CURRICULUM FRAMEWORK

MASTER OF SCIENCE

IN MECHANICAL ENGINEERING

PROGRAM CODE: 8520103

Applicable from Academic Year 2025-2026

(Released along with Decision No. 588/2025/ QĐ-VUNI dated September 19th 2025 by Provost of VinUniversity)

Records of changes

Version	Published date	Effective Date	Approved by	Description of changes
1	19/9/2025	19/9/2025	Developed by Curriculum Development Taskforce Reviewed by Curriculum Review Committee Approved by: Provost (Decision No. 588/2025/ QĐ-VUNI dated 19/9/2025)	First release

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1. PROGRAM OVERVIEW

1.1 Program Profile

Name of the degree	Master of Science in Mechanical Engineering
Name of the program	Master of Science in Mechanical Engineering
Program Code	8520103
Vietnam Qualifications Framework Level	7
Length of Program	2 years
Mode of Delivery	Full-time
Language of Delivery	English
Total credits	60 credits
Home College	College of Engineering and Computer Science

1.2 Program Purpose

The purpose of the Master of Science in Mechanical Engineering program is to develop mechanical engineering researchers and professionals with an in-depth understanding of fundamental and advanced principles of mechanical systems, design, analysis, and manufacturing, while fostering significant exposure to research and practical applications. The program aims to produce graduates who can contribute to society as innovative, ethical, and well-rounded professionals, capable of leading technological advancements and addressing complex engineering challenges. Upon graduation, students will be prepared to work in research and development, advanced manufacturing, design engineering, consulting, and academia, contributing to sustainable development and industrial transformation at both local and global levels.

1.3 Program Educational Objectives and Program Learning Outcomes

1.3.1 Program Educational Objectives (PEOs)

The educational objectives of the Master of Science in Mechanical Engineering program are that, within three to five years after graduation, graduates are expected to:

- **PEO1:** Demonstrate advanced technical competence in mechanical engineering by applying cutting-edge knowledge, analytical reasoning, and engineering judgment to design, analyze, and implement complex systems and technologies in industry, academia, or entrepreneurial ventures.
- **PEO2:** Engage in research and development activities that contribute to scientific innovation, technological advancement, or interdisciplinary applications of mechanical engineering in areas such as robotics, manufacturing, automation, energy systems, and systems engineering.

- **PEO3:** Take on leadership roles in engineering teams, research projects, or professional organizations, fostering effective collaboration and promoting ethical, sustainable, and inclusive practices in diverse and dynamic environments.
- **PEO4:** Pursue continued learning and professional growth through advanced studies, certifications, scholarly publications, or leadership in engineering-driven initiatives that contribute to national development and global technological transformation.

1.3.2 Program Learning Outcomes (Student Outcomes)

Knowledge

Upon successful completion of the program, graduates will be able to:

- **PLO1:** Demonstrate in-depth and systematic knowledge of advanced mechanical engineering principles, mathematics, and scientific methods to model, analyze, and solve complex engineering problems.
- **PLO2:** Integrate interdisciplinary and up-to-date knowledge in engineering and related fields to design and evaluate solutions in academic, industrial, or applied research settings.
- **PLO3:** Exhibit comprehensive knowledge of contemporary issues, sustainable practices, and innovations relevant to the mechanical engineering profession.

Skills

Graduates will be able to:

- **PLO4:** Apply critical thinking and advanced problem-solving skills to design, implement, and optimize solutions for complex, open-ended engineering problems with consideration of technical, environmental, and economic constraints.
- **PLO5:** Design and conduct independent research or major design projects, including formulating hypotheses, selecting methodologies, analyzing data, and synthesizing findings.
- **PLO6:** Communicate effectively in academic, technical, and professional settings through research papers, technical documentation, and oral presentations tailored to diverse audiences.
- **PLO7:** Work collaboratively and lead effectively in multidisciplinary and multicultural teams, demonstrating project management, innovation, entrepreneurial mindset, and adaptability.
- **PLO8:** Independently acquire and apply emerging knowledge, tools, and technologies in mechanical engineering through lifelong learning and professional development.

Attitudes

Graduates will demonstrate:

- **PLO9:** A commitment to ethical conduct, professional responsibility, and integrity in research and engineering practice.
- **PLO10:** Awareness of the social, environmental, and global impacts of engineering solutions, and a dedication to responsible and sustainable innovation.

2. ADMISSION CANDIDATES

Candidates refer to those who meet the following requirements:

a. Have graduated with a bachelor's degree with a good grade or higher, or possess scientific publications (books, textbooks, articles published in academic journals, or papers published in the proceedings of specialized conferences or symposia) related to the discipline of Mechanical Engineering or relevant disciplines, in particular:

   - Disciplines of Mechanical Engineering: Mechanical Engineering; Mechanical Engineering Technology, Manufacturing Technology, Mechanical Engineering in Manufacturing, Mechanical Manufacturing Technology
   - Close disciplines: Mechtronics Engineering, Mechatronics Engineering Technology, Mechatronics Technology, Engineering Mechanics, Automotive and Power Mechanical Engineering, Aerospace Engineering, Architecture and Marine Engineering, Automotive Engineering Technology, Thermal Engineering, Thermal Engineering Technology, Refrigeration and Thermal Technology.
   - For other disciplines, the Admissions Council will consider and decide.

Candidates from closely related or other disciplines are required to take 4–16 credits of supplementary courses from the list below. The number of credits for each candidate will be defined by Admission Council.

No	Course Code	Name of course	Number of credits
1	MECE3010	Statics and Mechanics of Solids	4
2	MECE3020	Thermodynamics	3
3	MECE3030	Dynamics	3
4	MECE3040	Mechanical Synthesis	4
5	MECE3050	Introductory Fluid Mechanics	3
6	MECE4010	Heat Transfer	3
7	MECE3060	Mechatronics	3
8	MECE4020	System Dynamics and Control	3
9	MECE3070	Mechanics of Engineering Materials	3
10	MECE3080	Intelligent Physical Systems	3

b. Having an IELTS certificate of 6.5 (or equivalent) in English within two years (24 months) before the admission registration date or have a bachelor's degree taught in English.

3. CURRICULUM STRUCTURE

3.1 Curriculum Composition

No.	Curriculum Components	Number of Credits	Notes
I	**COURSE WORK**	**30**	
I.1	*Required courses*	***19***	
1	*Philosophy*	*3*	
2	*Research Communication*	*4*	
3	*Major course 1*	*4*	
4	*Major course 2*	*4*	
5	*Major course 3*	*4*	
I.2	*Elective courses*	***11***	
	Students select 3-4 project-based courses		
II	**RESEARCH WORK***	***30***	
1	*Research Proposal*	*5*	
2	*Research Project 1*	*5*	
3	*Research Project 2*	*5*	
4	*Master Thesis*	*15*	
	TOTAL	**60**	

** The research component is designed to equip students with advanced research capabilities and prepare them to contribute original and impactful knowledge to the field of mechanical engineering. Students are expected to produce* ***at least two high-quality publications*** *in Scopus-indexed journals or conference proceedings, based on their research work under faculty supervision.*

3.2 Courses and Credit Distribution by Courses

No	Course code	Name of Courses	Credit	Credit Hour Allocation		Prerequisite(s)	Grading System
				Theory	Practice		
I	**COURSE WORK**		**30**				
II.1	**Required Courses**		**19**				
1	PHIL5010	Philosophy	3	3	0		
2	CECS5010	Research Communication	4	3	1		
	CECS5050	Robotics	4	3	1	Control Systems	
	ELEC5060	Ubiquitous Sensing and Intelligent Systems	4	3	1	Undergraduate level in Computer Science or Electrical Engineering program with minimum grade of C	
	MECE6050	Nonlinear Control System	4	3	1	Undergraduate Control System courses	
I.2	***Elective courses*** *(Students select 3-4 project-based courses from the list below or from other BSc, Master and PhD programs)*		**>=11**				
1	COMP5030	Computer Vision	4	3	1	Advanced Machine Learning	
2	COMP5120	Visualization	4	3	1	Statistics and Probability (R), Data Mining, Web Programming, JavaScript, Python	
3	MECE6010	Finite Element Analysis	4	3	1	Undergraduate level in Statics, Dymanics, and Strength of Materials	
4	MECE6020	Advanced Additive Manufacturing	4	3	1	Undergraduate level in Manufacturing processes, Mechanical design	

