CURRICULUM FRAMEWORK

MASTER OF SCIENCE

Electrical Engineering

PROGRAM CODE: 8520201

Applicable from Academic Year 2025-2026

(Released along with Decision No. 589/2025/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 Committee Reviewed by Curriculum Review Committee & Scientific and Educational Committee Approved by: Provost (Decision No. 589/2025/QĐ-VUNI dated 19/9/2025 by Provost of VinUniversity).	First Release

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1. PROGRAM OVERVIEW

1.1.Program Profile

Name of the Degree	Master of Science in Electrical Engineering
Name of the Program	Master of Science in Electrical and Computer Engineering
Orientation	Research
Program Code	8520201
Vietnam Qualifications Framework Level	7
Length of the 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 Electrical Engineering program at VinUniversity is to develop highly capable electrical engineers with a strong foundation in advanced engineering principles and significant experience in research and practical applications. The program is designed to cultivate creativity, innovation, and a well-rounded professional mindset, enabling graduates to proactively lead and contribute to technological and societal advancement. Upon graduation, students will be prepared to work in research and development roles, design and implement cutting-edge technologies, or pursue careers in academia.

1.3.Program Educational Objectives and Program Learning Outcomes

1.3.1. Program Educational Objectives

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

PEO1: Demonstrate advanced technical competence in electrical 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 electrical engineering in areas such as energy systems, communications, automation, or embedded intelligence.

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 electrical 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 electrical 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 electrical 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. Having 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 Electrical Engineering or relevant disciplines, in particular:

   - Disciplines of Electrical Engineering: Electrical and Electronics Engineering; Computer Engineering; Electronics and Telecommunication Engineering; Control and Automation Engineering; Robotics Engineering; Mechatronics Engineering; Biomedical Engineering.
   - Closely related disciplines: Computer Science; Cryptographic Engineering
   - For other disciplines, the College 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	MATH2020	Discrete Mathematics	4
2	ELEC2010	Introduction to Circuits for Electrical Engineers	4
3	ELEC2020	Signals and Information	4
4	ELEC3010	Digital Logic and Computer Organization	4

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 in English.

3. CURRICULUM STRUCTURE

3.1 Curriculum Composition

No.	Curriculum Components	Number of Credits	Notes
I	**COURSE WORK**		
I.1	***General Knowledge (required)***	***7***	
1	*Philosophy*	*3*	
2	*Research Communication*	*4*	
I.2	***Foundation Knowledge (required)***	***12***	
3	*Major course 1*	*4*	
4	*Major course 2*	*4*	
5	*Major course 3*	*4*	
I.3	***Specialized Knowledge (elective)***	***11***	
	Students select 3-4 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 electrical 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		Grading System
				Theory	Practice	
I	**COURSE WORK**		**30**			
I.1	***General Knowledge (required)***		***7***			
1	PHIL5010	Philosophy	3	3	0	
2	CECS5010	Research Communication	4	3	1	
I.2	***Foundation Knowledge (required)***		***12***			
1	ELEC5060	Ubiquitous Sensing and Intelligent Systems	4	3	1	
2	ELEC5120	Advanced DSP & Time-Series ML	4	3	1	
3	ELEC5130	Optimization for Communication Systems	4	3	1	
I.3	***Specialized Knowledge (elective)***					
	Elective courses *(Students select 3-4 courses from the list below or from other BSc, Master and PhD programs)*		**>=11**			
1	ELEC5050	Robotics	4	3	1	
2	ELEC5150	Advanced Semiconductor Physics and IC Design	4	3	1	
3	ELEC5070	Internet of Things	4	3	1	
4	ELEC5100	System, Network and Cloud Security	4	3	1	
5	ELEC5140	Neural Networks and Intelligent Systems in Electrical Engineering	4	3	1	

No	Course code	Name of Courses	Credit	Credit Hour Allocation		Grading System
				Theory	Practice	
6	ELEC5160	Signal integrity, High Speed Digital Design and EMC	4	3	1	
II.	**RESEARCH WORK**		**30**			
1	ELEC5960	Research Proposal	5		*5*	
2	ELEC5970	Research Project 1	5		*5*	
3	ELEC5980	Research Project 2	5		*5*	
4	ELEC5990	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	***General Knowledge (required)***		**7**				
1	PHIL5010	Philosophy	*3*	*X*			
2	CECS5010	Research Communication	*4*	*X*			
I.2	***Foundation Knowledge (required)***		**12**				
1	ELEC5060	Ubiquitous Sensing and Intelligent Systems	4	*X*			
2	ELEC5120	Advanced DSP & Time-Series ML	*4*	*X*			
3	ELEC5130	Optimization for Communication Systems	*4*		*X*		
I.3	***Specialized Knowledge (elective)*** *(Students select 3-4 courses from the list below or from other BSc, Master and PhD programs)*		***>=11***				
1	ELEC5140	Neural Networks and Intelligent Systems in Electrical Engineering	4		*X*		
2	ELEC5050	Robotics	4		*X*		
3	ELEC5070	Internet of Things	4		*X*		
4	ELEC5150	Advanced Semiconductor Physics and IC Design	4		*X*		
5	ELEC5100	System, Network and Cloud Security	4		*X*		
6	ELEC5160	Signal integrity, High Speed Digital Design and EMC	4		*X*		
II	**RESEARCH WORK**		***30***				
1	ELEC5960	*Research Proposal*	*5*	X			
2	ELEC5970	*Research Project 1*	*5*		X		
3	ELEC5980	*Research Project 2*	*5*			X	
4	ELEC5990	*Master Thesis*	*15*			X	X
TOTAL:			**60**				

3.4 Course Descriptions

PHIL5010: Philosophy

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

Pre-requisites: none

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

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

This course aims to provide students 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.

