Edition). Cengage Learning, 2006.

Course	**Modelling and Simulation for Advanced Mechatronics**
ECTS	**5**
Description	This course, designed for master's-level students in Mechatronics Engineering, focuses on advanced simulation methods essential for complex systems in the field. It encompasses the development of skills in problem specification, mathematical modeling, simulator implementation, model validation, problem-solving, and the presentation of results. The study includes an introduction to simulation tools across various disciplines relevant to mechatronics, such as mechanical multibody systems, electrical circuits, and control engineering. Emphasis is placed on numerical integration methods for time-continuous systems, described by ordinary differential equations or time-dependent systems, ensuring a deeper understanding of the numerical algorithms involved. The course further delves into stochastic simulation, exploring the use of random number generators to model stochastic influences on dynamic systems. Foundational concepts from probability theory and statistics are introduced to support this understanding. Additionally, the simulation of discrete event systems is covered, demonstrating its significance in automation systems, digital circuits, and manufacturing processes.

	This course integrates theoretical knowledge with practical applications, preparing students to address complex challenges in advanced mechatronic systems with a strong foundation in modeling and simulation.
Learning Outcomes	Upon completion of the course, the students will be able to: • Develop mathematical models and validate simulations for complex mechatronic systems. • Analyze time-continuous systems using advanced numerical integration methods and evaluate the effectiveness of different simulation techniques. • Apply stochastic simulation methods to model and analyze the influence of random variables on dynamic systems. • Interpret and implement probability and statistical concepts in the simulation of stochastic systems. • Design and execute simulations of discrete event systems relevant to automation, manufacturing, and digital circuits. • Critically assess and present simulation results to solve complex engineering problems in mechatronics.
Teaching/Learning methods	Lectures Seminars Laboratory E-learning
Assessment methods	• Individual Project (25%) • Mid-semester test (25%) • Final exam (50%)
Equipment	MATLAB, Simulink, PC, Projector
Theoretical/practical ratio	Lectures: 30 Seminars: 30 Lab: 45 Self-study: 45
Literature	• Law, Averill M. and W. David Kelton: Simulation Modeling and Analysis (5th Edition). McGraw-Hill Education, 2014. • Ogata, Katsuhiko: System Dynamics (5th Edition). Pearson, 2010.

	• Zeigler, Bernard P., Herbert Praehofer, and Tag Gon Kim: Theory of Modeling and Simulation: Integrating Discrete Event and Continuous Complex Dynamic Systems (3rd Edition). Academic Press, 2018. • Allen B. Downey (Author), Modeling and Simulation in Python: An Introduction for Scientists and Engineers, 2023 • Banks, Jerry, John S. Carson II, Barry L. Nelson, and David M. Nicol: Discrete-Event System Simulation (5th Edition). Pearson, 2009. • Kleijnen, Jack P. C.: Design and Analysis of Simulation Experiments (2nd Edition). Springer, 2015.

Course	**Advanced Mechatronic Systems**
ECTS	**5**
Description	This course offers comprehensive knowledge of advanced mechatronic systems, combining theoretical concepts with practical expertise. The course begins with an introduction to mechatronic systems, followed by detailed exploration of sensors and signal processing, programmable logic devices (PLDs), drives and mechanisms, hydraulic and pneumatic systems, and concludes with CNC programming and industrial robotics. The objective of this course is to equip students with scientific and professional knowledge, enabling them to analyze and understand mechatronic systems. Students will gain the skills to address scientific and engineering problems by applying the principles of advanced mechatronics. The integration of theoretical knowledge with hands-on learning ensures students are prepared to meet the demands of modern engineering challenges in mechatronics.
Learning outcomes	Upon completion of this course, students will: • Analyze and interpret the functioning of advanced mechatronic systems, including their components such as sensors, signal processing units, and programmable logic devices (PLDs). • Design and evaluate hydraulic and pneumatic systems, ensuring their integration with drives and mechanisms in complex mechatronic applications. • Develop and implement CNC programming techniques for automation and control in industrial applications.

	• Apply principles of industrial robotics to analyze, model, and optimize robotic systems for engineering solutions.
Teaching/Learning methods	The course comprises lecturing and discussions after each meeting. This involves personal and group discussions and the presentation of projects and research articles. · Lectures · Project · Research article · Case studies · Role simulation · Problem-solving
Assessment methods	Attendance (10%) Project (50%) Research article (30%) Presentation (10%)
Equipment	Class; Moodle; Software; Projector; PC or Laptop; Laboratory
Theoretical/Practical ratio	Total hours: 150 Lectures: 30 Project: 30 Research article: 25 Independent learning: 55 Presentation: 10

Literature	• **W. Bolton. (2021).** *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, 7th Edition.* Pearson. ISBN 978-1292250997 • **David G. Alciatore, Michael B. Histand. (2018).** *Introduction to Mechatronics and Measurement Systems, 5th Edition.* McGraw-Hill Education. ISBN 978-1260042307 • **Rolf Isermann. (2005).** *Mechatronic Systems: Fundamentals.* Springer-Verlag London. ISBN 1-85233-930-6 • **Clarence W. de Silva. (2005).** *Mechatronics: An Integrated Approach.* CRC Press. ISBN 978-0203611647

Course	**Advanced Design and Control Engineering**
ECTS	**5**
Description	This subject provides an introduction to modern control theory with a particular focus on state-space methods and optimal control. The role of feedback in control will be reinforced within this context, alongside the role of optimization techniques in control system synthesis. Topics include: State-space models - first-order vector differential/difference equations; Lyapunov stability; linearization; discretization; Kalman decomposition (observable, detectable, reachable and stabilizable subspaces); state feedback and pole placement; output-feedback and observer design in both continuous-time a discrete-time Optimal control - dynamic programming; linear quadratic regulation in both continuous- time and discrete-time. Model predictive control in discrete- time; moving-horizon with constraints.
Learning outcomes	Upon completion of this course, students will: • Analyze state-space models and assess system stability using Lyapunov methods to ensure robust system performance. • Apply advanced linearization, discretization, and optimization methods to model and control mechatronic systems. • Design state-feedback controllers and observers for dynamic systems using modern control techniques.

	• Synthesize and evaluate optimal control strategies, such as LQR and MPC, for enhancing system efficiency and stability. • Explore and integrate emerging trends in control engineering, including model predictive control and optimization methods, into practical applications.
Teaching/Learning methods	The course comprises of lecturing and discussions after each lecture. This involves personal and group discussions and presentation of seminar work. The final element is the testing. Lecture - Seminars, using hands-on student - Case Studies - Laboratory - Student individual assignments based on Tutorial material - Team assignment - Readings from texts and selected relevant articles and publications
Assessment methods	• One written examination, not exceeding three hours at the end of semester, worth 60% • Continuous assessment of submitted project work completed in small groups (2-3 students), not exceeding 20 pages over the semester (approximately 35-40 hours of work), worth 40%
Equipment	Laboratory, Dashboards/Other related equipment
Theoretical/practical ratio	Total hours: 150 Lectures: 30 Seminars: 30 Research article: 30 Laboratory: 10 Self-study: 50
Literature	**Ogata, Katsuhiko. (2020).** *Modern Control Engineering, 6th Edition.* Pearson. ISBN 978-0136156734 **Dorf, Richard C., and Robert H. Bishop. (2020).** *Modern Control Systems, 13th Edition.* Pearson. ISBN 978-0134407623 **Camacho, Eduardo F., and Carlos Bordons. (2012).** *Model Predictive Control, 2nd Edition.* Springer. ISBN 978-1447126230

Course	**Complex System Engineering**
ECTS	**4**
Description	This course provides an advanced understanding of the principles and practices required to design, analyze, and manage large-scale, multidisciplinary systems. The course explores system lifecycle processes, including requirement analysis, system decomposition, integration, and optimization, with a focus on addressing the complexities of real-world engineering challenges. Students will develop expertise in designing robust system architectures, managing dynamic interactions, and optimizing performance under constraints. Advanced methodologies for risk assessment, scalability, and trade-off analysis are emphasized to ensure system reliability and sustainability. Through case studies, research, and collaborative projects, learners will refine their ability to lead interdisciplinary teams and communicate solutions effectively. By the end of the course, students will be equipped to drive innovation and successfully manage complex engineering systems in academic, industrial, and research contexts.
Learning outcomes	Having completed this unit, the student is expected to have the skills to: • Develop and apply foundational systems engineering principles to design and manage complex engineering systems. • Analyze system requirements and evaluate various practices and theories to select the most suitable methods and technologies for designing complex systems. • Implement effective processes for managing the lifecycle of complex systems, including design, development, testing, deployment, and maintenance. • Integrate multidisciplinary components into cohesive systems while addressing trade-offs, constraints, and performance optimization. • Present system designs and management plans to diverse stakeholders and collaborate in multidisciplinary engineering teams.