No	Course code	Name of Courses	Credit	Credit Hour Allocation		Prerequisite(s)	Grading System
				Theory	Practice		
5	MECE6040	Continuum Mechanics and Thermodynamics	4	3	1	Undergraduate level of Solid Mechanics, Dynamics, Thermodynamics	
6	CECS5020	Optimization: Models and Methods	4	3	1	Linear Algebra	
7	MECE6060	Advanced Materials	3	2	1	Mechanics of Engineering Materials	
8	MECE6070	Biomaterials and Medical Devices	3	2	1	Undergraduate level of Solid Mechanics and Mechanical Design	
II.	**RESEARCH WORK**		**30**				
1	MECE5960	Research Proposal	5		*5*		
2	MECE5970	Research Project 1	5		*5*		
3	MECE5980	Research Project 2	5		*5*		
4	MECE5990	Master Thesis	15		*15*		
TOTAL			**60**				

3.3 Curriculum Planner

No	Course code	Name of Courses	Credits	Semester			
				1	2	3	4
I	**COURSE WORK**		**30**				
I.1	**Required courses**		**19**				
1	PHIL5010	Philosophy	*3*	*X*			
2	CECS5010	Research Communication	*4*	*X*			
3	CECS5050	Robotics	4	*X*			
4	ELEC5060	Ubiquitous Sensing and Intelligent Systems	*4*	*X*			
5	MECE6050	Nonlinear Control System	*4*		*X*		
I.2	**Elective courses** *(Students select 3-4 project-based courses from the list below or from other BSc, Master and PhD programs offered by College of Engineering and Computer Science)*		**>=11**				
1	COMP5030	Computer Vision	4		*X*		
2	COMP5120	Visualization	4		*X*		
3	MECE6010	Finite Element Analysis	4		*X*		
4	MECE6020	Advanced Additive Manufacturing	4		*X*		
5	MECE6040	Continuum Mechanics and Thermodynamics	4		*X*		
6	CECS5020	Optimization: Models and Methods	4		*X*		
7	MECE6060	Advanced Materials	3		*X*		
8	MECE6070	Biomaterials and Medical Devices	3		*X*		
II	**RESEARCH WORK**		***30***				
1	MECE5960	*Research Proposal*	*5*	X			
2	MECE5970	*Research Project 1*	*5*		X		
3	MECE5980	*Research Project 2*	*5*			X	
4	MECE5990	*Master Thesis*	*15*				X
TOTAL:			**60**				

3.4 Course Descriptions

PHIL5010: Philosohpy

3 credits

Pre-requisites: none

This course introduces fundamental knowledge of philosophy. Topics include characteristics of Western philosophy, Eastern philosophy and Marxist philosophy; advanced content on Marxist-Leninist philosophy in the current period and its role in worldview and methodology; interrelationship between philosophy and science; the role of science in social life.

CECS5010: Research Communication

4 credits

Course Description:

This course introduces and discusses practical aspects of research communication skills, including technical paper writing and oral presentation. Students will learn about effective scientific communications through extensive practical training including written, spoken, and individual exercises.

CECS5050: Robotics

4 credits

Pre-requisites: Control Systems

Course Description:

The course will cover: components of robotic systems; selection of coordinate frames; homogeneous transformations; solutions to kinematic equations; velocity and force/torque relations; manipulator dynamics in Lagrange's formulation; digital simulation of manipulator motion; trajectory planning; obstacle avoidance; controller design using the computed torque method; and different controllers for manipulators.

ELEC5060: Ubiquitous Sensing and Intelligent Systems

4 credits

Pre-requisites: Undergraduate level in Computer Science or Electrical Engineering program with a minimum grade of C

Course Description:

This course aims to provide student with an overview and the foundation of the multidisciplinary research field of the next generation of computing. It covers the sensing technology, the mechanism behind sensing data, embedded computing, and methods to analyze sensing data.

MECE6050: Nonlinear Control System

4 credits

Pre-requisites: Undergraduate Control System courses

This course introduces methods for analyzing and designing nonlinear control systems. Topics covered include mathematical models of nonlinear systems, fundamental differences between the behavior of linear and nonlinear systems, phase plane analysis, Lyapunov stability, input-to-state stability, input-output stability, passivity analysis, feedback linearization, and application to nonlinear circuits and control systems. Nonlinear control design, including Lyapunov-based control, energy-based control, Cascaded control, passivity-based control, input-output linearization, adaptive control and backstepping, are also covered in this course.

COMP5030 Computer Vision

4 credits

Pre-requisites: Advanced Machine Learning

Computer Vision is the area of engineering and computer science concerned with the use of artificial vision tools to collect and process information in order to provide automatic systems with some autonomy. The objective of this course is to present an insight into the world of machine vision that goes beyond image processing algorithms and traditional computer vision approaches. Students will acquire knowledge and an understanding of artificial vision from a practical implementation perspective and gain the capability to design physical vision systems. Various aspects will be examined, as time permits, and some of the main approaches currently found in the literature will be discussed, opening the door to many research themes.

COMP5120 Visualization

4 credits

Pre-requisites: Statistics and Probability (R), Data Mining, Web Programming, JavaScript, Python

Visual media are increasingly generated, manipulated, and transmitted by computers. When well designed, such displays capitalize on human facilities for processing visual information and thereby improve comprehension, memory, inference, and decision making. Yet the digital tools for transforming data into visualizations still require low-level interaction by skilled human designers. As a result, producing effective visualizations can take hours or days and consume considerable human effort.

In this course, we will study techniques and algorithms for creating effective visualizations based on principles and techniques from graphic design, visual art, perceptual psychology, and cognitive science. The course is targeted both towards students interested in using visualization in their own work, as well as students interested in building better visualization tools and systems. In addition to participating in class discussions, students will have to complete several short programming and data analysis assignments as well as a final programming project.

MECE6010: Finite Element Analysis

4 credits

Pre-requisites: Undergraduate level in Statics, Dynamics, and Strength of Materials

Course Description:

Introduction to linear finite element static analysis for discrete and distributed mechanical and aerospace structures. Prediction of load, deflection, stress, strain, and temperature distributions. Major emphasis on underlying mechanics and mathematical formulation. Introduction to computational aspects via educational and commercial software (such as MATLAB and ANSYS). Selected mechanical and aerospace applications in the areas of trusses, beams, frames, heat transfer, and elasticity. A selection of advanced topics such as dynamic modal analysis, transient heat transfer, or design optimization techniques may also be covered, time permitting.

MECE6020: Advanced Additive Manufacturing

4 credits

Pre-requisites: Undergraduate level in Manufacturing processes, Mechanical design

Course Description:

You will develop a rich knowledge of 3D printing technologies, devices, capabilities, materials and applications. You will learn the trade-offs between various 3D printing processes and technologies, along with the various related software tools, processes and techniques, such as 3D scanning, injection molding and casting. You will explore the broad range of 3D printing applications, including biomedical, aerospace, consumer products, and creative artistry, to mention a few.