ELEC5120 Advanced Digital Signal Processing & Time-Series Machine Learning

4 credits

Pre-requisites: Undergraduate Digital Signal Processing and Probability/Statistics (or equivalent background in signals and data analysis)

Advanced Digital Signal Processing & Time-Series Machine Learning is an area of electrical and computer engineering concerned with sophisticated techniques for processing signals and sequential data, combining classical signal processing methods with modern machine learning tools to extract information and make predictions. The objective of this course is to provide insight into advanced signal processing and time-series modeling that goes beyond basic filtering algorithms and traditional forecasting approaches. The curriculum spans both classical models and frequency-domain analysis (e.g. ARIMA, state-space models, Fourier and wavelet transforms) and state-of-the-art machine learning techniques for sequential data. Students will acquire knowledge and understanding of advanced DSP concepts such as the geometry of signal and system spaces, approximation methods, and advanced filtering techniques and learn time-series machine learning methods from a practical implementation perspective, gaining the capability to design intelligent signal analysis and forecasting 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.

ELEC5130 Optimization for Communication Systems

4 credits

Pre-requisites: Calculus and Linear Algebra, Probability and Statistics, Basic knowledge of data communication or computer networks, Programming experience in Python or MATLAB

This course explores foundational and advanced topics in optimization and computer networking, with a focus on applying optimization techniques to the design, analysis, and performance of modern communication systems. Students will first study fundamental concepts in convex optimization, linear and nonlinear programming, duality, and gradient-based methods. These tools will then be applied to solve engineering problems in resource allocation, scheduling, traffic engineering, and congestion control in computer networks. In the networking component, students will examine layered architectures, protocols for data link, transport, and network layers, and the principles behind network routing, flow control, and quality of service (QoS). Students will apply theoretical methods to practical scenarios using tools such as MATLAB and Python.

ELEC5140 Neural Networks and Intelligent Systems in Electrical Engineering

4 credits

Pre-requisites: none

This course provides an introduction to neural networks and their applications in electrical engineering. Students will learn the foundational concepts of neural network architectures, including perceptron, multi-layer networks, convolutional networks, and recurrent networks. The course emphasizes practical applications such as signal processing, power system optimization, control systems, and renewable energy prediction. MATLAB will be used extensively for building, training, and applying neural networks to solve real-world engineering problems.

ELEC5050 Robotics

4 credits

Pre-requisites: Control Systems

The course covers 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.

ELEC5070 Internet of Things

4 credits

Pre-requisites: Networks or Equivalent

This course covers the main cybersecurity principles and technologies motivated by the evolving ecosystem of Internet of Things (IoT): smart devices, sensors, operating systems, data storage, networking, communication protocols, and system services. The topics include IoT device and system security threats, privacy issues, open challenges, and countermeasure techniques.

ELEC5150 Advanced Semiconductor Physics and IC Design

4 credits

Pre-requisites: none

Current advances in AI have driven the need for more customized chip architectures. This course will first refresh and build upon student's understanding of what a semiconductor is and how they work. Then, common components such as MOSFETs will be investigated in detail, and current SOTA 3D manufacturing topologies (such as FinFETs and GAA FETs) will be taught. Current trends in semiconductor design such as chiplet design, High-bandwidth memory interfaces, neuromorphic processors and using FPGAs to prototype ASICs and similar bespoke ICs will be demonstrated. Modern advancements in semiconductor processes such as etching, lithography, wire bonding, masking, testing and novel III-V/compound semiconductor technologies (GaAs, GaN) with their relative advantages to give students everything they need to work in the semiconductor industry.

ELEC5100 System, Network and Cloud Security

4 credits

Pre-requisites: Networks, Operating Systems or Equivalent

The course gives an overview of security topics for operating systems, networks and Cloud. It covers the main operating systems in the market and gives the overview of securing their main elements according to a variety of usage scenarios. It also discusses network security, setting up secure network environments and responding to security threats in a networked environment. Finally, it considers approaches to securing Cloud and distributed systems and data, with a special focus on data privacy.

ELEC5160 Signal Integrity, High Speed Digital Design, and EMC

4 credits

Pre-requisites: None

Entering the world of digital high-speed communications and data presents challenges not only at the encoding and modulation level, but also of that within the frequency domain and RF space. This module will teach the principles of Signal Integrity, why it matters, “eye/I” diagrams, and some current industry best-practice and design guidelines to mitigate common pitfalls and issues that can arise when designing high-speed systems.

ELEC5960 Research Proposal

5 credits

Students identify a relevant and challenging research topic in electrical 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 graduate research committee.

ELEC5970 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.

ELEC5980 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.

ELEC5990 Master Thesis

15 credits

Students synthesize their research into a comprehensive thesis that demonstrates innovation, scholarly depth, and relevance to electrical 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: • Understand characteristics of Western philosophy, Eastern philosophy and Marxist philosophy • Understand advanced content on Marxist-Leninist philosophy in the current period and its role in worldview and methodology • Understand the interrelationship between philosophy and science; the role of science in social life.
Topics Covered/ Indicative Syllabus	• Fundamental of philosophy o What is philosophy? o Eastern vs. Western philosophy • Marxist-Leninist philosophy o The birth of Marxist-Leninist philosophy o Two basic principles of the materialist dialectic o Dialectical materialism o Historical materialism o Marxist-Leninist philosophy in the present period • The relationship between science and philosophy • The role of science in social life o Scientific Consciousness o Science and technology - the driving force of social development o Science and technology in Vietnam
Class/Laboratory Schedule	Two (2) 1.5 hour-lectures per week
Assessment Methods in Alignment with	• Project (40%) • In-class participation and quizzes (20%) • Final exam (40%)