Teaching/Learning methods	The course comprises of lecturing and discussions after each lecture. This involves personal and group discussions and presentation of seminar work. The final element is the testing. Lecture - Seminars, using hands-on student - Case Studies - Laboratory - Student individual assignments based on Tutorial material - Team assignment - Readings from texts and selected relevant articles and publications
Assessment methods	- Final Project Report (40%) - Midterm Exam (20%) - Midterm Exam (20%) - Oral Presentation (10%) - Participation and Peer Review (10%)
Equipment	Laboratory, Dashboards/Other related equipment
Theoretical/practical ratio	Total Hours: 120 Lectures: 30 hours Seminars: 15 hours Laboratory: 15 hours Self-study: 60 hours
Literature	Kossiakoff, Alexander, William N. Sweet, Samuel J. Seymour, and Steven M. Biemer. (2020). Systems Engineering Principles and Practice, 3rd Edition. Wiley. ISBN 978-1119516668 Maier, Mark W., and Eberhardt Rechtin. (2009). The Art of Systems Architecting, 3rd Edition. CRC Press. ISBN 978-1420079135 Sayama, Hiroki. (2015). Introduction to the Modeling and Analysis of Complex Systems. Open SUNY Textbooks. ISBN 978-1942341086

Course	Robotics and Automation Systems
ECTS	4
Description	The subject aims to provide advanced knowledge of automation technologies, focusing on robotics and process automation. Students will explore the use of robots and automated systems in performing complex tasks and develop computational techniques for the operation and control of robotic manipulators and general automated systems. The subject emphasizes the roles, strengths, and capabilities of robotics and automation technologies, focusing on methods to optimize and expand these capabilities. Topics include advanced manipulator kinematics, trajectory planning, manipulator dynamics, nonlinear and adaptive control methods, and robotic programming. The course integrates theoretical foundations with applications in research and modern industry challenges.
Learning outcomes	Having completed this unit, the student is expected to have the skills to: • Analyze and interpret the kinematic and dynamic behavior of robotic manipulators to optimize automation systems. • Apply trajectory planning and optimization techniques to robotic systems to meet specific application requirements. • Utilize advanced robotics principles to design and implement automation systems for complex engineering challenges. • Compare and integrate robotics and automation technologies to propose innovative solutions for improving system performance. • Explore and incorporate emerging trends in robotics and automation to address modern industry challenges.
Teaching/Learning methods	The course comprises of lecturing and discussions after each lecture. This involves personal and group discussions and presentation of seminar work. The final element is the testing. Lecture - Seminars, using hands-on student - Case Studies - Laboratory - Student individual assignments based on Tutorial material - Team assignment - Readings from texts and selected relevant articles and publications

Assessment methods	• One 2 hour end of semester written examination (40%), • Group and individual projects, assignments and lab reports of equal weight (not exceeding 5000 words each) (60% total). Requiring approximately 75 - 80 hours of work per student in total
Equipment	Laboratory, Dashboards/Other related equipment
Theoretical/practical ratio	Total hours: 120 Lectures: 30 Seminars: 15 Laboratory: 30 Self-study: 45
Literature	**Craig, John J. (2021).** *Introduction to Robotics: Mechanics and Control, 4th Edition.* Pearson. ISBN 978-0133489798 **Siciliano, Bruno, Lorenzo Sciavicco, Luigi Villani, and Giuseppe Oriolo. (2010).** *Robotics: Modelling, Planning and Control.* Springer. ISBN 978-1846286414 **Corke, Peter. (2017).** *Robotics, Vision, and Control: Fundamental Algorithms in MATLAB, 2nd Edition.* Springer. ISBN 978-3319544120

Course	**Micro-mechatronics**
ECTS	**4**
Description	The course introduces students to key concepts and applications of micromechatronic systems, with a focus on piezoelectric actuators. Students will explore the theoretical basis of piezoelectricity, actuator materials, and ceramic fabrication methods. They will also study drive and control techniques for piezoelectric actuators and engage in computer simulations to model and analyze piezoelectric devices. Practical applications, such as energy harvesting systems, servo displacement transducers, and ultrasonic motors, are discussed, providing insights into the future potential of solid-state actuators in micromechatronic systems. Through project-based activities, students develop foundational skills in designing and analyzing micromechatronic components.
Learning outcomes	Upon successful completion of this course, students will be able to: • Explain the fundamental principles of piezoelectricity and its application in micromechatronic systems. • Identify and evaluate actuator technologies for specific applications in micromechatronic systems. • Document and present simulation results and design methodologies for advanced actuators through professional reports and oral presentations. • Analyze and simulate the performance of solid-state actuators to enhance their integration into microsystems.
Teaching/Learning methods	The course comprises of lecturing and discussions after each lecture. This involves personal and group discussions and presentation of seminar work. The final element is the testing. Lecture - Seminars, using hands-on student - Case Studies - Student individual assignments based on Tutorial material - Team assignment - Readings from texts and selected relevant articles and publications

Assessment methods	Weekly lab tasks – 20% Programming assignement – 20% Participation: 10% Final Exam – 50%
Equipment	Laboratory, Dashboards/Other related equipment
Theoretical/practical ratio	Total hours: 120 Lectures: 30 Seminars: 20 Self-study: 70
Literature	MicroMechatronics, Second Edition By Kenji Uchino, 2020

Course	**Digital Signal Processing**
ECTS	**4**
Description	The course focuses on the principles and applications of Digital Signal Processing (DSP), providing an in-depth understanding of techniques for analyzing, designing, and implementing digital signal processing systems. Topics include discrete-time signals and systems, Fourier analysis, digital filter design, and transform techniques. The course also explores practical applications such as audio and image processing, communication systems, and embedded DSP systems. Emphasis is placed on both theoretical concepts and practical implementations, equipping students with the skills to develop efficient signal processing solutions for complex engineering challenges.
Learning outcomes	Upon successful completion of this course, students will be able to: Applications of signal processing techniques • Analyze and interpret discrete-time signals and systems using mathematical tools such as Fourier transforms and z-transforms. • Design and implement digital filters for practical applications in audio, image processing, and communication systems. • Apply advanced DSP techniques to develop solutions for real-world engineering challenges. • Explore emerging DSP tools and techniques to develop innovative solutions and continuously enhance professional expertise.
Teaching/Learning methods	The course comprises of lecturing and discussions after each lecture. This involves personal and group discussions and presentation of seminar work. The final element is the testing. Lecture - Seminars, using hands-on student - Case Studies - Laboratory - Student individual assignments based on Tutorial material - Team assignment - Readings from texts and selected relevant articles and publications
Assessment methods	Weekly lab tasks – 20% Programming assignement – 20% Participation: 10% Final Exam – 50%
Equipment	Laboratory, Dashboards/Other related equipment

Theoretical/practical ratio	Total hours: 150 Lectures: 30 Project: 30 Laboratory: 15 Self-study: 75
Literature	**Oppenheim, Alan V., and Ronald W. Schafer. (2013).** *Discrete-Time Signal Processing, 3rd Edition.* Pearson. ISBN 978-1292025728 **Proakis, John G., and Dimitris G. Manolakis. (2007).** *Digital Signal Processing: Principles, Algorithms, and Applications, 4th Edition.* Pearson. ISBN 978-0131873742 **Mueller, John W., and Alexandre N. Carvalho. (2018).** *Digital Signal Processing with Python Programming.* CRC Press. ISBN 978-1138744381

Course	**Embedded System Design**
ECTS	**4**
Description	The course develops the student's technical knowledge of the design, implementation and testing of software modules and application frameworks for embedded systems. Students develop their ability to interpret and evaluate a set of software specifications and work in small groups to write software modules and applications for an embedded system. Students are introduced to abstracting hardware functionality into software modules and researching and implementing software data structures. Students also develop their ability to test and modify their software to ensure compliance with the application specifications and be introduced to reviewing and evaluating their own and others software. The technical content is contextualised in a project in which students analyse the requirements of an embedded system and design the software to meet those requirements. Skills in debugging software are also developed through the practice-based nature of the subject.