MECE6040: Continuum Mechanics and Thermodynamics

4 credits

Pre-requisites: Undergraduate level of Solid Mechanics, Dynamics, Thermodynamics

Course Description:

Continuum mechanics is the basis for a vast array of problems in modern and classical engineering. The focus of this course is the development of the fundamentals of continuum mechanics and thermodynamics which will allow for the description of complex phenomena in solids, fluids, and mixtures (solid-fluid) and quickly take us to modern and exciting topics of coupled problems in multiphysics problems in solids as well as the mechanics of soft and biological materials. Most natural phenomena are nonlinear, so the main aim of this course is the development of an adequate framework to model nonlinear phenomena in solids. The models that will be developed to capture physical phenomena can be solved analytically or numerically; towards the latter, a connection of the proposed modeling with the Finite Element Method in the context of multiphysical modeling will be covered.

CECS5020: Optimization: Models and Methods

4 credits

Pre-requisites: Linear Algebra

Course Description:

This course offers an introduction to optimization models and their applications, ranging from machine learning and statistics to decision-making and control, with emphasis on numerically tractable problems, such as linear or constrained least-squares optimization. The course covers two main topics: practical linear algebra and convex optimization.

MECE6060: Advanced Materials

3 credits

Pre-requisites: Mechanics of Engineering Materials

Course Description:

This course provides in-depth knowledge of advanced materials used in modern mechanical engineering applications. It covers the structure–property relationships, design principles, processing techniques, and performance evaluation of metals, polymers, ceramics, composites, and smart materials. Emphasis is placed on materials selection for high-performance applications in aerospace, automotive, biomedical, robotics, energy, and manufacturing industries. Students will also be introduced to emerging materials research areas such as nanomaterials, biomaterials, and additive manufacturing materials.

MECE6070: Biomaterials and Medical Devices

3 credits

Pre-requisites: Undergraduate level of Solid Mechanics and Mechanical Design

Course Description:

This course introduces the fundamental principles and advanced applications of biomaterials and their integration into medical devices. It covers the structure–property–function relationships of metallic, polymeric, ceramic, and composite biomaterials, as well as the design, manufacturing, and evaluation of medical devices. Emphasis is placed on biocompatibility, mechanical performance, degradation mechanisms, regulatory requirements, and ethical considerations. Students will engage in case studies and project-based learning to connect material properties with medical device performance and patient outcomes.

MECEP5960: Research Proposal

5 credits

Students identify a relevant and challenging research topic in mechanical engineering, conduct a comprehensive literature review, and define research questions or hypotheses. They develop a detailed research proposal outlining objectives, methodology, expected outcomes, publication plan, and timeline. The proposal must be approved by a faculty advisor and the graduate research committee.

MECEP5970: Research Project 1

5 credits

Students conduct a research project related to the proposed research proposal under faculty supervision. The project may involve theoretical analysis, software development, experimental work, or applied research. Deliverables include a project report and potentially a draft or submission to a Scopus-indexed publication.

MECE5980: Research Project 2

5 credits

Students conduct a research project related to the proposed research proposal under faculty supervision. The project may involve theoretical analysis, software/hardware development, experimental work, or applied research. Deliverables include a project report and potentially a draft or submission to a Scopus-indexed publication.

MECE5990: Master Thesis

15 credits

Students synthesize their research into a comprehensive thesis that demonstrates innovation, scholarly depth, and relevance to mechanical engineering. The thesis is expected to consolidate findings from the research proposal and the research projects. Students must defend the thesis before a committee and meet the graduation requirement of two Scopus-indexed publications, with at least one led by the student based on their thesis or research projects.

3. Course Outlines

Course Code	PHIL5010
Course Title	**Philosophy**
Catalogue Description	This course introduces fundamental knowledge of philosophy. Topics include characteristics of Western philosophy, Eastern philosophy and Marxist philosophy; advanced content on Marxist-Leninist philosophy in the current period and its role in worldview and methodology; interrelationship between philosophy and science; the role of science in social life.
Credit Value	3
Required or elective	Required
Pre-requisite/ Co-requisite/Exclusion	None
Textbook(s) and other required materials	- Philosophy textbook promulgated by the Ministry of Education and Training. - Reference materials under the guidance of the instructor.
Course Learning Goals	1. Fostering philosophical thinking, worldview and philosophical methodology in the fields of natural science and technology. 2. Consolidate awareness of the theoretical and philosophical basis of Vietnam's revolutionary approach, especially Vietnam's science and technology development strategy.
Course Learning Objectives	Upon completion of this course, students will be able to: 1. Understand the characteristics of Western philosophy, Eastern philosophy and Marxist philosophy 2. Understand advanced content on Marxist-Leninist philosophy in the current period and its role in worldview and methodology. 3. Understand the interrelationship between philosophy and science; the role of science in social life.

Topics Covered/ Indicative Syllabus	• Fundamentals of philosophy
	  ○ What is philosophy?
	  ○ Estearn vs. Western philosophy
	• Marxist-Leninist philosophy
	  ○ The birth of Marxist-Leninist philosophy
	  ○ Two basic principles of the materialist dialectic
	  ○ Dialectical materialism
	  ○ Historical materialism
	  ○ Marxist-Leninist philosophy in the present period
	• The relationship between science and philosophy
	• The role of science in social life
	  ○ Scientific Consciousness
	  ○ Science and technology - the driving force of social development
	  ○ Science and technology in Vietnam

Class/Laboratory Schedule	Two (2) 1.5 hour-lectures per week
Assessment Methods in Alignment with Intended Learning Outcomes	• Project (40%) • In-class participation and quizzes (20%) • Final exam (40%)
Course Webpage	TBA

Course Code	PHIL5010
Ethical Behavior Statement	Each student in this course is expected to abide by the VinUni Code of Academic Integrity. Any work submitted by a student in this course for academic credit will be the student's own work (with acknowledgement that many projects are carried out in groups in which participants will contribute equally). The Code is available on the web at (insert website). Violations are taken seriously.

Course Code	**CECS5010**
Course Title	**Research Communication**
Catalogue Description	This course introduces and discusses practical aspects of research communication skills, including technical paper writing and oral presentation. Students will learn about effective scientific communications through extensive practical training including written, spoken, and individual exercises.
Credit Value	4
Required or elective	Required
Pre-requisite/ Co-requisite/ Exclusion	None
Textbook(s) and other required materials	TBD by VinUni Faculty. Sample texts include: 1. Paul V. Anderson (2013), *Technical Communication. A Reader-centered Approach*, 8e (Wadsworth). 2. Gerald J. Alred, Charles T. Brusaw, Walter E. Oliu (2020), *Handbook of Technical Writing, 12th edition.*Strunk and White, The Elements of Style (free download book available)
Course Learning Goals	Students will: 1. analyze the structure of the best research articles in their fields; 2. learn how to write a good research article; 3. learn how to give a good oral presentation of research results.
Course Learning Objectives	Upon completion of the course, students will be able to: 1. identify the key elements of clear effective communication in the research process; 2. recognize and reproduce the structure of excellent research articles; 3. organize and present data in different formats including graphs, charts, tables, etc. appropriate for various purposes; 4. write a good research article that maximizes clarity and understanding; 5. craft and deliver an oral presentation of technical information effectively.

Topics Covered/ Indicative Syllabus	• Publication Basics
	    o Building scientific knowledge
	    o The peer-review process
	    o Research publication landscape
	    o Communication Ethics
	• Manuscript Writing
	    o Literature reading and problem finding
	    o Manuscript structure and narrative
	    o Words, sentences, and paragraphs
	    o Infographics
	    o Titles, abstracts, and cover letters
	    o Edit and revise manuscripts
	• Oral Presentation
	    o Communication in an era of global science

	○ How to prepare a scientific presentation ○ How to deliver a scientific presentation ○ Preparing and giving conference posters • Public Communication
Class/Laboratory Schedule	NA
Contribution of course to meeting the professional component	After taking this course, students should be able to produce well-written research papers and deliver effective oral presentations.
Assessment Methods in Alignment with Intended Learning Outcomes	• Assignments: 40% • Presentation: 30% • Exam: 30%
Course Webpage	TBD
Rationale for Offering	
Date/Person Prepared	Curriculum Development Taskforce (May 2025)
Ethical Behavior Statement	Each student in this course is expected to abide by the Vin University Code of Academic Integrity. Any work submitted by a student in this course for academic credit will be the student's own work (with the acknowledgment that many projects are carried out in groups in which participants will contribute equally). The Code is available on the web at www.vinuni.edu.vn. Violations are taken seriously.