Course Code	PHIL5010
Intended Learning Outcomes	
Course Webpage	TBA
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: • identify the key elements of clear effective communication in the research process. • recognize and reproduce the structure of excellent research articles. • organize and present data in different formats including graphs, charts, tables, etc. appropriate for various purposes. • write a good research article that maximizes clarity and understanding. • 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

Course Code	CECS5010
	• Oral Presentation o Communication in an era of global science o How to prepare a scientific presentation o How to deliver a scientific presentation o 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	Supporting PLO 2.2 and PLO 2.4
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	**ELEC5050**
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: • Identify the basic components of robot, select the right coordinate system for particular manipulator movement, and perform position transformation between different coordinates. • Characterize the kinematics in static and dynamic situations, calculate and solve the kinematics problems • 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 • Implement dynamic modelling, Lagrange's energy expression and equation of motion • Describe the sensors and devices in a robotics system and robotic applications • 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 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.
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	**ELEC5060**
Course Title	**Ubiquitous Sensing and Intelligent Systems**
Catalogue Description	This course aims to provide students with an overview and the foundation of multidisciplinary research field of next generation of computing. It covers sensing technology, mechanism behind sensing data, embedded computing, and methods to analyze sensing data.
Credit Value	4
Required or elective	Required
Pre-requisite/Co-requisite/Exclusion	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	Students will: 1. Learn the principles of sensors, actuators, and embedded systems. 2. Analyze and interpret sensing mechanisms and data. 3. Learn about the standard methods and techniques of analyzing measure sensing data 4. Get hands-on experience with intelligent systems integrating sensors and analysis.
Course Learning Objectives	Upon completion of the course, students will be able to: • Understand the fundamental physical/chemical sensor & actuator mechanism • Analyze mechanism behind sensing data • Acquire knowledge of embedded computing • Learn about the standard methods and techniques of analyzing measure sensing data • 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. • Supporting PLO 1.1
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. Violations are taken seriously.

Course Code	ELEC5070
Course Title	Internet of Things (IoT)
Catalogue Description	This course covers the main cybersecurity principles and technologies motivated by the evolving ecosystem of Internet of Things (IoT): smart devices, sensors, operating systems, data storage, networking, communication protocols, and system services. The topics include IoT device and system security threats, privacy issues, open challenges, and countermeasure techniques.
Credit Value	4
Required or elective	Elective
Pre-requisite/Co-requisite/Exclusion	Networks or Equivalent
Textbook(s) and other required materials	TBD by VinUni Faculty. Sample texts include: • *The Internet of Things*, by Samuel Greengard, ISBN: 9780262527736 • *Internet of Things: Architectures, Protocols, and Standards*, by Simon Cirani, Marco Picone, and Luca Veltri • *Internet of Things: Principles and Paradigms*, by Rajkumar Buyya and Amir Vahid Dastjerdi
Course Learning Goals	At the end of the course, students should be able to: 1. understand the core technology in IoT, including embedded systems, smart devices, communication protocols, and data processing techniques. 2. understand and explain the core IoT cybersecurity principles and technologies. 3. examine and explain security threats and data trustworthiness issues in IoT based applications.
Course Learning Objectives	On completion of the course, the student shall be able to: • understand and describe concepts in IoT technology, design principles of IoT systems, and IoT application development. • analyze IoT devices and systems from a cybersecurity perspective. • identify appropriate security and privacy solutions for IoT. • explain open challenges and issues related to IoT applications.
Topics Covered/ Indicative Syllabus	• Introduction to IoT systems: definitions, applications, and technologies. • IoT cybersecurity principles and technologies. • Security threats and techniques in IoT. • Data trustworthiness and privacy in IoT. • IoT in healthcare: Interoperability and security issues. • IoT in smart home: Security risks. • Open issues, challenges, and countermeasures.
Class/Laboratory Schedule	Lectures: Two 75-min lectures per week Design Project: The course has a IoT system design project that will last throughout the semester.
Contribution of course to meeting	

Course Code	ELEC5070
the professional component	
Assessment Methods in Alignment with Intended Learning Outcomes	• Assignments: 10% • Presentation: 15% • Project: 25% • Midterm: 20% • Exam: 30%
Course Webpage	TBD
Rationale for Offering	Supporting PLO 1.1
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	ELEC5100
Course Title	**System, Network and Cloud Security**
Catalogue Description	The course gives an overview of security topics for operating systems, networks and Cloud. It covers the main operating systems in the market and gives the overview of securing their main elements according to a variety of usage scenarios. It also discusses network security, setting up secure network environments and responding to security threats in a networked environment. Finally, it considers approaches to securing Cloud and distributed systems and data, with a special focus on data privacy.
Credit Value	4
Required or elective	Elective
Pre-requisite/ Co-requisite/ Exclusion	Networks, Operating Systems or Equivalent
Textbook(s) and other required materials	TBD by VinUni Faculty. Sample texts include: 1. Charles P. Pfleeger and Shari Lawrence Pfleeger. *Analyzing Computer Security: A Threat/Vulnerability/Countermeasure Approach*. Prentice Hall, Upper Saddle River, NJ, 2011. ISBN 978-0-13-278946-2. 2. William Stallings (2016). *Cryptography and Network Security - Principles and Practices*, 7th Edition, Prentice Hall.
Course Learning Goals	Students will: 1. describe the security design principles of the operating systems, networks, and Cloud infrastructure. 2. understand the impacts of known threats, risks, vulnerabilities, and privacy issues to organization. 3. explore the guiding security design patterns, applied technologies, and skills relating to IT services' safeguards and countermeasures. 4. apply approaches to securing Cloud and distributed systems and data, with a special focus on data privacy.
Course Learning Objectives	Upon completion of the course, students will be able to: • explain the concepts of confidentiality, availability, and integrity (CIA) in the context of information assurance. • understand the fundamentals of the operating system, network, and Cloud computing architectures based on current standards, protocols, and best practices. • understand the concepts and guiding principles for designing and implementing appropriate safeguards and countermeasures for IT services. • design secure environments to assure isolation of physical and logical infrastructures. • identify the known threats, risks, vulnerabilities, and privacy issues associated with the operating system, network, and cloud-based services. • understand the industry security standards, regulatory, audit policies, and compliance requirements for the operating system, network, and cloud-based infrastructures.
Topics Covered/ Indicative Syllabus	Topics to be covered: • Overview of operating systems, virtualization, and distributed systems • Network architectures and key protocols • Cloud Computing Fundamentals