Learning Outcomes	Upon successful completion of the course, the student will be able to: • Design, write and test a variety of software modules found in modern embedded systems, such as: hardware abstraction layers; data structures; and interrupt service routines • Develop and test modular, hierarchical, and real-time responsive embedded applications constrained by time, size, and cost. • Utilize a variety of software tools to write, execute and test embedded software applications • Test software performance in an embedded system by selecting and using appropriate laboratory equipment • Design and implement embedded systems while adhering to project requirements and integrating interdisciplinary engineering principles.
Teaching/Learning methods	Lectures Seminars Laboratory E-learning
Assessment methods	• Individual Project (25%) • Mid-semester test (25%) • Final exam (50%)
Equipment	Laboratory, PC
Theoretical/practical ratio	Total: 120 Lectures: 30 Project: 30 Lab: 15 Self-study: 45
Literature	Wolf, Marilyn. (2019). *Computers as Components: Principles of Embedded Computing System Design, 4th Edition.* Morgan Kaufmann. ISBN 978-0128053874 Barr, Michael, and Anthony Massa. (2006). *Programming Embedded Systems: With C and GNU Development Tools, 2nd Edition.* O'Reilly Media. ISBN 978-0596009830 White, Elecia. (2011). *Making Embedded Systems: Design Patterns for Great Software.* O'Reilly Media. ISBN 978-1449302143

Course	**Research Methods**
ECTS	**5**
Description	The aim of this course is to equip students with the knowledge and skills required for conducting high-quality scientific research in Mechatronics Engineering and related fields. The course emphasizes critical thinking, scientific rigor, and ethics. Students will learn to design experiments, locate and analyze relevant literature, develop research plans, and communicate findings effectively through written and spoken formats. The course combines theoretical learning with practical workshops and project work, providing hands-on experience in research planning, analysis, and experimental design.
Learning outcomes	Upon successful completion of this course, students will be able to: 1. Explain the principles of scientific research and their application in Mechatronics Engineering. 2. Analyze and evaluate research literature to identify gaps and formulate relevant research questions. 3. Apply ethical guidelines and demonstrate scientific rigor in designing and conducting research. 4. Develop comprehensive research plans, including experimental designs, hypotheses, and justifications. 5. Communicate research findings effectively through written reports, literature reviews, and oral presentations.
Teaching/Learning methods	The subject will comprise a mixture of lectures and workshops (3 hours each week). A significant amount of project work is assigned throughout the semester
Assessment methods	A 1500 word literature review on a chosen research topic (30%) draft due in approximately week 4 and second draft due in approximately week 11. Requiring approximately 35 - 40 hours of work
	• A 10 minute presentation on a research topic (20%), addressing to be delivered in approximately week 11, requiring approximately 25 30 hours of work • A 2000 word research plan and experimental design, focusing on research questions with justifications and discussion of plausible outcomes and an experimental design to test a hypothesis (30%) Requiring approximately 35-45 hours of work • A 1500 word research paper review (20%), week 7 and requiring approximately 25 -30 hours of work
Equipment	Laboratory, Dashboards/Other related equipment

Theoretical/practical ratio	Total hours: 150 Lectures: 30 Seminars: 30 Self-study: 75
Literature	Thiel, David V. (2014). Research Methods for Engineers, 1st Edition. CRC Press. ISBN 978-1482234511 Evans, David, Paul Gruba, and Justin Zobel. (2011). How to Write a Better Thesis, 3rd Edition. Melbourne University Press. ISBN 978-0522861266 Creswell, John W., and J. David Creswell. (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 5th Edition. SAGE Publications. ISBN 978-1506386706

Course	**Operations and Project Management**
ECTS	**5**
Description	This course combines principles of operations and project management, providing students with practical experience in managing development projects and understanding operational strategies. Topics include project planning, organizing, staffing, controlling, directing, process optimization, supply chain management, and quality control. The course emphasizes quantitative methods, leadership, and tools for monitoring and controlling projects. Students will gain hands-on experience through team projects, collaborating with peers from different disciplines to develop a comprehensive project and operational plan.
Learning Outcomes	Upon successful completion of the course, the student will be able to: • Use advanced project management methodologies to design and implement efficient operational strategies for complex engineering projects. • Develop and present a detailed project plan with clear objectives, timelines, and risk management strategies. • Demonstrate teamwork and leadership in diverse project teams to achieve specified goals. • Critically analyze and optimize operational strategies to improve project outcomes and supply chain efficiency.
Teaching/Learning methods	Lecture • Tutorial, using hands-on student • Case Studies • Guest speakers from industry (if available) • Student individual assignments based on Tutorial material • Team assignment • Readings from texts and selected relevant articles and publications
Assessment methods	*Student assessment will be based on the following:* Group Project and Presentation: 30% Individual Report: 20% Class Participation: 10% Final Exam: 40%
Equipment	PC, Projector, Moodle E-Learning
Theoretical/practical ratio	Total hours: 150 Lectures: 30

	Seminars:30 Practice: 15 Self-study: 75
Literature	• Meredith, Jack R., Samuel J. Mantel Jr., and Scott M. Shafer. (2020). *Project Management: A Managerial Approach, 10th Edition.* Wiley. ISBN 978-1119702961 • Kerzner, Harold. (2022). *Project Management: A Systems Approach to Planning, Scheduling, and Controlling, 13th Edition.* Wiley. ISBN 978-1119805372 • Heizer, Jay, Barry Render, and Chuck Munson. (2020). *Operations Management: Sustainability and Supply Chain Management, 13th Edition.* Pearson. ISBN 978-0135173626

Course	**Engineering Economics and Management**
ECTS	**5**
Description	The course is designed to provide advanced concepts in engineering economics. Economics is the study of value, costs, resources and their relationship in a given context or situation. In the discipline of engineering, activities have costs and economic attributes. The course provides an opportunity for students to learn about the engineering finance and accounting, inflation, depreciation, time value of money, taxation, efficiency, effectiveness and productivity.
Learning Outcomes	Upon successful completion of this course, the students will: • Understand the advanced of engineering economics • Apply concepts of inflation, depreciation, and taxation to evaluate financial decisions in engineering projects. • Use decision-making methods in finance, costing, and accounting to prepare and present economic analyses for engineering projects. • Evaluate and integrate efficiency, effectiveness, and productivity concepts to assess the need for technology in engineering projects. • Critically analyze financial and economic trade-offs to improve the management and execution of engineering projects.
Teaching/Learning methods	Lectures Exercises E-Learning

Assessment methods	Student Assessment will be based on: Essay: 20% Participation: 10% Group project: 30% Final Exam: 50%
Equipment	Laboratory, PC, Projector
Theoretical/practical ratio	The course total hours are equivalent with 120 nominal hours. The teaching load is divided as follows: Lectures – 30 Exercises – 15 Self-Study: 75
Literature	Engineering Economy and Management, Pravin Kumar, 2019 Engineering Economic Analysis 13th Edition by Donald G. Newnan (Author), Ted G. Eschenbach (Author), Jerome P. Lavelle (Author), 2017 Sullivan & Bontadeli, Engineering Economics, Prentice Hall, NY, 2011

Course	**Management Information Systems**
ECTS	**5**
Description	This course provides an advanced understanding of the role of management information systems (MIS) in modern organizations, focusing on the integration of advanced information technologies and infrastructures. It equips students with the skills needed to address complex managerial, technological, and organizational challenges associated with the effective use of MIS in business and non-business settings. Students will explore advanced systems theory, analyze the interaction between information systems and dynamic business environments, and critically evaluate the advantages and limitations of these technologies. The course emphasizes practical application by bridging theoretical knowledge with real-world organizational scenarios, preparing students to manage and optimize MIS in complex environments.

Learning outcomes	After finishing the course, students should be able to: - Analyze and apply advanced concepts of systems theory to management information systems in complex environments. - Differentiate between various types of systems (e.g., open, closed, and hybrid) and assess their relevance to MIS. - Evaluate the interaction between information systems and dynamic business environments, emphasizing adaptability and innovation. - Present advanced MIS concepts and project findings effectively through professional reports and oral presentations. - Apply advanced MIS principles and tools to design and implement effective solutions in real-world organizational settings.
Teaching/Learning methods	Students will be presented with a series of concepts and then use case studies and team-based discussions and activities to explore the main topics and concepts in real-life contexts. The emphasis, where practicable, will be on building understanding through reflective learning and problem-based learning (PBL).
Assessment methods	Course grades will be determined based upon (i) student performance on a final examination and (ii) portfolio of projects submitted during the semester. The breakdown between these two is as follows: Final Examination 60 (%): 2 hour written examination. Continuous Assessment: 40 (%)
Equipment	PC; Microsoft Office package.
Theoretical/practical ratio	The course total hours are equivalent with 150 nominal hours. The teaching load is divided as follows: Lectures – 30 Exercises – 20 Project-20 Research article: 20 Self-Study: 40

Literature	- Laudon, Kenneth C., and Jane P. Laudon. (2020). Management Information Systems: Managing the Digital Firm, 17th Edition. Pearson. ISBN 978-0135191798 - Piccoli, Gabriele, and Federico Pigni. (2019). Information Systems for Managers with Cases, 4th Edition. Prospect Press. ISBN 978-1943153433 - Laudon, Kenneth C., and Jane P. Laudon. (2018). Essentials of MIS, 13th Edition. Pearson. ISBN 978-0134802756

Course	**Marketing Management**
ECTS	**5**
Description	The aim of the course is to provide students with a thorough understanding of establishing market driven strategies in order to maximize company performance and management and marketing skills essential of building profitable customer relations. Students will have the opportunity to practice the process of creating and launching marketing strategies through case studies. Through a managerial perspective issue in the process of creating and developing marketing strategies will be elaborated such as the selection of target markets, meaningful points of differentiation and positioning statements, choosing and creating value proposition, allocating resources, designing products, setting and managing prices, utilizing distribution and promotion strategies and professional sales
Learning outcomes	After finishing the module students should be able to: - Evaluate a company's environment to identify marketing implications for technological products. - Solve marketing mix issues for engineering solutions. - Communicate marketing strategies clearly to diverse audiences. - Present marketing decisions and forecasts to professional standards. - Work effectively in teams to respond to client needs and develop actionable marketing strategies for innovative products.