Course Code	**CECS5050**
Course Title	**Robotics**
Catalogue Description	The course will cover: components of robotic systems; selection of coordinate frames; homogeneous transformations; solutions to kinematic equations; velocity and force/torque relations; manipulator dynamics in Lagrange's formulation; digital simulation of manipulator motion; trajectory planning; obstacle avoidance; controller design using the computed torque method; and different controllers for manipulators.
Credit Value	4 [Theory: 3, Practice: 1]
Required or elective	Elective
Pre-requisite/ Co-requisite/ Exclusion	Pre-requisites: Control Systems Co-requisites: None
Textbook(s) and other required materials	TBD by VinUni faculty. Recommended text: 1. **Craig John J**, *Introduction to Robotics: Mechanics and Control*, 4th Edition, Pearson, 2017. Supplementary texts: 2. **A.J. Koivo,** *Fundamentals for Control of Robotic Manipulators*, J. Wiley & Sons, Inc., 1989, ISBN No. 0-471-85714-9.
Course Learning Goals	Students will: 1. Learn the Components of robotics systems 2. Learn the coordinate transformation, Selection of coordinate frames, the transform arithmetic. 3. Understand the kinematics and trajectory planning. 4. Learn the Velocities, Forces, Torques in Joint and Base Coordinates. 5. Learn Dynamic Modelling, Lagrange's energy expressions for a manipulator 6. Learn the sensors and devices in a robotics system. 7. Design PID-controller and Force-torque control strategy
Course Learning Objectives	Upon completion of the course, students will be able to: 1. Identify the basic components of robot, select the right coordinate system for particular manipulator movement, and perform position transformation between different coordinates. 2. Characterize the kinematics in static and dynamic situations, calculate and solve the kinematics problems 3. Calculate a trajectory for the desired motion of a manipulator in multidimensional space; Calculate Forces and Torques in the Joints and Arms of the robot 4. Implement dynamic modelling, Lagrange's energy expression and equation of motion 5. Describe the sensors and devices in a robotics system and robotic applications 6. Calculate the parameters of controllers.

Topics covered/ Indicative Syllabus	• Introduction to Robotics • Coordinate Transformation • Kinematics • Trajectory Planning • Control Techniques • Sensors and Devices • Robot Applications
Class/Laboratory Schedule	Lectures: Two 75 min lectures per week Homework: Weekly assignments Exams: One midterm exams and one final exam. Design Project: The course has a design project that will last throughout the semester.
Contribution of course to meeting the professional component	This course serves as a graduate course in Master in CS and Ph.D. in CS programs. It contributes to the students' understanding of a broad range of topics in robotics with an emphasis on basics of manipulators, coordinate transformation and kinematics, trajectory planning, control techniques, sensors and devices, and robot applications.
Assessment Methods in Alignment with Intended Learning Outcomes	Course outcomes are primarily assessed through homework assignments, project, and exams: Homework (10%), Midterm Exam (30%), Project (20%), and Final Exam (40%).
Course Webpage	TBD by VinUni Faculty
Rationale for offering	This course provides students with both basic and advanced knowledge of a robot motions including kinematics and dynamics, as well as control techniques and sensor systems. This course fits into the program mission and complements the existing program curriculum because it covers a broad range of topics in robotics with an emphasis on basics of manipulators, coordinate transformation and kinematics, trajectory planning, control techniques, sensors and devices, robot applications and economics analysis. This course is unique and does not overlap with any existing courses, thereby complementing the area/subarea offerings. This course will enhance graduates' education from the control system area and will support students' career in the control system applications, especially in robotics.
Person preparing this description and date	Curriculum Development Taskforce (May 2025)
Ethical behavior statement	Each student in this course is expected to abide by the Vin University Code of Academic Integrity. Any work submitted by a student in this course for academic credit will be the student's own work (with the acknowledgment that many projects are carried out in groups in which participants will contribute equally). The Code is available on the web at www.vinuni.edu.vn. Violations are taken seriously.

Course Code	**ELEC5060**
Course Title	**Ubiquitous Sensing and Intelligent Systems**
Catalogue Description	This course aims to provide student with an overview and the foundation of multidisciplinary research field of next generation of computing. It covers the sensing technology, mechanism behind sensing data, embedded computing, and methods to analyze sensing data.
Credit Value	4
Required or elective	Elective
Pre-requisite/ Co-requisite/ Exclusion	Pre-requisites: Undergraduate level in Computer Science or Electrical Engineering program with minimum grade of C
Textbook(s) and other required materials	TBD by VinUni Faculty. Sample texts include: 1. Mechatronic Systems, Sensors, and Actuators : Fundamentals and Modeling, Robert H. Bishop, CRC Press, 2017. 2. ARM® v7-M Architecture Reference Manual 3. G. Buttazzo, *Hard Real-Time Computer Systems: Predictable Scheduling Algorithms and Applications*, 3rd Edition, Springer, 2011. 4. Ubiquitous Computing Fundamentals (1st ed.). Chapman & Hall/CRC
Course Learning Goals	Upon completion of the course, students will be able to: 1. Understand the fundamental physical/chemical sensor & actuator mechanism 2. Analyze mechanism behind sensing data 3. Acquire knowledge of embedded computing 4. Learn about the standard methods and techniques of analyzing measure sensing data 5. Hand-on experiment with intelligent system including (sensor and analysis)
Topics Covered/ Indicative Syllabus	• Physical/chemical types of sensors • Types of actuators • Embedded computing • Overview of wearable computing • Sensor data analysis including applied machine learning • Sensor fusion techniques • Privacy in mobile and ubiquitous computing • Real world applications: implications and challenges
Class/Laboratory Schedule	Lectures: Two 75-min lectures per week Design Project: The course has a design project that will last throughout the semester.

Contribution of course to meeting the professional component	This course provides the knowledge of real-world ubiquitous computing system that students will face in future career. It contributes to the students' skills in applying and integrating the knowledge from other courses to design, analyze and interface with a physical system. In addition, students will learn the values and tradeoffs between theory, simulation, and physical implementations. This course also contributes to student's hands-on skills on design, prototyping, implementation, and control of a real-time intelligent system.
Assessment Methods in Alignment with Intended Learning Outcomes	Course outcomes will be assessed through in-class quizzes (20%), homework assignments (20%), and final project report and presentation (60%).
Course Webpage	Canvas website
Rationale for Offering	The world is moving to the third generation of computing where Internet of Things and intelligent systems are pervasive and ubiquitous. This course aims to support students' skills in designing a physical system that meets future practical requirements through projects.
Date/Person Prepared	Curriculum Development Taskforce (May 2025)
Ethical Behavior Statement	Each student in this course is expected to abide by the VinUniversity Code of Academic Integrity. Any work submitted by a student in this course for academic credit will be the student's own work. Violations are taken seriously.