	• Basic security principles • Incidents for security breaches. • System-level security and analysis • Network protocols and security • Cloud security • Data security and storage • Access and authentication control • Security risks evaluation
Class/Laboratory Schedule	
Contribution of course to meeting the professional component	
Assessment Methods in Alignment with Intended Learning Outcomes	• Assignments: 10% • Presentation: 15% • Project: 25% • Midterm: 20% • Exam: 30%
Course Webpage	
Rationale for Offering	Supporting PLO 1.1
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 (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	ELEC5120
Course Title	**Advanced Digital Signal Processing & Time-Series Machine Learning**
Catalogue Description	This course explores the intersection of advanced digital signal processing (DSP) and time-series machine learning (ML), focusing on modern techniques for analyzing, modeling, and forecasting sequential data. It builds upon foundational DSP and probability concepts to provide students with a deeper understanding of signal structures, spectral behavior, and predictive modeling in both the time and frequency domains. Topics include stochastic signal modeling, autoregressive (AR), moving average (MA), and ARIMA models, spectral estimation, and state-space systems. These classical techniques are combined with machine learning approaches such as artificial neural networks (ANNs), recurrent models (e.g., LSTM), and hybrid data-driven systems. Practical applications include signal denoising, power consumption prediction, fault detection, system identification, and intelligent forecasting for energy and communication systems. MATLAB and Python will be used for hands-on implementation of signal analysis and ML pipelines. The course prepares students to design, implement, and evaluate intelligent signal processing systems for modern electrical engineering applications, including those found in smart grids, industrial automation, biomedical systems, and communication networks.
Credit Value	4
Required or elective	Required
Pre-requisite/ Co-requisite/ Exclusion	Undergraduate Digital Signal Processing and Probability/Statistics, or equivalent background in signals and data analysis.
Textbook(s) and other required materials	1. **P. J. Brockwell & R. A. Davis**, *Introduction to Time Series and Forecasting*, 3rd Edition, Springer, 2016. 2. **Sergios Theodoridis**, *Machine Learning and Deep Learning for Signal Processing*, Academic Press, 2nd Edition, 2020. 3. **Zhang, J., & Wang, H.**, *Artificial Neural Networks: Applications in Electrical Engineering*, Springer, 2021. 4. **Software**: MATLAB (Signal Processing Toolbox, Deep Learning Toolbox), Python (NumPy, SciPy, scikit-learn, TensorFlow/Keras)
Course Learning Goals	Students will: 1. Analyze and model real-world time-series and signals using both classical DSP and modern machine learning methods. 2. Apply spectral and statistical techniques (e.g., ARIMA, state-space models) to signal decomposition and forecasting. 3. Implement neural network architectures for dynamic system modeling, signal classification, and intelligent control. 4. Bridge DSP and ML to develop hybrid solutions for power systems, communication signals, and smart sensing. 5. Use MATLAB and Python to simulate, train, and validate forecasting and signal processing systems.

	6. Develop engineering judgment to choose between model-driven and data-driven methods in real applications.
Course Learning Objectives	Upon successful completion of this course, students will be able to: • Formulate and estimate time-series models (AR, MA, ARIMA) and assess model quality. • Analyze signal properties using Fourier and spectral techniques for system identification and filtering. • Build and train neural networks for sequence learning tasks such as signal classification, denoising, and load prediction. • Evaluate and compare the performance of classical and machine learning-based forecasting models. • Develop intelligent processing pipelines combining signal modeling with predictive analytics. • Apply tools such as MATLAB and Python to solve advanced DSP and time-series problems in practical contexts.
Topics Covered/ Indicative Syllabus	• Review of stochastic processes and classical signal modeling • Autoregressive (AR), moving average (MA), and ARIMA models • Spectral analysis and power spectral density estimation • Kalman filtering and state-space models • Neural networks for signal classification and regression • Recurrent networks and LSTMs for sequential data • Hybrid intelligent systems for fault detection, load forecasting, and control • Deep learning pipelines for time-series forecasting • Implementation of DSP + ML workflows in MATLAB and Python • Case studies from power systems, communication signals, and biomedical signal analysis
Class/Laboratory Schedule	• Weekly 3-hour lecture • Weekly 2-hour laboratory session (MATLAB + Python-based) • Bi-weekly tutorial and discussion sections
Contribution of course to meeting the professional component	This course provides students with essential competencies in signal modeling, time-series forecasting, and machine learning—skills increasingly required in smart infrastructure, control systems, and real-time decision-making in engineering. Through integration of theoretical models and practical tools, students will be well-equipped to design intelligent systems and apply advanced data-driven methods in engineering research and industry.
Assessment Methods in Alignment with Intended Learning Outcomes	• Assignments: 15% • Midterm Exam: 20% • Project (Signal ML System Design): 25% • Final Exam: 30% • In-class Participation/Presentation: 10%
Course Webpage	To be made available via the university LMS.
Rationale for Offering	The convergence of signal processing and machine learning is redefining the role of electrical engineers in domains such as renewable energy, smart cities, wireless communications, and healthcare technologies. This course addresses the growing

	demand for engineers capable of modeling, forecasting, and making intelligent decisions using both signal models and data-driven methods. It aligns with national and global industry trends toward predictive, adaptive, and AI-enabled systems.
Ethical Behavior Statement	All students are expected to adhere to the VinUniversity Code of Academic Integrity. Work submitted must be original or properly cited. Violations such as plagiarism, cheating, or fabrication will be dealt with seriously and in accordance with university policy.