Teaching/Learning methods	The course uses the benefits of both theory and practical approach. It adopts a combination of theoretical lectures and background knowledge and uses real life cases to analyse certain marketing concepts. Students will be provided with such real life case studies and will be invited for team-based activities to explore these issues in real-life contexts.
Assessment methods	Course grades will be determined based upon student performance on set of tests, projects and class participation. The breakdown between those is as follows: Tests - 50% • Required Works (projects) - 25% • Active Participation -15% • Marketing Current Events -10%
Equipment	PC; Microsoft Office package; Statistical packages (SPSS)
Theoretical/practical ratio	The course total hours are equivalent with 150 nominal hours. The teaching load is divided as follows: Lectures – 30 Exercises – 15 Seminar 30 Research paper: 20 Self-Study: 55
Literature	- Kotler, Philip, and Kevin Lane Keller. (2021). Marketing Management, 16th Edition. Pearson. ISBN 978-1292404813 - - Winer, Russell S., and Ravi Dhar. (2010). Marketing Management, 4th Edition. Pearson. ISBN 978-0136074892. - - Peter, J. Paul, and James H. Donnelly Jr. (2012). Preface to Marketing Management, 13th Edition. McGraw-Hill Education. ISBN 978-0078028922. - - Aaker, David A. (2017). Strategic Market Management, 11th Edition. Wiley. ISBN 978-1119392209. - - Dacko, Scott. (2008). The Advanced Dictionary of Marketing: Putting Theory to Use. Oxford University Press. ISBN 978-0199286003.

Course	**Decision Analysis**
ECTS	**5**
Description	This course focuses on the systematic approach to making informed decisions in complex and uncertain situations. As a normative science, decision analysis provides a logical framework to structure and evaluate decision scenarios with the objective of achieving clarity in action. Students will learn to formulate creative alternatives, characterize uncertain events, and incorporate decision-makers' values and preferences into the decision-making process. The course introduces a coherent set of tools for framing problems, performing logical analyses, and building decision analytic models in Excel. Topics covered include decision trees, influence diagrams, the value of information, sensitivity analysis, risk preferences, and Monte Carlo simulation. This combination of theoretical concepts and practical tools equips students with the skills to analyze and solve real-world decision-making problems in a structured and logical manner.
Learning outcomes	After finishing the module students should be able to: • Prepare and present decision analytic models and findings to support data-driven decision-making. • Communicate decision analysis outcomes effectively through written reports and professional presentations. • Apply decision-making tools collaboratively in team-based projects to develop actionable solutions. • Analyze uncertainty, risk prefereances, and the value of information to enhance decision-making processes. • Explore and integrate advanced decision analysis techniques to continuously enhance problem-solving skills.

Teaching/Learning methods	The course is divided in three parts: -Introduction and classical techniques, which include decision structuring, decision under uncertainty, risk attitudes and the value of information -Time Value of Money (NPV, IRR) and -Monte Carlo Simulation and Group Decisions. Within the parts we will address both analytical and psychological aspects.
Assessment methods	Grading is based on contribution to in-class learning (20%), class assignments (15%), a midterm exam (25%) and a final exam (40%).
Equipment	PC; Microsoft Office package; Statistical packages (SPSS)
Theoretical/practical ratio	Course is a combination of case discussions (60%), lectures (20%), and in class exercises (20%).
Literature	- Palisade Corporation. (2017). Decision Tools Suite Industrial Edition. Palisade Press. ISBN 978-1521252203 - Kimbrough, Steven Orla, and Hoong Chuin Lau. (2016). *Business Analytics for Decision Making*. CRC Press. ISBN 978-1498721169 - Morris, Michael. (2024). *Tribal: How the Cultural Instincts That Divide Us Can Help Bring Us Together*. [Publisher information forthcoming -

Course	**Product Development and Management**
ECTS	**5**
Description	The course emphasizes the critical early stages of product development, including product planning, concept development, and environmentally adapted practices. It introduces students to key methodologies such as LEAN product development, customer requirements analysis, and design for manufacturing and assembly (DFMA). Through the use of digital tools, case studies, and practical exercises, students will gain the skills needed to address real-world challenges in product development, focusing on creating sustainable and efficient solutions tailored to various industrial contexts.

Learning Outcomes	Upon completing this course, students will: • Describe available methods and techniques for the development of products in different industrial contexts. • Apply the most common methods for requirements management and concept development of a new product. • Analyze the causes of differences in prerequisites for product development across industries and business environments. • Describe factors that guide success and failure in industrial product development activities. • Demonstrate effective teamwork and collaboration skills in the context of product development projects. • Integrate sustainability and lifecycle considerations into the development process.
Teaching/Learning methods	The course comprises lecturing and discussions after each meeting. This involves personal and group discussions and the presentation of projects and research articles. · Lectures · Project · Research article · Case studies · Simulation · Problem-solving
Assessment methods	Attendance (10%) Project (60%) Research article (20%) Presentation (10%)
Equipment	Class; Moodle; Software; Projector; PC or Laptop; Laboratory

Theoretical/Practical ratio	Total hours: 150 Lectures: 30 Project: 45 Research article: 25 Independent learning: 45 Presentation: 5
Literature	Ulrich, Karl T., & Eppinger, Steven D. (2020). Product Design and Development (7th Edition). McGraw-Hill Education. ISBN: 978-1260043655 Jamnia, A. (2018). Introduction to Product Design and Development for Engineers. CRC Press. ISBN: 978-1138605814 Selected Research Articles on LEAN product development, sustainability, and DFMA.

Course	**Design Optimization**
ECTS	**5**
Description	The course integrates traditional design methodologies with modern optimization theory and practices. It enables students to create innovative design solutions with improved performance compared to traditional approaches. Topics include engineering approaches, optimization algorithms, material selection, multi-objective optimization, quality management, and additive manufacturing. Students will develop skills to optimize mechanical systems using advanced methods and tools.
Learning Outcomes	Upon completing this course, students will be able to: • Demonstrate the use of optimization tools and methods for mechanical product and structure design. • Develop improved components and systems using iterative design processes. • Integrate modeling, analysis, and testing in the development chain.

	• Apply advanced CAE tools for optimization tasks. • Incorporate material selection into product development effectively.
Teaching/Learning methods	The course comprises lecturing and discussions after each meeting. This involves personal and group discussions and the presentation of projects and research articles. · Lectures · Project · Research article · Case studies · Simulation · Problem-solving
Assessment methods	Attendance (10%) Project (60%) Research article (20%) Presentation (10%)
Equipment	Class; Moodle; Software; Projector; PC or Laptop; Laboratory
Theoretical/Practical ratio	<u>Total hours: 150</u> Lectures: 30 Project: 45 Research article: 25 Independent learning: 45 Presentation: 5

Literature	Papalambros, P. Y., & Wilde, D. J. (2017). *Principles of Optimal Design: Modeling and Computation* (3rd Edition). Cambridge University Press. ISBN: 978-1107132672. Cambridge University Press Christensen, P. W., & Klarbring, A. (2008). *An Introduction to Structural Optimization*. Springer. ISBN: 978-1402086656. SpringerLink Bendsøe, M. P., & Sigmund, O. (2003). *Topology Optimization: Theory, Methods, and Applications*. Springer. ISBN: 978-3540429920. Selected research articles

Course	**Design for Advanced Manufacturing**
ECTS	**5**
Description	This course focuses on equipping students with the skills to perform design tasks in the advanced manufacturing environment. Topics include fundamental concepts of manufacturing systems, computer-aided processes, CNC programming, additive manufacturing, lasers, and micro-parts manufacturing. The course emphasizes integrating design and manufacturing processes to optimize product performance and efficiency. Advanced CAD/CAM tools will be used extensively in practice sessions, providing project-based experience in design techniques and team-based tasks.
Learning Outcomes	Upon completion of this course, students will: • Understand the concepts and principles of design for advanced manufacturing. • Analyze and compare design techniques suitable for advanced manufacturing. • Synthesize and propose solutions for open-ended design problems. • Design engineering components and systems for advanced manufacturing. • Apply practical aspects of advanced manufacturing technologies. • Collaborate effectively in team-based design projects to address complex engineering challenges.

Teaching/Learning methods	The course comprises lecturing and discussions after each meeting. This involves personal and group discussions and the presentation of projects and research articles. · Lectures · Project · Research article · Case studies · Role simulation · Problem-solving
Assessment methods	Attendance (10%) Project (50%) Research article (30%) Presentation (10%)
Equipment	Class; Moodle; Software; Projector; PC or Laptop; Laboratory
Theoretical/Practical ratio	Total hours: 150 Lectures: 30 Project: 30 Research article: 25 Independent learning: 55 Presentation: 10

Literature	·Gillespie, L. K. (2017). *Design for Advanced Manufacturing: Technologies and Processes*. McGraw-Hill Education. ISBN: 978-1259587452 Malhotra, V. (2021). *Advanced Manufacturing Processes*. CRC Press. ISBN: 978-0367357746 Singh, Y., Singh, N. K., & Ram, M. (2022). *Advanced Manufacturing Processes: Modeling and Optimization*. CRC Press. ISBN: 978-1003220237 Tiwari, M. K., & Ramkumar, P. (2021). *Artificial Intelligence for Smart Manufacturing and Industry X.0*. Springer. ISBN: 978-3030699237 Selected Research Articles on additive manufacturing, CAD/CAM technologies, and sustainable manufacturing practices.