Course Code	**MECE6050**
Course Title	**Nonlinear Control System**
Catalogue Description	This course introduces methods for analyzing and designing nonlinear control systems. Topics covered include mathematical models of nonlinear systems, fundamental differences between the behavior of linear and nonlinear systems, phase plane analysis, Lyapunov stability, input-to-state stability, input-output stability, passivity analysis, feedback linearization, and application to nonlinear circuits and control systems. Nonlinear control design, including Lyapunov-based control, energy-based control, Cascaded control, passivity-based control, input-output linearization, adaptive control and backstepping, are also covered in this course.
Credit Value	4
Required or elective	Elective
Pre-requisite/ Co-requisite/ Exclusion	Undergarduate Control System courses
Textbook(s) and other required materials	TBD by VinUni Faculty. Sample texts include: 1. Alessandro Astolfi · Lorenzo Marconi (2008), *Analysis and Design Nonlinear Control System*, Springer Berlin Heidelberg New York (free download book available). 2. Jürgen Adamy (2022), *Nonlinear Control of Nonlinear Systems,* Springer-Verlag GmbH Germany, Springer Nature (free download book available)
Course Learning Goals	Students will: 1. Learn a thorough knowledge of the theory of nonlinear control systems. 2. Study the methods for the design and analysis of nonlinear control systems. 3. Practice with nonlinear control systems
Course Learning Objectives	Upon completion of the course, students will be able to: 1. Understand the methods for analyses of nonlinear systems, such as Lyapunov stability analysis, passivity-based control, input-output linearization, nonlinear adaptive and backstepping control design, etc. 2. Earn proficiency in independently assessing various nonlinear methods and applying them to analyze and design nonlinear control systems. 3. Get proficiency to assess the characteristics of the resulting nonlinear control systems. 4. Learn skills in applying knowledge and proficiency in new areas, advanced tasks, and projects. 5. Have skills in communicating extensive work to master the technical terms of nonlinear dynamical control systems.

Topics Covered/ Indicative Syllabus	• Nonlinear Behavior
	• Mathematics of Nonlinear Behaviors
	    o Discrete-Time State Space Equations
	    o Differential Equations

	o Input/Output Models o Finite State Automata and Hybrid Systems • Linearization o Linearization Around a Trajectory o Singular Perturbations o Harmonic Balance o Model Reduction o Feedback Linearization • System Invariants o Storage Functions o Lyapunov Functions and Search o Implicitly Defined Storage Functions • Local Behavior of Differential Equations o Local Stability o Center Manifold Theorems o Bifurcations • Controllability of Nonlinear Differential Equations o Frobenius Theorem o Existence of Feedback Linearization o Local Controllability of Nonlinear Systems • Nonlinear Feedback Design Techniques o Control Lyapunov Functions o Feedback Linearization o Adaptive Control o Invariant Probability Density Functions o Optimal Control o Dynamic Programming
Class/Laboratory Schedule	NA
Contribution of course to meeting the professional component	After taking this course, students should be able to do research in the fields of nonlinearity, dynamics, and control systems. They can apply the studied methods for analyzing and designing their own dynamic systems.
Assessment Methods in Alignment with Intended Learning Outcomes	• Assignments: 40% • Presentation: 30% • Exam: 30%
Course Webpage	TBD
Rationale for Offering	
Date/Person Prepared	Curriculum Development Taskforce (May 2025)
Ethical Behavior Statement	Each student in this course is expected to abide by the Vin University Code of Academic Integrity. Any work submitted by a student in this course for

	academic credit will be the student's own work (with the acknowledgment that many projects are carried out in groups in which participants will contribute equally). The Code is available on the web at www.vinuni.edu.vn. Violations are taken seriously.

Course Code	COMP5030
Course Title	**Computer Vision**
Catalogue Description	Computer Vision is the area of engineering and computer science concerned with the use of artificial vision tools to collect and process information in order to provide automatic systems with some autonomy. The objective of this course is to present an insight into the world of machine vision that goes beyond image processing algorithms and traditional computer vision approaches. Students will acquire a knowledge and an understanding of artificial vision from a practical implementation perspective and gain the capability to design physical vision systems. Various aspects will be examined, as time permits, and some of the main approaches currently found in the literature will be discussed, opening the door to many research themes.
Credit Value	4
Required or elective	R
Pre-requisite/ Co-requisite/ Exclusion	Advanced Machine Learning
Textbook(s) and other required materials	TBD by VinUni Faculty. Sample texts include: 1. Trucco, Emanuele, and Alessandro Verri. *Introductory Techniques for 3-D Computer Vision*. Prentice Hall, 2006. 2. Prince, Simon J. D. *Computer Vision: Models, Learning, and Inference*. Cambridge University Press, 2012. 3. Forsyth, David, and Jean Ponce. *Computer Vision: a Modern Approach*. Pearson, 2012. 4. Davies, E. R. *Computer Vision: Principles, Algorithms, Applications, Learning*. Academic Press, 2018. 5. Bradski, Gary, and Adrian Kaehler. *Learning OpenCV*. O'Reilly Media, 2015.
Course Learning Goals	Students will: 1. use mathematical modelling tools to represent digital images. 2. perform transformations and filtering operations in the time and frequency domains to achieve desired outputs such as edge detection, noise removal, line and corner detection, and image smoothing. 3. apply morphological operations for shape recognition and template matching 4. use advanced algorithms such as support vector machines and artificial neural networks and deep learning techniques for object recognition and classification. 5. use stereo vision techniques and optical flow methods to study motion. 6. use contemporary numerical and simulation tools to implement methods and algorithms. 7. communicate effectively in written and oral forms, and document and present results
Topics Covered/ Indicative Syllabus	• Camera and optics • Light and color • Image filtering • Image processing • Feature detection and matching • Image compression • Multiple views and stereo

Course Code	COMP5030

	• Recognition
	• Segmentation
	• Color imaging
	• Introduction to spectral imaging
	• Introduction to machine learning
	• Applications, including for example the following;
	  o Face detection
	  o Face recognition
	  o OCR
	  o Industrial applications
	  o Medical imaging
	  o Image stitching
	• Basics of computer vision
	  o Nature of images.
	  o Homogeneous transformations
	  o Image acquisition
	  o Geometrical and optical image formation
	  o Perspective projection
	  o Camera technologies
	  o Vision systems design.
	• Basics of image processing
	  o Filtering
	  o Edge detection
	  o Features detection
	  o Contours, segmentation
	  o Morphological operators.
	• Calibration
	  o Camera model
	  o Intrinsic and extrinsic camera parameters
	  o Camera calibration.
	• Motion
	  o Motion detection
	  o Optical flow
	  o Object tracking
	  o Motion capture.
	• Three-dimensional imaging
	  o Epipolar geometry
	  o Stereoscopic vision Active range imaging
	  o Structured lighting.
	  o Modelingandregistration
	• Modeling techniques for autonomous systems
	  o Data fusion
	  o Uncertainty mapping
	  o Registration, pose estimation.
	• Applications
	  o Quality control
	  o Visual feedback
	  o Mapping and robot guidance

Course Code	COMP5030
	○ Activity monitoring ○ Motion estimation ○ Autonomous systems ○ Biomedical imaging devices.
Contribution of course to meeting the professional component	This course serves as the foundational course in the computer vision field. It helps students develop and apply computer vision techniques for solving practical problems. After this course, students will be able to choose appropriate image processing methods for image filtering, image restoration, image reconstruction, segmentation, classification and representation.
Assessment Methods in Alignment with Intended Learning Outcomes	• Assignments: 10% • Presentation: 15% • Project: 25% • Midterm quiz: 20% • Exam: 30%
Course Webpage	TBD
Rationale for Offering	Computer Vision is an important field of Artificial Intelligence concerned with questions such as "how to extract information from image or video, and how to build a machine to see". Recent explosive growth of digital imaging technology, advanced computing, and deep learning makes the problems of automated image interpretation even more exciting and much more relevant than ever.
Date/Person Prepared	Curriculum Development Taskforce (May 2025)
Ethical Behavior Statement	Each student in this course is expected to abide by the Vin University Code of Academic Integrity. Any work submitted by a student in this course for academic credit will be the student's own work (with the acknowledgment that many projects are carried out in groups in which participants will contribute equally). The Code is available on the web at (insert website). Violations are taken seriously.