Course Code	ELEC5130
Course Title	**Optimization for Communication Systems**
Catalogue Description	This course explores foundational and advanced topics in optimization and computer networking, with a focus on applying optimization techniques to the design, analysis, and performance of modern communication systems. Students will first study fundamental concepts in convex optimization, linear and nonlinear programming, duality, and gradient-based methods. These tools will then be applied to solve engineering problems in resource allocation, scheduling, traffic engineering, and congestion control in computer networks. In the networking component, students will examine layered architectures, protocols for data link, transport, and network layers, and the principles behind network routing, flow control, and quality of service (QoS). Students will apply theoretical methods to practical scenarios using tools such as MATLAB and Python.
Credit Value	4
Required or elective	Required
Pre-requisite/ Co-requisite/ Exclusion	• Pre-requisites: Linear Algebra; Signals and Systems; Probability and Random Processes; Digital Communication Systems • Recommended: Convex Optimization; Wireless Communication
Textbook(s) and other required materials	1. Goldsmith, Andrea. "*Wireless communications*." Cambridge University Press, 2005. 2. Kurose, James F., and Keith W. Ross. "*Computer networking: A top-down approach edition*." Addision Wesley 12 (2007). 3. Marzetta, Thomas L., Erik G. Larsson, and Hong Yang. "*Fundamentals of Massive MIMO*." Cambridge University Press, 2016. 4. Boyd, Stephen P., and Lieven Vandenberghe. "*Convex optimization*." Cambridge University Press, 2004.
Course Learning Goals	Students will: 1. Gain a strong foundation in optimization theory as applied to communication systems. 2. Understand how mathematical tools solve practical engineering problems like power allocation, scheduling, and coding. 3. Learn to simulate and analyze wireless networks using optimization frameworks. 4. Evaluate tradeoffs in resource-constrained environments (e.g., energy, bandwidth). 5. Become familiar with modern 5G/6G and IoT optimization techniques.
Course Learning Objectives	Upon completion of the course, students will be able to: • Formulate constrained and unconstrained optimization problems in communication contexts. • Apply convex and non-convex optimization techniques to signal and system design. • Use KKT conditions to solve constrained optimization problems. • Analyze and simulate MIMO systems with optimal power allocation (e.g., water-filling). • Optimize multiuser communication systems with fairness and QoS constraints. • Develop resource allocation algorithms for wireless networks. • Understand and critique real-world protocol and system designs using optimization metrics.

	• Implement optimization algorithms using MATLAB or Python.
Topics Covered/ Indicative Syllabus	Topics to be covered: • Introduction about communicaiton systems • Introduction to optimization: role of optimization in communication systems, and examples from 5G, IoT, and satellite systems • Mathematical foundations: convex sets and functions, linear and nonlinear programming duality and KKT conditions • Numerical optimization techniques: gradient descent, Newton's method, CVX toolboxes • Power control and resource allocation water-filling algorithms channel capacity optimization • Scheduling and fairness: utility maximization, delay-aware scheduling • Beamforming and antenna selection: MIMO system optimization, SINR balancing and power allocation • Cross-layer optimization: joint PHY-MAC optimization, network utility maximization • Case studies & industry applications: optimization in 5G/6G, edge computing, vehicular networks
Class/Laboratory Schedule	TBD
Contribution of course to meeting the professional component	This course provides students with essential skills in applying optimization techniques to modern communication systems, preparing them for roles in wireless, IoT, and satellite industries. By integrating theory with practical tools like MATLAB and CVXPY, students learn to design and evaluate key system components such as resource allocation, MIMO, and scheduling algorithms. The course builds industry-ready capabilities in solving real-world engineering problems across PHY and MAC layers, aligning with the demands of advanced network planning and protocol optimization.
Assessment Methods in Alignment with Intended Learning Outcomes	• Quizzes: 10% • Homeworks: 10% • Project: 30% • Midterm Exam: 20% • Final Exam: 30%
Course Webpage	TBD
Rationale for Offering	Vietnam is rapidly positioning itself as a regional hub for digital infrastructure and smart connectivity, with national strategies focusing on the development of 5G/6G networks, IoT ecosystems, and AI-driven technologies. These advancements demand engineers who can design communication systems that are not only high-performance but also optimized for energy, spectrum, and cost efficiency. Optimization is central to achieving these goals. This course supports Vietnam's digital transformation roadmap by equipping students with the mathematical and practical skills to solve complex resource allocation and system design problems. It aligns with the government's vision under the National Digital Transformation Program and the 2045 Industry Development Strategy, helping develop a workforce capable of innovating in areas such as wireless communications, smart cities, and connected industries.
Ethical Behavior Statement	Each student is expected to abide by the VinUniversity Code of Academic Integrity. Any work submitted must be the student's own, with fair contributions in group projects. Violations of academic honesty will be taken seriously.