Course	**Advanced Manufacturing Processes**
ECTS	**5**
Description	Through this course, students are provided with knowledge for advanced manufacturing processes. Specifically, manufacturing processes will be elaborated separately, from basic knowledge of manufacturing processes in general, selection basics to detailed manufacturer-based processes including, machining, casting, powder processing, bulk deformation, sheet metal, and nonconventional manufacturing methods (Laser Beam Machining (LBM), Water Jet Cutting (WJC), Electron Beam Machining (EBM), Additive Manufacturing (3D Printing)). The aims of this course are specific and are based on providing students with scientific and engineering knowledge in the relevant field. Based on this, objectives are related to better understanding the manufacturing processes by theoretical explanations and practical investigations, using the newest technologies.

Learning Outcomes	Upon completion of this course, students will: · Understand the notions of advanced manufacturing processes · Select the relevant manufacturing processes for the specific purposes · Distinguish processes according to practical requirements · Analyze different processes in the advanced manufacturing · Describe the operations and tools for major manufacturing processes
Teaching/Learning methods	The course comprises lecturing and discussions after each meeting. This involves personal and group discussions and the presentation of projects and research articles. · Lectures · Project · Research article · Case studies · Role simulation · Problem-solving
Assessment methods	Attendance (10%) Project (50%) Research article (30%) Presentation (10%)
Equipment	Class; Moodle; Software; Projector; PC or Laptop; Laboratory

Theoretical/Practical ratio	Total hours: 150 Lectures: 30 Project: 30 Research article: 25 Independent learning: 55 Presentation: 10
Literature	Black, J. T., and Kohser, R. A. (2017). DeGarmo's Materials and Processes in Manufacturing, 12th Edition. John Wiley & Sons, Inc. ISBN 978-1119299585. Groover, M. P. (2020). Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 7th Edition. John Wiley & Sons, Inc. ISBN 978-1119722014. Gibson, I., Rosen, D., and Stucker, B. (2015). Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, 2nd Edition. Springer. ISBN 978-1493921137.

Course	**Finite Element Method**
ECTS	**5**
Description	The course provides an in-depth understanding of the Finite Element Method (FEM), focusing on its fundamental principles and applications in solid mechanics and frame structures. Students will explore stress and strain analysis, mathematical modeling, formulation techniques, and computational methods. Emphasis is placed on applying FEM techniques to solve engineering problems in computer-aided design and analysis. Through practical applications and case studies, students will develop the skills necessary to analyze and design components and structures, aligning with specific performance requirements.

Learning Outcomes	Upon completion of this course, students will: Explain the fundamental principles and mathematical foundations of the Finite Element Method. Model and analyze stress and strain in engineering components and structures using FEM techniques. Develop and implement finite element formulations for solving problems in solid mechanics and frame structures. Apply FEM tools for evaluating and improving the design and performance of engineering systems. Interpret and validate FEM results, ensuring alignment with real-world performance requirements and standards.
Teaching/Learning methods	The course comprises lecturing and discussions after each meeting. This involves personal and group discussions and the presentation of projects and research articles. · Lectures · Project · Research article · Case studies · Role simulation · Problem-solving
Assessment methods	• **Assignments (20%)** – Problem-solving tasks on FEM principles and applications. • **Project Work (30%)** – Modeling and analysis of real-world engineering problems using FEM, with a report and presentation. • **Midterm Exam (20%)** – Tests theoretical understanding and problem-solving skills. • **Practical Lab Work (10%)** – Assessment of FEM tool usage and result interpretation. • **Final Exam (20%)** – Comprehensive evaluation of theoretical and practical knowledge

Equipment	Class; Moodle; Software; Projector; PC or Laptop; Laboratory
Theoretical/Practical ratio	Total Hours: 150 • Lectures: 30 hours • Project: 30 hours • Research Article: 25 hours • Independent Learning: 65 hours
Literature	Reddy, J. N. (2019). An Introduction to the Finite Element Method, Fourth Edition. McGraw Hill. ISBN-13: 978-1259861901 Okereke, M., & Keates, S. (2018). Finite Element Applications: A Practical Guide to the FEM Process. Springer. ISBN-13: 978-3319671246 Lyu, Y. (2022). Finite Element Method: Element Solutions. Springer. ISBN-13: 978-9811933653 Öchsner, A., & Merkel, M. (2020). One-Dimensional Finite Elements: An Introduction to the FE Method. Springer. ISBN-13: 978-3662667583

Course	**Machine and System Dynamics**
ECTS	**5**
Description	This subject builds on prior knowledge from Dynamics to advance students' understanding of Engineering Mechanics with a focus on Analytical Mechanics. The course delves into key topics, including kinematics, generalized coordinates, and energy methods, to enhance analytical problem-solving skills in mechanical systems. Students will explore: Kinematics and Generalized Coordinates Virtual Work and Virtual Displacement, Generalized Force Energies: Kinetic and Potential Lagrange's Approach, addressing constraints and deriving equations of motion Comparison between Lagrange and Newton-Euler Methods Hamiltonian Mechanics Linearization of System Dynamics and Stability around Equilibrium Points

	This course equips students with a deeper theoretical and practical understanding of machine and system dynamics, emphasizing analytical ap
Learning outcomes	Having completed this unit, the student is expected to be able to: • Apply kinematics and generalized coordinates to model complex mechanical systems. • Derive equations of motion using Lagrange's and Newton-Euler approaches and compare their applications. • Analyze the stability of dynamic systems through linearization about equilibrium points. • Utilize energy methods, including kinetic and potential energy, in the analysis of mechanical and system dynamics.
Teaching/Learning methods	The course comprises of lecturing and discussions after each lecture. This involves personal and group discussions and presentation of seminar work. The final element is the testing. Lecture - Seminars, using hands-on student - Case Studies - Laboratory - Student individual assignments based on Tutorial material - Team assignment - Readings from texts and selected relevant articles and publications
Assessment methods	• One written 3 hour closed book end of semester examination (60%). • One mid-semester 1 hour test in week 8 (10%), • Three written assignments not exceeding 30 pages in total (30-35 hours of work), due in weeks 4, 6, and 11 (30%
Equipment	Laboratory, Dashboards/Other related equipment
Theoretical/practical ratio	Total hours: 120 Lectures: 30 Seminars: 15 Laboratory: 30 Self-study: 45
Literature	Fritzen, C.-P., „Machine and System Dynamics ", Lecture Notes, Univ. of Siegen, 2004. Davies, Matthew, and Chris J. Roy. (2014). System Dynamics for Mechanical Engineers. Springer. ISBN 978-1461492931 Ginsberg, Jerry H. (2001). Mechanical and Structural Vibrations: Theory and Applications. Wiley. ISBN 978-0471370840.

Course	**Robotic Vision**
ECTS	**5**
Description	Robotics Vision applies AI techniques to the problems of making devices capable of interacting with the physical world. This includes moving around in the world (mobile robotics), moving things in the world (manipulation robotics), acquiring information by direct sensing of the world (e.g. machine vision) and, importantly, closing the loop by using sensing to control movement. Applying AI in this context poses certain problems, and sets certain limitations, which have important effects on the general software and hardware architectures. For example, a robot with legs must be able to correct detected imbalances before it falls over, and a robot which has to look left and right before crossing the road must be able to identify approaching hazards before it gets run over. These constraints become much more serious if the robot is required to carry both its own power supply and its own brain along with it. This module introduces the concepts and methods in these areas.
Learning Outcomes	Upon completion of this course, students will: · Be able to recall and explain the essential facts, concepts and principles in robotics and computer vision. · Be able to describe and evaluate the strengths and weaknesses of some specific sensor and motor hardware; and some specific software methods for sensory processing and motor control. · Be able to employ hardware (e.g. cameras, robots) and software tools to solve a practical problem of sensory-motor control. · Identify problem criteria and context, discuss design and development, test, analyse and evaluate the behavior of the sensory-motor control system.

Teaching/Learning methods	The course comprises lecturing and discussions after each meeting. This involves personal and group discussions and the presentation of projects and research articles. · Lectures · Project · Research article · Case studies · Role simulation · Problem-solving
Assessment methods	Attendance (10%) Project (50%) Research article (30%) Presentation (10%)
Equipment	Class; Moodle; Software; Projector; PC or Laptop; Laboratory
Theoretical/Practical ratio	Total hours: 150 Lectures: 30 Project: 30 Research article: 25 Independent learning: 55 Presentation: 10

Literature	· Peter C., Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, 2011. · Lewis F.L., Dawson D.M. and Abdallah C.T., Robot Manipulator Control: Theory and Practice, Marcel Dekker Inc., NY, USA, 2004. · Siegwart R. and Nourbakhsh I.R., Introduction to Autonomous Mobile Robots, MIT Press, Cambridge, MA, USA, 2004.Godfrey O., Mechatronics: Principles and Applications, Elsevier, 2005.