Course Code	COMP5120
Course Title	Visualization
Catalogue Description	Visual media are increasingly generated, manipulated, and transmitted by computers. When well designed, such displays capitalize on human facilities for processing visual information and thereby improve comprehension, memory, inference, and decision making. Yet the digital tools for transforming data into visualizations still require low-level interaction by skilled human designers. As a result, producing effective visualizations can take hours or days and consume considerable human effort. In this course, we will study techniques and algorithms for creating effective visualizations based on principles and techniques from graphic design, visual art, perceptual psychology, and cognitive science. The course is targeted both towards students interested in using visualization in their own work, as well as students interested in building better visualization tools and systems. In addition to participating in class discussions, students will have to complete several short programming and data analysis assignments as well as a final programming project.
Credit Value	4
Required or elective	
Pre-requisite/ Co-requisite/Exclusion	Statistics and Probability (R), Data Mining, Web Programming, JavaScript, Python
Textbook(s) and other required materials	TBD by VinUni Faculty. Sample texts include: 1. Tufte, Edward R. *The Visual Display of Quantitative Information*. Graphics Press, 2009. 2. Tufte, Edward Rolf. *Envisioning Information*. Graphics Press, 2017. 3. Ward, Matthew, et al. *Interactive Data Visualization: Foundations, Techniques, and Applications*. CRC Press, 2015. 4. Thomas, James J. *Illuminating the Path:* IEEE, 2005.
Course Learning Goals	At the end of the course, students should be able to: 1. explore how to design and create data visualization based on data available and tasks to be achieved. 2. Understand data and image modeling, exploratory data analysis, and visualization design. 3. learn how to create and analyze their data visualizations by using open source data visualization tools.
Course Learning Objectives	Upon successful completion of this course, you will be able to: • understand the key concepts about visualization techniques and visual analytics. • identify and evaluate the key issues in the application of data visualization techniques. • use appropriate visualization tools effectively for data analysis.
Topics Covered/ Indicative Syllabus	• The Purpose of Visualization: • Data and Image Models • Visualization Design • Exploratory Data Analysis • Perception

Course Code	COMP5120
	• Interaction • Introduction to D3 • D3 Tutorial • Using Space Effectively: 2D • Visual Explainers • Deconstructing Visualizations • Color • Graph Layout • Network Analysis • Animation
Class/Laboratory Schedule	TBD
Contribution of course to meeting the professional component	ExCel
Assessment Methods in Alignment with Intended Learning Outcomes	• Class Participation: (10%) • Assignment 1: Visualization Design (10%) • Assignment 2: Exploratory Data Analysis (15%) • Assignment 3: Creating Interactive Visualization Software (25%) • Final Project (40%)
Course Webpage	TBD
Rationale for Offering	
Date/Person Prepared	
Ethical Behavior Statement	Each student in this course is expected to abide by the VinUni Code of Academic Integrity. Any work submitted by a student in this course for academic credit will be the student's own work (with acknowledgment that many projects are carried out in groups in which participants will contribute equally). The Code is available on the web at (insert website). Violations are taken seriously.

Course Code	**MECE6010**
Course Title	**Finite Element Analysis**
Catalogue Description	Advanced topics in finite element analysis, emphasized on nonlinear problems including nonlinear elasticity, hyperelasticity, elastoplasticity (small and large deformation), and contact problems.
Credit Value	4 [Theory: 3, Practice: 1]
Required or elective	Elective
Pre-requisite/ Co-requisite/ Exclusion	Pre-requisites: Undergraduate level in Statics, Dymanics, and Strength of Materials
Textbook(s) and other required materials	TBD by VinUni Faculty. Sample texts include: Ted Belytschko, Wing Kam Liu, Brian Moran (2014). Nonlinear Finite Elements for Continua and Structures. John Wiley & Sons, Ltd. [2014 edition]
Course Learning Goals	Upon completion of the course, students will be able to: 1. Understand advanced topics in finite element methods so that this tool can be used for analysis, design, and optimization of engineering systems. 2. Perform nonlinear structural analysis 3. Use computer programming and use of commercial finite element programs to analyze various nonlinearities in structural problems
Topics Covered/ Indicative Syllabus	• Preliminary concepts • Introduction to nonlinear FEA procedures • FEA for nonlinear elastic problems • FEA for elastoplasticity • FEA of contact problem • FEA of dynamic problem (Depending on course progress)
Class/Laboratory Schedule	Lectures: Two 75-min lectures per week Design Project: The course has a design project that will last throughout the semester.
Contribution of course to meeting the professional component	This course provides the knowledge of real-world structure analysis that students will face in future career. It contributes to the students' skills in applying and integrating the knowledge from other courses to design, analyze and optimize structures using mathematical models and commercial software. This course also contributes to student's hands-on skills on design, analysize various real life structural problems.
Assessment Methods in Alignment with Intended Learning Outcomes	Course outcomes will be assessed through in-class quizzes (20%), homework assignments (20%), and final project report and presentation (60%).
Course Webpage	Canvas website
Rationale for Offering	FEM allows for easier modeling of complex geometrical and irregular shapes. Because the student is able to model both the interior and exterior,

	he or she can determine how critical factors might affect the entire structure and why failures might occur. FEM can be adapted to meet certain specifications for accuracy in order to decrease the need for physical prototypes in the design process. Creating multiple iterations of initial prototypes is usually a costly and timely process. Instead of spending weeks on hard prototyping, the designer can model different designs and materials in hours via software.
Date/Person Prepared	Curriculum Development Taskforce (May 2025)
Ethical Behavior Statement	Each student in this course is expected to abide by the Vin University Code of Academic Integrity. Any work submitted by a student in this course for academic credit will be the student's own work. Violations are taken seriously.

Course Code	**MECE6020**
Course Title	**Advanced Additive Manufacturing**
Catalogue Description	In this course you will learn the importance of additive manufacturing (a.k.a. 3D Printing) and its huge role in global product development and innovation. You will develop a rich knowledge of 3D printing technologies, devices, capabilities, materials and applications. You will learn the trade-offs between various 3D printing processes and technologies, along with the various related software tools, processes and techniques, such as 3D scanning, injection molding and casting. You will explore the broad range of 3D printing applications, including biomedical, aerospace, consumer products, and creative artistry, to mention a few. And finally, you will learn the latest trends and opportunities in 3D printing, localized services, production parts, mass customization, and how to commercialize your ideas.
Credit Value	4 [Theory: 3, Practice: 1]
Required or elective	Elective
Pre-requisite/ Co-requisite/ Exclusion	Undergraduate level in Manufacturing processes, Mechanical design
Textbook(s) and other required materials	TBD by VinUni Faculty. Sample texts include: Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, 2nd Ed. (2015), Ian Gibson, David W. Rosen, Brent Stucker
Course Learning Objectives	Upon completion of the course, students will be able to: 1. learn what Advanced/Additive manufacturing (AM) is and understand why it has become one ofthe most important technology trends in decades for product development and innovation. 2. demonstrate comprehensive knowledge of the broad range of AM processes, devices, capabilities and materials that are available. 3. understand the various software tools, processes and techniques that enable advanced/additive manufacturing and personal fabrication. 4. learn how to create physical objects that satisfy product development/prototyping requirements, 5. using advanced/additive manufacturing devices and processes. 6. articulate the various tradeoffs that must be made in selecting advanced/additive manufacturing processes, devices and materials to suit particular product requirements. 7. design, engineer and fabricate an actual multi-component object using advanced/additive manufacturing devices and processes (the "project"). 8. understand the latest trends and business opportunities in AM, distributed manufacturing and mass customization.
Topics Covered/ Indicative Syllabus	• Introduction to the Basic Principles of Advanced/Additive Manufacturing • Overview of Additive Manufacturing Processes and Technology