Course Code	ELEC5140
Course Title	**Neural Networks and Intelligent Systems in Electrical Engineering**
Catalogue Description	This course provides a structured and application-focused introduction to neural networks and intelligent systems, with an emphasis on their role in modern electrical engineering. Students will first develop a solid understanding of core architectures such as perceptron, multilayer feedforward networks, and backpropagation learning. Building on this foundation, the course advances to cover convolutional neural networks (CNNs), recurrent neural networks (RNNs), and hybrid intelligent systems that integrate fuzzy logic and evolutionary algorithms—approaches particularly well-suited to solving nonlinear, uncertain, and adaptive problems in engineering. The course combines theoretical instruction with hands-on MATLAB-based exercises, enabling students to design, train, and validate neural models for real-world tasks. Applications include signal denoising, fault detection, predictive maintenance, power load forecasting, motor control, and renewable energy output prediction. Emphasis is placed on using neural networks not only as predictive tools, but also as intelligent components in control and optimization systems. As the electrical engineering field shifts toward intelligent automation, smart grids, and data-driven decision-making, this course equips students with the computational thinking and technical skills required to contribute meaningfully to this transformation. By bridging artificial intelligence with electrical engineering applications, students will be prepared for roles in advanced system design, industrial automation, and intelligent infrastructure development. The course also lays a strong foundation for further research or career advancement in emerging interdisciplinary areas where AI meets power, control, and energy systems.
Credit Value	4
Required or elective	Elective
Pre-requisite/ Co-requisite/ Exclusion	Linear algebra, signals and systems, and basic programming (e.g., MATLAB or Python).
Textbook(s) and other required materials	**Primary Textbooks:** 1. Zhang, J., & Wang, H. **Artificial Neural Networks: Applications in Electrical Engineering**. *Springer, 2021.* 2. Aggarwal, C. C. **Neural Networks and Deep Learning: A Textbook**. Springer, 2018. 3. Sergios Theodoridis, **Machine Learning and Deep Learning for Signal Processing,** Academic Press, 2nd Edition, 2020. **Supplementary Textbook:** 4. Beale, M. H., Hagan, M. T., & Demuth, H. B. **MATLAB® Deep Learning Toolbox User's Guide** 5. MathWorks documentation on **Neural Network Toolbox and Deep Learning Toolbox.**
Course Learning Goals	Students will:

	1. Understand core neural network architectures and their relevance to electrical engineering problems. 2. Apply neural networks to practical tasks such as signal denoising, pattern recognition, and time-series prediction in power and control systems. 3. Design intelligent controllers using neural models for automation and adaptive system regulation. 4. Develop fault detection and diagnostic systems using neural classification and anomaly detection techniques. 5. Predict energy consumption and renewable power output using neural forecasting models. 6. Gain proficiency in MATLAB for building, training, and evaluating neural networks tailored to electrical engineering applications.
Course Learning Objectives	Upon successful completion of this course, students will be able to: • Describe the structure and function of core neural network models (e.g., MLP, CNN, RNN) and explain their suitability for various electrical engineering applications. • Implement neural network solutions for signal processing tasks such as denoising, feature extraction, and pattern recognition using MATLAB. • Design and simulate intelligent control systems that leverage neural networks for adaptive and nonlinear control in electrical and electromechanical systems. • Develop neural-based fault detection systems capable of identifying abnormal operating conditions in power systems or industrial equipment. • Apply neural forecasting models to predict electrical load demand, equipment behavior, and renewable energy generation patterns. • Train, validate, and evaluate neural network models using MATLAB, and interpret their performance for solving practical engineering problems.

Topics Covered/ Indicative Syllabus	Topics Covered / Indicative Syllabus
	• Introduction to Neural Networks
	    o Artificial neurons, architectures, and learning paradigms
	    o Role of intelligent systems in electrical engineering
	• Core Neural Models and Training
	    o Perceptrons, MLPs, activation functions
	    o Backpropagation, gradient descent, regularization techniques
	• Advanced Architectures
	    o CNNs for signal/image analysis
	    o RNNs and LSTMs for time-series prediction
	    o Autoencoders for anomaly detection
	• Applications in Electrical Engineering
	    o Signal denoising, fault detection, and pattern recognition
	    o Power load forecasting and renewable energy prediction
	    o Neural-based adaptive control systems
	• Hybrid Intelligent Systems

	○ Neuro-fuzzy models and evolutionary neural networks ○ Optimization in control and power systems • MATLAB Implementation ○ Neural Network Toolbox usage ○ Data preprocessing, training workflows, and performance evaluation
Class/Laboratory Schedule	• Weekly 3-hour lecture • Weekly 2-hour MATLAB laboratory session • Bi-weekly tutorial sessions
Contribution of course to meeting the professional component	This course equips students with the advanced knowledge and technical skills required to apply neural networks in key areas of electrical engineering, including smart grids, predictive maintenance, renewable energy forecasting, and intelligent control systems. Through a combination of theoretical foundations and hands-on MATLAB implementation, students learn to design, train, and deploy intelligent systems tailored to real-world engineering challenges. By bridging AI with core electrical engineering practices, the course prepares graduates to meet the growing demand for engineers who can lead innovation in data-driven, automated, and sustainable systems. It directly contributes to their readiness for roles in industry, research, and interdisciplinary projects at the forefront of technological advancement.
Assessment Methods in Alignment with Intended Learning Outcomes	• Lab Assignments: 15% • Midterm Exam: 15% • Final Exam: 30% • Final Project (Neural Model for an EE Application): 40%
Course Webpage	To be made available via the university LMS.
Rationale for Offering	As AI continues to reshape the electrical engineering landscape, there is a growing demand for professionals who can integrate neural networks into real-world systems such as smart grids, renewable energy forecasting, intelligent control, and predictive maintenance. This course addresses that need by providing focused, application-driven training in neural networks tailored to electrical engineering contexts. It supports Vietnam's strategic goals in digital transformation, energy modernization, and AI capacity-building, while aligning with global trends in Industry 4.0. By bridging traditional EE knowledge with intelligent system design, the course prepares students to contribute to advanced engineering solutions and remain competitive in a data-driven global workforce.
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 for academic credit must be their own (while acknowledging that group work is often encouraged). Plagiarism, fabrication, cheating, or other forms of academic misconduct will be subject to disciplinary action as described in the Academic Integrity Policy.