Course	**Special Topics in Robotics**
ECTS	**5**
Description	This course introduces mechatronics students to robots and robotic systems, including the design of robot controllers, coordination of multiple robots, simulation of robotic systems, and optimization of robot task scheduling
Learning Outcomes	Upon completion of this course, students will: ● Understand and apply Robot Operating System (ROS). ● Apply concepts of Systems Engineering to simulated robotic systems. ● Understand, interpret, and modify Python code for the purposes of controlling robotic systems. .

Teaching/Learning methods	The course comprises lecturing and discussions after each meeting. This involves personal and group discussions and the presentation of projects and research articles. · Lectures · Project · Research article · Case studies · Role simulation · Problem-solving
Assessment methods	Attendance (10%) Project (50%) Research article (30%) Presentation (10%)
Equipment	Class; Moodle; Software; Projector; PC or Laptop; Laboratory
Theoretical/Practical ratio	Total hours: 150 Lectures: 30 Project: 30 Research article: 25 Independent learning: 55 Presentation: 10

Literature	· Modern Robotics: Mechanics, Planning, and Control 1st Editionby Kevin M. Lynch (Author) · Lewis F.L., Dawson D.M. and Abdallah C.T., Robot Manipulator Control: Theory and Practice, Marcel Dekker Inc., NY, USA, 2004. · Mastering ROS for Robotics Programming: Best practices and troubleshooting solutions when working with ROS, 3rd Edition 3rd ed

Course	**Motion Planning**
ECTS	**5**
Description	This course will focus on principles used in motion planning algorithms; i.e. algorithms that allow a robot move in a cluttered environment while avoiding collisions with obstacles. In particular, classic planning algorithms are employed when the geometry of the robot's stationary, surroundings is known in advance. This is in opposition to sensor-based planning algorithms, where the surroundings of the robot are poorly known in advance. The course focuses mainly on the modeling, design, algorithm, and computational issues that arise when building planning algorithms. Motion planning algorithms find application in a number of technologies and disciplines such as manufacturing, computer-aided design, computer graphics and virtual environments, and general mechanical and aerospace robotic applications.

Learning Outcomes	Upon completion of this course, students will: · Be able to apply knowledge of geometry, graph algorithms and linear algebra to robotic systems · Be able to use a numerical computing environment, to solve engineering problems · Be able to formulate and solve motion planning problems in robotics
Teaching/Learning methods	The course comprises lecturing and discussions after each meeting. This involves personal and group discussions and the presentation of projects and research articles. · Lectures · Project · Research article · Case studies · Role simulation · Problem-solving
Assessment methods	Attendance (10%) Project (50%) Research article (30%) Presentation (10%)
Equipment	Class; Moodle; Software; Projector; PC or Laptop; Laboratory

Theoretical/Practical ratio	<u>Total hours: 150</u> Lectures: 30 Project: 30 Research article: 25 Independent learning: 55 Presentation: 10
Literature	· H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, L. E. Kavraki, and S. Thrun. Principles of Robot Motion: Theory, Algorithms and Implementations. The MIT Press, 2005. · S. M. LaValle. Planning algorithms. 2006. · B. Siciliano, L. Sciavicco, L., Villani, G. Oriolo, Robotics: Modeling, Planning and Control, Springer, 2009.

Course	**Neural Networks and Deep Learning**
ECTS	**5**
Description	Over the past few years, neural networks have enjoyed a major resurgence in machine learning, and today yield state-of-the-art results in various fields. This course provides an introduction to deep neural network models, and surveys some the applications of these models in areas where they have been particularly successful. The course covers feedforward networks, convolutional networks, recurrent and recursive networks, as well as general topics such as input encoding and training techniques. The course also provides acquaintance with some of the software libraries available for building and training deep neural networks.

Learning Outcomes	Upon completion of this course, students will: · explain different network architectures and how these are used in current applications · implement, train, and evaluate neural networks using existing software libraries · present and critically assess current research on deep neural networks and their applications · relate the concepts and techniques introduced in the course to their own research · plan and carry out a research project on deep neural networks within given time limits
Teaching/Learning methods	The course comprises lecturing and discussions after each meeting. This involves personal and group discussions and the presentation of projects and research articles. · Lectures · Project · Research article · Case studies · Role simulation · Problem-solving
Assessment methods	Attendance (10%) Project (50%) Research article (30%) Presentation (10%)
Equipment	Class; Moodle; Software; Projector; PC or Laptop; Laboratory

Theoretical/Practical ratio	<u>Total hours: 150</u> Lectures: 30 Project: 30 Research article: 25 Independent learning: 55 Presentation: 10
Literature	· Ian Goodfellow, Yoshua Bengio, and Aaron Courville. Deep Learning. MIT Press, 2016. · Simon O. Haykin. Neural Networks and Learning Machines. Third edition. Prentice Hall, 2008.

Course	**Biomimetic**
ECTS	**5**

Description	This course explores the field of biomimetic design and engineering, focusing on biologically inspired technologies that emulate nature's design principles to recreate, engineer, and utilize the physiological structures and functions of living organisms. The course emphasizes the study of "Human Organs-on-Chips," microengineered systems that mimic the physiological biomechanics and complex intercellular interactions of human organs in vitro. Key topics include microfluidics, cell and tissue engineering, clinical microbiology, synthetic biology, microtechnology, biomaterials, drug delivery systems, and high-resolution imaging. Students will examine how these transdisciplinary technologies can model human pathophysiology, investigate disease mechanisms, and support advancements in precision medicine. The course also explores the host-microbiome ecosystem's role in regulating metabolism, immune defense, and inter-organ communication, highlighting its relevance to human health and disease. Applications of these approaches to replace animal testing, evaluate drug efficacy and toxicity, and accelerate the development of personalized medicine will also be discussed. This course provides a comprehensive understanding of how nature-inspired engineering principles can drive innovation in biomedical research and healthcare.
Learning Outcomes	Upon completion of this course, students will: · explain key concepts of biomimetic microengineering. · describe how the organ-level physiology should be designed and recreated. · evaluate engineered models that emulate human disease pathophysiology.

	· understand and leverage a human microbiome and their community.
Teaching/Learning methods	The course comprises lecturing and discussions after each meeting. This involves personal and group discussions and the presentation of projects and research articles. · Lectures · Project · Research article · Case studies · Role simulation · Problem-solving
Assessment methods	Attendance (10%) Project (50%) Research article (30%) Presentation (10%)
Equipment	Class; Moodle; Software; Projector; PC or Laptop; Laboratory
Theoretical/Practical ratio	<u>Total hours: 150</u> Lectures: 30 Project: 30 Research article: 25 Independent learning: 55 Presentation: 10

Literature	· Biomimetics: Nature-Inspired Design and Innovation Kindle Edition by Sandy B. Primrose (Author) · Black, J. T., Kohser, R. A. (2012). DeGarmo's MATERIALS AND PROCESSES IN MANUFACTURING ELEVENTH EDITION. John Wiley & Sons, Inc. ISBN-13 978-0-470-92467-9 · Biomimetic Medical Materials: From Nanotechnology to 3D Bioprinting (Advances in Experimental Medicine and Biology, 1064) 1st ed. 2018 Edition by Insup Noh (Editor) ·

Course	**Biomedical Instrumentation and Signals**
ECTS	**5**
Description	In this course, you will learn key measurement principles of sensors found in health technologies, ranging from medical devices used in hospitals to wearables for fitness monitoring. You will learn how to build bio-potential amplifiers and record and interpret your own bioelectrical data (e.g. heart activity, muscle activity). You will gain insight into the working principles underlying the instrumentation for measuring respiratory and cardiovascular function such as blood pressure, blood flow as well as biochemical sensors and neuro-stimulators.
Learning Outcomes	• On successful completion of this course students will be able to: • Describe the origin of biopotentials and the function of biopotential electrodes in biomedical instrumentation. • Design and operate biopotential amplifiers to record and analyze bioelectrical signals. • Identify and address signal artifacts in biomedical signals and implement strategies for artifact suppression. • Explain the working principles of medical devices such as cardiac pacemakers, neurostimulators, and defibrillators.