	• AM Technology: Extrusion, Beam Deposition, Sheet Lamination, Direct-Write, Photopolymerization, Sintering, Powder Bed Fusion, Jetting and the latest new methods, such as HP's Multi-Jet Fusion, CLIP and the latest methods for printing metal parts • Design/Fabrication Processes: Data Sources, Software Tools, File Formats, Model Repair and Validation, Pre- & Post-processing • Designing for Additive Manufacturing • Process & Material Selection : Biomaterials, Metal Technology & Processes, Multiple Materials, Hybrids, Ceramics and Bioceramics, Composite Materials and future directions • Direct Digital Manufacturing, Distributed Manufacturing and Mass Customization • Related Technologies: 3D Scanning, Injection Molding and Casting • Applications of AM: Aerospace, Biomedical, Automotive, Bio-printing, Tissue & Organ Engineering, Architectural Engineering, Surgical simulation, Art, Health care and many more • Intellectual Property, Product Development, Commercialization • Trends, Business Opportunities and Future Directions in Additive Manufacturing
Class/Laboratory Schedule	
Contribution of course to meeting the professional component	Students will develop a rich knowledge of 3D printing technologies, devices, capabilities, materials and applications. They will learn the trade-offs between various 3D printing processes and technologies, along with the various related software tools, processes and techniques, such as 3D scanning, injection molding and casting. Students will explore the broad range of 3D printing applications, including biomedical, aerospace, consumer products, and creative artistry.
Assessment Methods in Alignment with Intended Learning Outcomes	• Quizzes: 20% • Assignment and Presentation: 20% • Project: 60%
Rationale for Offering	Additive manufacturing (AM) carries unique benefits compared to traditional manufacturing. Production of everything from prototypes to end-use parts is faster, cheaper, easier to use, and more accessible than subtractive manufacturing methods — which are more complicated and expensive to operate. Investing in additive manufacturing can greatly improve efficiency and agility while minimizing supply chain risk, while its automated processes reduce the need for specialized labor. Additive manufacturing is also efficient: you build only what you need to, and nothing more.
Date/Person Prepared	Curriculum Development Taskforce (May 2025)
Ethical Behavior Statement	Each student in this course is expected to abide by the Vin University Code of Academic Integrity. Any work submitted by a student in this course for academic credit will be the student's own work (with the acknowledgment

	that many projects are carried out in groups in which participants will contribute equally). The Code is available on the web at www.vinuni.edu.vn. Violations are taken seriously.

Course Code	**MECE6040**
Course Title	**Continuum Mechanics and Thermodynamics**
Catalogue Description	Continuum mechanics is the basis for a vast array of problems in modern and classical engineering. The focus of this course is the development of the fundamentals of continuum mechanics and thermodynamics which will allow for description of complex phenomena in solids, fluids, and mixtures (solid-fluid) and quickly take us to modern and exciting topics of coupled problems in multiphysics problems in solids as well mechanics of soft and biological materials. Most natural phenomena are nonlinear, so the main aim of this course is the development of an adequate framework to model nonlinear phenomena in solids. The models that will be developed to capture physical phenomena, can be solved analytically or numerically; towards the latter, a connection of the proposed modeling with the Finite Element Method in the context of multiphysical modeling will be covered.
Credit Value	4
Required or elective	Elective
Pre-requisite/ Co-requisite/ Exclusion	Undergraduate level of Solid mechanics, Dynamics, Thermodynamics
Textbook(s) and other required materials	TBD by VinUni Faculty. Sample texts include: *Introduction to Continuum Mechanics, David Rubin, Erhard Krempl, and W. M. Lai, Elsevier 4th edition, 2009*
Course Learning Objectives	Students will: 1. understand the concept of Tensors and able to do tensors calculation 2. understand the balance principles 3. have deep knowledge of materials in term of hyperelastic, thermodynamics 4. implement different Multiphysics coupling models: Electrical, magnetic, and chemical 5. perform the soft tissue mechanics analysis
Topics Covered/ Indicative Syllabus	• Introduction to Vectors and Tensors • Kinematitcs (Large Deformations) • The Concept of Stress • Balance Principle • Thermodynamics of Materials • Hyperelastic Materials • Viscoelasticity • Plasticity • Poroelasticity • Mixture Theory • Soft Tissue Mechanics • Multiphysics: Electrical, Magnetic and Chemical Coupling

	• Variational Principles(towards the Finite Element Method)
Class/Laboratory Schedule	
Contribution of course to meeting the professional component	
Assessment Methods in Alignment with Intended Learning Outcomes	• Assignments: 20% • Presentation: 20% • Midterm: 30% • Exam: 30%
Course Webpage	
Rationale for Offering	
Date/Person Prepared	Curriculum Development Taskforce (May 2025)
Ethical Behavior Statement	Each student in this course is expected to abide by the Vin University Code of Academic Integrity. Any work submitted by a student in this course for academic credit will be the student's own work (with the acknowledgment that many projects are carried out in groups in which participants will contribute equally). The Code is available on the web at www.vinuni.edu.vn. Violations are taken seriously.

Course Code	**CECS5020**
Course Name	**Optimization: Models and Methods**
Catalogue Description	This course offers an introduction to optimization models and their applications, ranging from machine learning and statistics to decision-making and control, with emphasis on numerically tractable problems, such as linear or constrained least-squares optimization. The course covers two main topics: practical linear algebra and convex optimization.
Credit Value	4
Required or elective	Required
Pre-requisite/ Co-requisite/ Exclusion	Linear Algebra
Textbook(s) and other required materials	TBD by VinUni Faculty. Sample texts include: 1. Optimization Models in Engineering (Giuseppe Calafiore and Laurent El Ghaoui) 2. Livebook on Optimization Models (free registration)
Course Learning Goals	1. Develop a practical understanding of the applications and limitations of optimization as a solution approach to engineering analysis and design. 2. Develop an ability to use rapid prototyping software to guide optimization solutions.
Course Learning Objectives	Upon completion of this course, students will be able to: 1. Understand the basic concepts of linear algebra: vectors, matrices, rank, projections; symmetric matrices, positive semidefinite matrices, eigenvalues; singular value decomposition and principal component analysis. 2. Learn about basic optimization models such as least-squares, linear programming, quadratic programming, and SOCP, and develop an understanding of the more general convex optimization. 3. Become aware of the wide-ranging applications where optimization models are useful, such as learning, control, finance and engineering design. 4. Be able to use prototyping software to develop optimization-based solutions in concrete applications.
Topics Covered/ Indicative Syllabus	• Linear Algebra 1. Vectors, projections, matrices, symmetric matrices 2. Linear equations, least-squares and minimum-norm problems 3. SVD, PCA and related optimization problems

	• Convex Optimization 1. Convex sets, convex functions, convex optimization problems 2. KKT optimality conditions, duality (weak and strong), Slater's condition. 3. Special convex models: LP, QP, GP, SOCP 4. Robustness • Applications 1. Machine Learning 2. Control Systems 3. Engineering design 4. Finance
Class/Laboratory Schedule	Three hours of lecture, plus 1 hour of lab/discussion, per week
Contribution of course to meeting the professional component	
Assessment Methods in Alignment with Intended Learning Outcomes	• Homework (30%) • Midterm Exam (30%) • Final Exam (40%)
Course Webpage	
Rationale for Offering	This course helps students to make sure that students master the fundamentals of optimization underlying all AI systems.
Date/Person Prepared	Curriculum Development Taskforce (May 2025)
Ethical behavior statement	Each student in this course is expected to abide by the VinUni Code of Academic Integrity. Any work submitted by a student in this course for academic credit will be the student's own work (with acknowledgment that many projects are carried out in groups in which participants will contribute equally). The Code is available on the web at www.vinuni.edu.vn. Violations are taken seriously.