Course Code	ELEC5150
Course Title	**Advanced Semiconductor Physics and IC Design**
Catalogue Description	With the rapid advancement of AI, autonomous systems, and data-centric computing, the semiconductor industry is undergoing a revolution in architecture, materials, and manufacturing. This module provides students with a solid foundation in semiconductor physics before progressing to the design and fabrication of modern integrated circuits. Students will investigate foundational components such as MOSFETs, JFETs, and IGBTs, as well as advanced structures including FinFETs, Gate-All-Around (GAA) FETs, and 3D-stacked chiplets. The course explores state-of-the-art fabrication techniques—such as etching, lithography, masking, and wire bonding—and examines the strategic use of compound semiconductors (e.g., GaAs, GaN, SiC) for high-performance and wide-bandgap applications. Emphasis will be placed on modern design workflows, including the use of FPGAs for ASIC prototyping, SoCs, and emerging approaches like neuromorphic and AI-optimized silicon. Students will also gain exposure to industry-standard EDA tools (e.g., Cadence Virtuoso), understand current process node scaling (from 180 nm to 1.8 nm), and analyze real-world case studies from companies such as Intel, TSMC, and NVIDIA to build both technical and entrepreneurial insight into this rapidly evolving sector. *This course offers a uniquely integrated approach that spans semiconductor physics, cutting-edge fabrication processes, and system-on-chip design, while also embedding industry strategy and real-world innovation. Unlike traditional courses that separate device physics from system design or fab process, this module gives students the full-stack knowledge needed to innovate in the modern semiconductor ecosystem—mirroring the challenges faced by industry leaders like TSMC, Intel, and NVIDIA.*
Credit Value	4
Required or elective	Elective
Pre-requisite/ Co-requisite/ Exclusion	Electromagnetic fields and waves. Embedded systems.
Textbook(s) and other required materials	1. Sendra, Adel S et. Al. Microelectronic Circuits. 2. Van Zant, P. Microchip Fabrication: A Practical Guide to Semiconductor Processing. 6th Edition. 3. Sze, S. Lee, M. Semiconductor Devices: Physics and Technology 4. Plummer, J. Griffin, P. Integrated Circuit Fabrication. 5. Miller, C. Chip War. 6. Kim, T. The NVIDIA way.
Course Learning Goals	Students will: 1. Understand the underlying physics involved in semiconductor operation and be able to explain common foundational components. 2. Trace the evolution from TTL (1960s) to CMOS (1980s) to FinFET/GAA (2010)s to chiplets and beyond (2030+); *from 180nm to current 1.8nm processes.* 3. Learn from common CMOS topologies used to build common components such as memories and MOSFETs/JFETs/IGBTs/GAA FETs.

	4. Understand the prototyping process behind defining, building and fabricating SoCs and ASICs. 5. Have an awareness of current SOTA chip manufacture technologies and equipment.
Course Learning Objectives	Upon completion of the course, students will be able to: • Explain P-I-N and P-N semiconductor structures, explain the depletion zone, and understand how biasing and charge carriers operate to conduct electricity and provide non-linear behavior. • Describe how these semiconductor principles are articulated in FET topologies, and the successive improvements, limitations and future challenges. • Compare the alternatives of using materials other than silicon to form these junctions such as III:V GaAs/GaN or SiC devices that are currently being introduced into the market. • Map the hierarchy from transistor-level design to full-scale processors, including logic, memory, ALUs, and their integration into ASICs and SoCs. • Discuss technological advances such as EUV lithography, GAA-FETs, 3D packaging, and chiplet integration. • To be made aware of current industry trends such as utilizing chip let designs, and optimization of chips for AI solutions. • Demonstrate familiarity with industry-standard design and simulation tools (e.g., Cadence Virtuoso) and their application to chip optimization. • Identify and analyze key players and innovation strategies in the semiconductor industry (e.g., TSMC, Intel, NVIDIA), extracting entrepreneurial and technological insights. (Entrepreneurial skills).
Topics Covered/ Indicative Syllabus	Topics to be covered: • Semiconductor physics principles (1D to 3D conceptualization) • Compound semiconductors and wide-bandgap materials • CMOS device topologies: MOSFETs, JFETs, IGBTs, GAA-FETs • Fabrication and manufacturing processes (etch, doping, lithography, EUV) • Advanced packaging: 3D ICs, CoWoS, chiplets • Design methodologies: SoC, FPGA, ASIC architectures • CAD and EDA workflows (e.g., Cadence, Synopsys, Mentor Graphics) • Industry trends and roadmaps (e.g., IRDS, AI-optimized silicon, RISC-V) • Case studies of major semiconductor companies and innovations
Class/Laboratory Schedule	
Contribution of course to meeting the professional component	Within the semiconductor industry, the selected course books have frequently been cited as containing an expert level depth of understanding. This course aims to teach students the key building blocks for them to go further and invent/change and design more efficient semiconductor topologies and solutions in future. It will also give students the required skills to be "industry ready" with legacy processes; whilst also already be informed of current best practice to guide suggest and build techniques, equipment or processes being used within Vietnamese companies. The aim is for a student to be able to be immediately employed by a semiconductor foundry or design house (NVIDA/TSMC/Apple/AMD/Microsoft or similar); so that employers have little to no "bring-up-to-speed" overhead for their projects – improving student value.