	• Analyze measurement principles for cardiovascular and respiratory variables, including blood pressure, blood flow, and respiratory function.
Teaching/Learning methods	This course relies on lectures as the primary delivery mechanism for the material. Tutorials supplement the lectures by providing exercises and examples to enhance the understanding obtained through lectures. Practical work is used to provide hands-on experience for students to reinforce the theoretical concepts encountered in lectures. Continuous assessment activities provide the formative assessment opportunities for students to gauge their progress and understanding. · Lectures · Project · Research article · Case studies · Role simulation · Problem-solving
Assessment methods	Attendance (10%) Project (50%) Research article (30%) Presentation (10%)
Equipment	Class; Moodle; Software; Projector; PC or Laptop; Laboratory
Theoretical/Practical ratio	Total hours: 150 Lectures: 30 Project: 30 Research article: 25

	Independent learning: 55 Presentation: 10
Literature	- Webster, John G., and Amit J. Nimunkar. (2020). Medical Instrumentation: Application and Design, 5th Edition. Wiley. ISBN 978-1119457336 - Khandpur, Raghbir Singh. (2014). Handbook of Biomedical Instrumentation, 3rd Edition. McGraw-Hill Education. ISBN 978-9355328021 - Chatterjee, Shakti, and Aubert Miller. (2012). Biomedical Instrumentation Systems. Cengage Learning. ISBN 978-8131519530

Course	**Biomedical Signal Processing**
ECTS	**5**
Description	The course gives an in-depth analysis of the origin and processing of bioelectrical signals in humans. The analysis is related to differentiating between healthy and pathological conditions and emerges from clinical situations and issues. Signal analysis: time- and frequency, sampling, digital signals, Fouriertransform (FFT), estimation of the power spectrum, input windows, leakage, aliasing, convolution and correlation properties, digital filters Physiological and mathematical models of bioelectricity: cell membrane, resting- and action potentials, Nernst equation, volume conducting, forward-och inverse problems. Measurement of bioelectrical signals: electrode properties, measurement systems Electrocardiography: origin of the ECG, ECG-leads, ECG analysis Neurophysiology: nervous system, muscles, EEG, EP, EMG, ERG, EOG, signal analysis Electro stimulation: defibrillation, pacemakers,

Learning Outcomes	Upon completion of this course, students will: • Describe, apply and evaluate physical, electrical and mathematical models for the origin of bioelectrical signals in the cell, and their conduction in nerves and in tissue. • Give an in-depth description of bioelectricity in the heart and in the centraland peripheral nervous system. • Describe and evaluate the most important bioelectrical measurement methods: The ECG, the EEG and the EMG, in relation to normal and pathological condiitions. • Apply and evaluate different methods for signal processing of the ECG, the EEG and the EMG, with respect to time- and frequency domain analysis. Describe, apply and evaluate Fourier transform based methods for signal processing..
Teaching/Learning methods	The course is partly based on problem based learning and comprises lectures, problem solving individually and in various groups and laboratory work. · Lectures · Project · Research article · Case studies · Role simulation · Problem-solving
Assessment methods	Attendance (10%) Project (50%) Research article (30%) Presentation (10%)
Equipment	Class; Moodle; Software; Projector; PC or Laptop; Laboratory

Theoretical/Practical ratio	<u>Total hours: 150</u> Lectures: 30 Project: 30 Research article: 25 Independent learning: 55 Presentation: 10
Literature	- Sörnmo L. and Laguna P, (2005) Bioelectrical Signal Processing in Cardiac and Neurological Applications Academic Press (Elsevier) Rangayyan, Rangaraj M., and Sridhar Krishnan. (2024). Biomedical Signal Analysis: A Case-Study Approach, 3rd Edition. Wiley-IEEE Press. ISBN 978-1119825852. · Vyas, N. (2012). Biomedical Signal Processing. IK International Publishing House. ISBN 978-9381159040.

Course	**Biomechanics**
ECTS	**5**
Description	Explores how the physical and mechanical properties of organisms and their environment affect biological tissues, structures, and behavior. Demonstrates how principles and techniques from fields such as physics, engineering, functional morphology and physiology can be used to understand motor performance, capability and failure. Emphasis will be placed on investigating causes of injury and disease, and understanding or designing techniques to overcome motor impairments. The laboratory component involves using current biomechanical measurement and analysis techniques to perform detailed investigation of specific movements

Learning Outcomes	Upon completion of this course, students will: • Analyze how physical and mechanical properties of biological tissues and structures influence motor performance and behavior. • Apply principles from physics, engineering, and physiology to evaluate motor capability and identify causes of injury or failure. • Investigate and design techniques to overcome motor impairments using biomechanical analysis. • Utilize biomechanical measurement and analysis techniques to assess specific movements and develop practical solutions. • Evaluate the impact of environmental and organismal factors on tissue performance, injury prevention, and rehabilitation strategies.
Teaching/Learning methods	The course comprises lecturing and discussions after each meeting. This involves personal and group discussions and the presentation of projects and research articles. · Lectures · Project · Research article · Case studies · Role simulation · Problem-solving
Assessment methods	Attendance (10%) Project (50%) Research article (30%) Presentation (10%)
Equipment	Class; Moodle; Software; Projector; PC or Laptop; Laboratory

Theoretical/Practical ratio	Total hours: 150 Lectures: 30 Project: 30 Research article: 25 Independent learning: 55 Presentation: 10
Literature	• Winter, David A. (2024). Biomechanics and Motor Control of Human Movement, 5th Edition. Wiley. ISBN 978-1119827047 • Knudson, Duane. (2020). Fundamentals of Biomechanics, 3rd Edition. Springer. ISBN 978-303051837X

Course	**Advanced Power Systems**
ECTS	**5**
Description	The Electricity supply system, AC power & reactive power, Three-phase systems, fundamental principles of electricity generation and their influence on the design and operation of electrical power stations. The economics of electricity generation. Fuel availability and environmental considerations, Transmission lines and cables, Power system calculations, Steady-state stability, Transient stability, Control of system voltage and frequency, Power Quality Issues, and Protection requirements for transmission and distribution networks. Components of a protection system. Types of protection relay. Principles of protection, unit protection schemes, non-unit protection schemes • Power System Analysing Tools and Techniques in Singapore Power Industry • Introduction to ETAP Software to carry out Power System Analysis

Learning Outcomes	• Analyze and evaluate electrical power networks under balanced three-phase conditions, including power flows, reactive power, busbar voltages, and fault levels. • Assess the steady-state, transient, and dynamic stability of power systems, and perform stability calculations for synchronous generators. • Apply protection principles to design and evaluate network protection schemes, including overcurrent, unit, and distance protection. • Critically evaluate the operation of large power networks using advanced power system analysis tools and software packages. • Identify and solve operational challenges in electricity networks, utilizing theoretical concepts, numerical techniques, and computer-aided tools.
Teaching/Learning methods	· Interactive lectures and communication with students · Discussion and Group Works · Presentation · Homework · Project
Assessment methods	Activity: Attendance 5% Quiz 10% Homework 10% Renewable Energy Portfolio 10% Midterm Examination 15% Lab/Practical Exam 15% Final Exam 20%
Equipment	Class; Moodle; Software; Projector; PC or Laptop; Laboratory

Theoretical/Practical ratio	Lectures: 30 Project: 30 Research article: 35 Independent learning: 45 Presentation: 10
Literature	Singh, L.P. (2012). Advanced Power System Analysis and Dynamics, 6th Edition. New Academic Science. ISBN 978-1906574870 Grainger, John, and Stevenson, William. (2015). Power System Analysis, 2nd Edition (SI Units). McGraw-Hill Education. ISBN 978-1259008351

Course	**Special Topic in Energy Engineering**
ECTS	**5**
Description	The first course part about heat and power technology brings up techniques for large- and small-scale electricity and heat generation in power plants fired on biomass, oil, natural gas or coal. Thermodynamic power cycles and analysis, combustion, boilers, emissions, life-cycle-cost and availability are all included in this course part. The second part of the course brings up nuclear reactor technology and nuclear power safety and focuses on BWR and PWR technologies. Here material aspects, fuel cycles and plant control are included. Environment and security issues are brought up.

Learning Outcomes	After the course the student should be able to Understand the principles of different power generation methods, both conventional and renewable Analyze the conventional power methods thermodynamically Make a simple economical assessment of a power plant Perform an environmental assessment and suggest measures for emission control in a power plant Compare different power generation alternatives and choose the most suitable for given conditions Understand physics of nuclear power and how such a system can be built up Describe some of the components in a power plant
Teaching/Learning methods	Lectures will be interactive with an aim to involve students in elaborating on topics. Seminars will be based on the problem solving of certain course related problems both theoretical and empirical.
Assessment methods	Written final exam (50%) Team work (40 %) Participation and class activities (10%)
Equipment	Class; Moodle; Software; Projector; PC or Laptop; Laboratory
Theoretical/Practical ratio	50/50

Literature	· Sustainable Power Technologies and Infrastructure, 1nd Edition Authors: Galen Suppes Truman Storvick, eBook ISBN: 9780128039281, Published Date: 29th September 2015 · - Green Power: Perspectives on Sustainable Electricity Generation, Authors: Joao Neiva de Figueiredo, Mauro F. Guillén, eBook ISBN 9781466590489 - CAT# K20467, Published Date: February 5, 2014 by Productivity Press · - Materials provided by the lecturer