Course Code	**MECE6060**
Course Name	**Advanced Materials**
Catalogue Description	This course provides in-depth knowledge of advanced materials used in modern mechanical engineering applications. It covers the structure–property relationships, design principles, processing techniques, and performance evaluation of metals, polymers, ceramics, composites, and smart materials. Emphasis is placed on materials selection for high-performance applications in aerospace, automotive, biomedical, robotics, energy, and manufacturing industries. Students will also be introduced to emerging materials research areas such as nanomaterials, biomaterials, and additive manufacturing materials.
Credit Value	3
Required or elective	Required
Pre-requisite/ Co-requisite/ Exclusion	Mechanics of Engineering Materials
Textbook(s) and other required materials	TBD by VinUni Faculty. Sample texts include: 1. Behera, A., 2021. Advanced materials: an introduction to modern materials science. Springer Nature. 2. Chang, S.H., Parinov, I.A. and Topolov, V.Y. eds., 2014. Advanced materials: physics, mechanics and applications (Vol. 152). Springer Science & Business Media)
Course Learning Goals	1. Understand the advanced structure–property–processing–performance relationships of metals, polymers, ceramics, composites, and smart materials. 2. Apply materials science principles to select and design materials for high-performance mechanical engineering applications. 3. Analyze the behavior of advanced materials under mechanical, thermal, and environmental loading conditions. 4. Evaluate the sustainability, ethical implications, and life-cycle impact of materials in engineering applications. 5. Develop independent research and problem-solving skills through project-based or experimental investigations of advanced materials.
Course Learning Objectives	Upon completion of this course, students will be able to: 1. Classify advanced materials (metals, polymers, ceramics, composites, and smart materials) based on their structures and properties. 2. Analyze the mechanical, thermal, and environmental behavior of advanced materials using theoretical and computational approaches.

	3. Select appropriate materials for engineering applications considering performance, cost, and sustainability criteria. 4. Evaluate the life-cycle, ethical, and environmental impacts of materials choices in mechanical engineering systems. 5. Apply advanced characterization and testing methods to assess material performance in experimental or simulation settings. 6. Propose innovative materials solutions for emerging applications in robotics, energy, aerospace, automotive, and biomedical systems.
Topics Covered/ Indicative Syllabus	• Introduction to Advanced Materials • Metals and Advanced Alloys • Ceramics and Glasses • Polymers and Composites • Smart and Functional Materials • Nanomaterials and Nanostructures • Biomaterials and Emerging Applications • Materials for Additive Manufacturing • Characterization and Testing of Advanced Materials • Sustainability and Life-Cycle Assessment • Case Studies and Research Frontiers
Class/Laboratory Schedule	Two hours of lecture, plus 1 hour of lab/discussion, per week
Contribution of course to meeting the professional component	
Assessment Methods in Alignment with Intended Learning Outcomes	• Homework (30%) • Midterm Exam (30%) • Final Exam (40%)
Course Webpage	
Rationale for Offering	Advanced materials play a central role in driving innovation across modern mechanical engineering applications, from aerospace and automotive systems to robotics, energy technologies, and biomedical devices. With rapid advancements in nanomaterials, smart materials, and additive manufacturing, there is a growing need for engineers who can understand, design, and evaluate materials that meet demanding performance, sustainability, and societal requirements.
Date/Person Prepared	Curriculum Development Taskforce (May 2025)
Ethical behavior statement	Each student in this course is expected to abide by the VinUni Code of Academic Integrity. Any work submitted by a student in this course for academic credit will be the student's own work (with acknowledgment that

	many projects are carried out in groups in which participants will contribute equally). The Code is available on the web at www.vinuni.edu.vn. Violations are taken seriously.

Course Code	**MECE6070**
Course Name	**Biomaterials and Medical Devices**
Catalogue Description	This course introduces the fundamental principles and advanced applications of biomaterials and their integration into medical devices. It covers the structure–property–function relationships of metallic, polymeric, ceramic, and composite biomaterials, as well as the design, manufacturing, and evaluation of medical devices. Emphasis is placed on biocompatibility, mechanical performance, degradation mechanisms, regulatory requirements, and ethical considerations. Students will engage in case studies and project-based learning to connect material properties with medical device performance and patient outcomes.
Credit Value	3
Required or elective	Required
Pre-requisite/ Co-requisite/ Exclusion	Undergraduate level of Solid Mechanics and Mechanical Design
Textbook(s) and other required materials	TBD by VinUni Faculty. Sample texts include: 1. Mahyudin, F. and Hermawan, H. eds., 2016. Biomaterials and medical devices: a perspective from an emerging country (Vol. 58). Springer. 2. Hasirci, V. and Hasirci, N., 2018. Fundamentals of biomaterials (pp. 141-157). Verlag: Springer New York.
Course Learning Goals	1. Understand the fundamental principles governing the structure, properties, and biocompatibility of biomaterials. 2. Apply materials science and mechanical engineering concepts to the design and evaluation of medical devices. 3. Analyze the performance, degradation, and safety of biomaterials in physiological environments. 4. Evaluate regulatory, ethical, and societal considerations in the development and application of medical devices. 5. Develop independent research and problem-solving skills by engaging with current challenges and innovations in biomaterials and biomedical engineering.
Course Learning Objectives	Upon completion of this course, students will be able to: 1. Classify biomaterials (metals, polymers, ceramics, composites, and natural biomaterials) based on their structure, properties, and biocompatibility. 2. Analyze the mechanical, chemical, and biological performance of biomaterials in physiological environments.

	3. Design medical devices by selecting appropriate biomaterials to meet clinical, mechanical, and safety requirements. 4. Evaluate degradation mechanisms, failure modes, and long-term performance of biomaterials and medical devices. 5. Apply experimental, computational, and characterization methods to assess biomaterial behavior. 6. Interpret regulatory standards and ethical considerations in medical device development. 7. Propose innovative solutions or research directions in biomaterials and medical devices for healthcare applications..
Topics Covered/ Indicative Syllabus	• Introduction to biomaterials and medical devices • Classes of biomaterials: metals, ceramics, polymers, composites, and smart materials • Biocompatibility and host response • Mechanical behavior, degradation, and long-term performance • Design and case studies: implants, prosthetics, stents, surgical tools • Additive manufacturing for medical devices • Testing and characterization (in vitro, in vivo, standards, simulations) • Regulatory frameworks • Ethical and societal considerations in medical technology • Emerging frontiers: tissue engineering, nanobiomaterials, soft robotics, personalized devices
Class/Laboratory Schedule	Two hours of lecture, plus 1 hour of lab/discussion, per week
Contribution of course to meeting the professional component	
Assessment Methods in Alignment with Intended Learning Outcomes	• Homework (30%) • Midterm Exam (30%) • Final Exam (40%)
Course Webpage	
Rationale for Offering	Biomaterials and medical devices are at the forefront of healthcare innovation, bridging mechanical engineering with biomedical applications. This course equips students with advanced knowledge of material–biology interactions, device design, and regulatory standards, preparing them for research and development in biomedical engineering, medical robotics, and healthcare technologies. It aligns with the research-intensive focus of the MSc Mechanical Engineering program and supports pathways toward doctoral studies or careers in medical technology industries.

Date/Person Prepared	Curriculum Development Taskforce (May 2025)
Ethical behavior statement	Each student in this course is expected to abide by the VinUni Code of Academic Integrity. Any work submitted by a student in this course for academic credit will be the student's own work (with acknowledgment that many projects are carried out in groups in which participants will contribute equally). The Code is available on the web at www.vinuni.edu.vn. Violations are taken seriously.