Assessment Methods in Alignment with Intended Learning Outcomes	• Assignments: 10% • Presentation: 15% • Project: 25% • Midterm: 20% • Exam: 30%
Course Webpage	TBD
Rationale for Offering	According to data from Statista Market Insights, Vietnam's domestic semiconductor market revenue is expected to reach USD 31.39 billion by 2029, with a compound annual growth rate (CAGR) of 11.48 percent during the 2024-29 period[1]. Additionally, the Vietnamese government has issued its current development strategy to improve and grow Vietnam's skillset with semiconductor production by 2050 [2]. This course directly addresses this need, producing informed and highly skilled engineers with a specialism of semiconductor best practice and SOTA to inform and build Vietnam's semiconductor future. [1] Ngo Huyen. "*Cong nghiep ban dan Viet Nam buoc vao thoi ky khoi sac moi.*" VnEconomy, November 11, 2024, https://vneconomy.vn/cong-nghiep-ban-dan-viet-nam-buoc-vao-thoi-ky-khoi-sac-moi.htm. [2] Prime Minister's Decision 1018/QD-TTg of 2024 promulgating the Strategy for development of Vietnam's semiconductor industry through 2030, with a vision toward 2050.
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 (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	ELEC5160
Course Title	**Signal integrity, High Speed Digital Design and EMC**
Catalogue Description	Entering the world of digital high-speed communications and data presents challenges not only at the encoding and modulation level, but also within the frequency domain and RF space. This module will teach the principles of Signal Integrity, why it matters, “eye/I” diagrams, S-parameters, and current industry best-practice to mitigate common pitfalls and issues that can arise when designing high-speed systems. Common protocols such as PCIe, DDR, and USB will be investigated and analyzed from a hardware Signal Integrity basis including how SI and PI impact yield, cost and product reliability. The course emphasizes practical strategies including zoning, shielding, filter design, power decoupling, and transmission line termination. Students will also become proficient in advanced PCB design techniques—such as multi-layer stacking, strategic trace routing, and microvia usage—to ensure high-speed performance and noise robustness. Case studies of compliance failures and industry protocols will reinforce the legal and financial implications of EMC design, while preparing students for modern engineering roles in hardware development and testing. *This course offers a rare and highly practical combination of high-speed signal design, electromagnetic compatibility engineering, and real-world regulatory compliance—unlike most top-tier institutions where these topics are fragmented across RF, communications, or circuit design courses. Students not only learn to visualize and solve Signal and Power Integrity issues, but also prepare for industry certification (e.g., CE/EMC) and understand the financial and reputational impact of poor EMI practices. With deep coverage of routing, grounding, shielding, and parasitic control, this course uniquely positions graduates for careers in consumer electronics, medical devices, automotive, and advanced PCB/system design—where EMC compliance is as critical as speed and performance.*
Credit Value	4
Required or elective	Elective
Pre-requisite/ Co-requisite/ Exclusion	Introduction to circuits for electrical engineers. Digital logic and computer organization. Recommended: Digital signal and image processing OR Digital Communication system design.
Textbook(s) and other required materials	1. Horowitz, H. The art of Electronics 2. Armstrong, K. EMC Design Techniques 3. Armstrong, K. EMC for Printed Circuit Boards. 4. OTT, H. Electromagnetic Compatibility. 5. Altium. PCB Design Techniques to Reduce EMI. 6. Armstrong, K. The first 855 “Banana Skins”
Course Learning Goals	Students will: 1. Understand EMC/EI/CE and why it matters for consumer products (Especially for export or use within the EU). Understand industry design best-practice techniques to produce robust EMC and EMI tolerant designs. 2. Be aware of how “accidental antennas” may be formed through visualizing EM waves and fields in the 3D space. 3. Understand Signal Integrity and Power Integrity; and how this can affect the performance of electronics systems.

	4. Understand "Knee frequency", electrical length and other key underpinning principles to make informed design decisions for SI and PI. 5. Be aware of common industry protocols and signal transfer mechanisms for high-speed, noise tolerant communication.
Course Learning Objectives	• Define and visualize circuit parasitics and know the difference between common mode and differential mode noise. • Gain an overview of previous EMC-responsible issues with consumer products, and the adverse effects of legal, financial and reputational damage to the companies responsible. • Knowledge of "zoning" principles and how to protect circuit ground and isolate noisy or fast switching signals. • Understand critical techniques for attenuation, shielding and active compensation. • Understand the need and implementation for power supply decoupling and analysis of power supply transient responses. • Utilize transmission line analysis to determine termination techniques and improve Signal to Noise ratios. • Look at filter design for both passive and active networks to provide hardware solutions. • Investigate "360degree" shielding techniques and market offerings to achieve in real systems. • Become adept at applying strategic routing, PCB stacking and micro via technologies. • Understand industry used techniques to describe and articulate SI and PI.
Topics Covered/ Indicative Syllabus	Topics to be covered: • EMC/EMI/CE compliance • EM field behavior in real-world electronics • Signal Integrity (SI) and Power Integrity (PI) • Parasitics and Noise Modes • Zoning and Grounding techniques, and power decoupling • Attenuation, shielding and compensation. • Advanced PCB design strategies
Class/Laboratory Schedule	
Contribution of course to meeting the professional component	Consumer electronics, especially those used for export or highly critical industries (such as medical, automotive, defense) typically have stringent performance criteria to ensure they don't adversely affect or are affected by other devices. This is ever more critical with higher speeds and data rates – meaning good SI design becomes critical to hardware success.
Assessment Methods in Alignment with Intended Learning Outcomes	• Assignments: 10% • Presentation: 15% • Project: 25% • Midterm: 20% • Exam: 30%
Course Webpage	
Rationale for Offering	Naivety in design techniques can be dramatically costly for businesses, causing many month delays at mature hardware design levels, creating huge financial

	and reputational impact to companies. Hence there is a call for industry to create a new generation of engineers that have an awareness and design products "right-first-time" to avoid costly and lengthy delays-to-market.
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 (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.