Course	**Smart Grid Technologies**
ECTS	**5**
Description	This course introduces students to the design process of digital hardware systems, with a focus on digital design methodologies, Verilog, VHDL, and hardware description languages (HDLs). Topics include the design of digital circuits, design entry methods, logic synthesis, and key elements like entities, architecture, packages, configurations, and types of models. Students will also gain insight into smart grid systems, exploring their function, operation, and the vision of their future development. The course covers the following topics: Smart Grid Systems: Overview of smart grids, communication, and data within the grid Designing with VHDL and Verilog: Digital hardware design using hardware description languages Modeling and Verification: Techniques for modeling and verifying digital systems Programmable Logic Devices: The role of programmable logic devices (PLDs) in system design

	State Machines and Controllers: Design and implementation of state machines and data path controllers Smart Grid Control and Monitoring: Techniques for controlling, operating, and monitoring the smart grid
Learning Outcomes	Design and implement digital hardware systems using Verilog and VHDL, applying digital design methodologies. Model and verify digital circuits using hardware description languages (HDLs) for combinational and sequential logic. Analyze and implement programmable logic devices (PLDs) in the design of complex systems. Understand the function, operation, and components of smart grid systems, including communication and data management. Control, operate, and monitor smart grids using modern design and monitoring techniques.
Teaching/Learning methods	· Interactive lectures and communication with students · Discussion and Group Works · Presentation · Homework · Project
Assessment methods	Activity: Attendance 5% Quiz 10% Homework 10% Renewable Energy Portfolio 10% Midterm Examination 15% Lab/Practical Exam 15%

	Final Exam 20%
Equipment	Class; Moodle; Software; Projector; PC or Laptop; Laboratory
Theoretical/Practical ratio	Lectures: 30 Project: 30 Research article: 30 Independent learning: 50 Presentation: 10
Literature	Refaat, Shady S., Ellabban, Omar, Bayhan, Sertac, Abu-Rub, Haitham, Blaabjerg, Frede, Begovic, Miroslav M. (2021). Smart Grid and Enabling Technologies. Wiley-IEEE Press. ISBN 978-1119422310 Borlase, Stuart. (2020). Smart Grids: Advanced Technologies and Solutions, Second Edition. CRC Press. ISBN 978-1351228480 Kamran, Muhammad. (2023). Fundamentals of Smart Grid Systems. Elsevier. ISBN 978-0323995608

Course	**Renewable Energy Sources**
ECTS	**5**

Description	This course provides an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and application. The class will explore society's present needs and future energy demands, examine conventional energy sources and systems, including fossil fuels and nuclear energy, and then focus on alternate, renewable energy sources such as solar, biomass (conversions), wind power, geothermal, and hydro. Energy conservation methods will be emphasized.
Learning Outcomes	• List and generally explain the main sources of energy and their primary applications in the world. • Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the environment. • Discuss remedies/potential solutions to the supply and environmental issues associated with fossil fuels and other energy resources. • List and describe the primary renewable energy resources and technologies. • Describe/illustrate basic electrical concepts and system components. • Convert units of energy—to quantify energy demands and make comparisons among energy uses, resources, and technologies. • Collect and organize information on renewable energy technologies as a basis for further analysis and evaluation.
Teaching/Learning methods	· Interactive lectures and communication with students · Discussion and Group Works · Presentation · Homework · Project

Assessment methods	Activity: Attendance 5% Quiz 10% Homework 10% Renewable Energy Portfolio 10% Midterm Examination 15% Lab/Practical Exam 15% Final Exam 20%
Equipment	Class; Moodle; Software; Projector; PC or Laptop; Laboratory
Theoretical/Practical ratio	Lectures: 30 Project: 30 Research article: 35 Independent learning: 55 Presentation: 10
Literature	• Schaeffer, John. (2021). Real Goods Solar Living Sourcebook: The Complete Guide to Renewable Energy Technologies and Sustainable Living (30th Anniversary Edition). Gaiam. ISBN 978-0916571061. • Rajput, R.K. (2020). Non-Conventional Energy Sources and Utilisation. S. Chand & Company Ltd. ISBN 978-8121939713. • Boyle, Godfrey. (2021). Renewable Energy (3rd Edition). Oxford University Press. ISBN 978-0199261787. • Boyle, Godfrey, Everett, Bob, and Ramage, Janet (Eds.). (2018). Energy Systems and Sustainability: Power for a Sustainable Future (3rd Edition). Oxford University Press. ISBN 978-0199261794.

<table>
<tr><td>Course</td><td>Mechatronics Applied Project</td></tr>
<tr><td>ECTS
Description</td><td>6
The Mechatronics Applied Project is a substantial, group-based project designed to integrate and apply knowledge gained throughout the Mechatronics program. Typically undertaken in small groups (2-3 students), this project involves an independent investigation on an approved topic related to advanced engineering design or research. The course emphasizes both professional practice and research, with two potential project directions:
Industry-Based Project: Students will work on a well-defined project, often stemming from a task required by an external industrial client. This approach emphasizes the synthesis of practical solutions to complex technical problems, simulating a professional engineering working environment.
Research-Oriented Project: Students will engage in a more explorative approach, where they will focus on new knowledge and understanding, often contributing to existing academic research initiatives within the mechanical sciences disciplines.
At the end of the semester, students will present their findings in a formal conference podium presentation, simulating a professional academic or industry setting. The project aims to foster both problem-solving skills and innovative thinking within the realms of mechatronics engineering</td></tr>
<tr><td></td><td>.</td></tr>
<tr><td>Learning outcomes</td><td>Having completed this subject it is expected that the student be able to:
Independently research and investigate a well-defined engineering or academic problem within mechatronics.
Apply engineering design principles to develop practical solutions for complex technical challenges in industrial or research contexts.
Collaborate effectively in small groups to address interdisciplinary issues and present coherent, workable solutions.
Present findings in a professional conference podium format, demonstrating effective communication skills in both technical and non-technical terms.
Integrate research and professional practice principles in the development of innovative solutions that contribute to the advancement of mechatronics engineering.</td></tr>
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Teaching/Learning methods	The course involves only independent learning in the laboratory. Contact hours are upon request.
Assessment methods	• Final report not exceeding 15 pages per student plus 30 pages, (excluding appendices) due in the end-of-semester 2 at the beginning of examination period (approximately 180-200 hours of working per student) (50%) • Continuous assessment of the lecture component of the subject, comprising submitted work not exceeding 25 pages over semester 1 (approximately 75-80 hours of working per student) (20%) • Oral examination not exceeding 60 minutes towards the end of semester 2 (approximately 75-80 hours of working per student) (20%) • Public display of project outcomes towards the end of semester 2 (approximately 35-40 hours of working per student) (10%)
Equipment	Laboratory, Dashboards/Other related equipment
Theoretical/practical ratio	Total hours: 180 Laboratory: 180
Literature	N/A

Course	**Thesis**
ECTS	**24**
Description	The Master Thesis is a significant research project that students undertake under the supervision of academic staff. This course requires students to engage in an in-depth investigation of a topic within their area of study, which can be experimental or theoretical in nature. The thesis is a culmination of the student's learning and research during the master's program and should demonstrate their ability to conduct independent, advanced research. The course runs alongside the Capstone Project to fulfill the required total ECTS of 24. Students will be expected to contribute original findings to their field and present their research effectively.
Learning outcomes	Upon successful completion of this course, students will be able to: • Conduct independent, original research in the chosen area of study, demonstrating the ability to plan, execute, interpret, and report

	findings from computational experiments or theoretical investigations. • Communicate research outcomes effectively, both in written thesis format and oral presentations, ensuring clarity, coherence, and logical flow of ideas. • Demonstrate advanced critical thinking, analysis, and reflection throughout the research process, ensuring high levels of intellectual maturity and research maturity. • Adhere to the highest standards of intellectual integrity and ethical scholarship, respecting research guidelines and best practices in the discipline. • Achieve a deep understanding of the specialized discipline(s) and apply this knowledge to solve complex problems or propose innovative solutions. • Demonstrate proficiency in writing, problem-solving, and communication, including the ability to produce high-quality research documents and presentations. • Exhibit self-directed learning, continually engaging with new literature, techniques, and research methods relevant to the chosen topic. • Develop transferable skills for different professional careers, including project management, interdisciplinary knowledge integration, and problem-solving.
Teaching/Learning methods	The subject will comprise a mixture of lectures and workshops (3 hours each week). Students are required to attend regular meetings with their supervisor, and to participate in the academic activities of the Department Students are required to undertake approximately 800 hours of investigative work, over an 18 week period
Assessment methods	• A written thesis of approximately 20,000 words (contributing 90% of the grade for the subject) • An oral presentation of their project work prior to submission of the thesis (contributing the remaining 10% of the grade).
Equipment	Laboratory, Dashboards/Other related equipment
Theoretical/practical ratio	Total hours: 720 Lectures: 15 Workshops: 15

	Self-study: 690
Literature	Evans, D. and Gruba, P. and Zobel, J. *How to Write a Better Thesis*, 3rd edition, Melbourne University Press, 2011 Zobel, J. *Writing for Computer Science*, 2nd edition, Springer, 2004