Alpha Institute of Technology

Engineering Graduate School of CAEDMI

AIT GRADUATE CATALOG

2024-2026

Course Listing for Mechatronics and Robotics

(Rev. 1.2)

CAEDMI

Central Asia Engineering Dentistry Medicine Institute

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Office of the AIT Academic Affairs

General Courses

G 5001 – Pedagogy and Psychology

This course is designed to s to equip engineering students with the psychological knowledge and skills needed to create technologies that are safe, efficient, and user-friendly. Also, students will study the physiological basis of behavior, including how engineers understand humans in designing systems that align with human physical and cognitive capabilities.

Credit Hour(s): 3
Lecture Hour(s): 3 hours (6 weeks) including practice hours
Semester: Fall
Instruction Type(s): Lecture, Online Lecture, practice
Prerequisite(s):

G 5005 – Technical Writing Essentials for Engineers

This course is designed to equip engineering students with the skills to produce clear, accurate, and informative technical documents, including research methods and proper documentation practices, research reports, project proposals, and feasibility studies. Students are introduced to ethical considerations and legal issues related to technical documentation, such as intellectual property, confidentiality, and plagiarism.

Credit Hour(s): 5
Lecture Hour(s): 3
Semester: Fall
Instruction Type(s): Lecture, Online Lecture, practice
Prerequisite(s): Upper-Intermediate level of spoken and written English

G 5010 – Thesis Writing in English

This course provides thesis writing skills and knowledge needed to complete their M.S. Thesis successfully. Students learn the following components in the classroom: Introduction to thesis writing, literature review, research methodology, thesis proposal development, formatting and submission, and ethical considerations, oral defense preparation.

Credit Hour(s): 5
Lecture Hour(s): 3
Semester: Spring
Instruction Type(s): Lecture, Online Lecture, practice
Prerequisite(s): G 5005: Technical Writing Essentials for Engineers

MeRo 5030 – Engineering Mathematics

This course covers a diverse range of mathematical topics that are essential for early graduate engineering courses. It includes subjects such as linear algebra, systems of ordinary differential equations, Laplace transforms, Fourier series and transforms, and partial differential equations, among others.

Credit Hour(s): 5
Lecture Hour(s): 3
Semester: Fall/Spring (TBD)
Instruction Type(s): Lecture, Online Lecture, laboratory
Prerequisite(s): Basics of Calculus and some familiarity with differential equations.

Major courses

MeRo 5010 – Simulation Techniques for Dynamic systems
This course is designed to provide an introduction to the use of software tools for dynamic system modeling, control system analysis, and design. The course will focus on practical applications in real-world dynamic systems, placing particular emphasis on the development of models, validation processes, parameter identification techniques, effective control algorithms, and presentation of results. Students will gain hands-on experience with various software tools and learn how to apply them to solve complex dynamic system problems.
Credit Hour(s): 5
Lecture Hour(s): 3
Semester: Fall
Instruction Type(s): Lecture, Online Lecture, laboratory
Prerequisite(s): Familiarity with electrical circuit and linear system control
Corequisite(s):

MeRo 5020 – Microcomputer-based (Embedded) Control Systems
This graduate-level course provides a comprehensive introduction to embedded control systems for first-year students, including the fundamentals of embedded control systems. It focuses on technology relevant to mechatronics and robotics control systems, using single-board micro-computers, such as Raspberry Pi- and/or Arduino-based control systems.
Credit Hour(s): 5
Lecture Hour(s): 3
Semester: Fall
Instruction Type(s): Lecture, Online Lecture, laboratory
Prerequisite(s): Electrical circuit and electronics, understanding of hardware and programming language
Corequisite(s):

MeRo 5011 - Linear Control Systems for Mechatronics
This course offers a comprehensive introduction to the principles of linear systems, including an in-depth exploration of transfer functions and Laplace transforms. It delves into the concept of stability and feedback, providing essential design tools for specifying transient response. Furthermore, the course encompasses frequency-domain techniques, offering a thorough understanding of their application.
Credit Hour(s): 5
Lecture Hour(s): 3
Semester: Fall
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s): Familiarity with linear system model, calculus
Corequisite(s):

MeRo 5040 – Sensors and Actuators
This course introduces advanced concepts in sensing and actuation for mechatronic systems. It covers both traditional sensors and actuators, as well as emerging trends in sensor and actuator technology used in Mechatronic systems.
Credit Hour(s): 5
Lecture Hour(s): 3
Semester: Spring
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s): Basic knowledge of electrical circuit, electronics, linear control systems
Corequisite(s):

MeRo 5041 – Mechatronics and Robotic Systems, and Applications
This course provides a comprehensive introduction to the fundamentals of mechatronics and robotic systems. It is designed to expose students to the theoretical knowledge and practical skills necessary to design, analyze, and implement advanced mechatronic and robotic systems. The course covers a wide range of topics, including sensors and actuators, control systems, microcontrollers, and the integration of mechanical, electrical, and computer engineering principles.
Credit Hour(s): 5
Lecture Hour(s): 3
Semester: Fall or Spring
Instruction Type(s): Lecture, Online Lecture, seminars
Prerequisite(s): Basic knowledge of electrical circuit, electronics, linear control systems

MeRo 5050 – Power Electronics
This course covers advanced analysis, design, and control of power electronic systems, providing graduate students with the knowledge and skills to engineer efficient and robust power conversion circuits for various applications in areas like renewable energy systems, motor drives, electric vehicles, and power supplies.
Credit Hour(s): 5
Lecture Hour(s): 3
Semester: Spring
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s): Strong foundation in electrical engineering fundamentals, including circuit analysis, control theory, and MeRo 5010: Simulation technique of dynamic systems.

MeRo 5051 – Energy conversion systems and control
All-electric actuators and drives are being vigorously developed and applied to transportation, robot, aircraft, and naval applications, to name a few, to enhance reliability and efficiency. This course will meet such emerging needs with the science and engineering aspects involved in the modeling, analysis, design, and control of such systems. Furthermore, as a part of the coursework, students will learn and utilize an online motor design tool (EasiMotor) to design AC motors, expecting to have a practical learning experience. I would like to express my gratitude to *EasiTech company* for providing online software that is accessible to students.
Credit Hour(s): 5
Lecture Hour(s): 3
Semester: Fall
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s): MeRo 5011 Power Electronics, Mero 5050 Linear control systems

MeRo PRC6010 – Computer-Aided Design (CAD) for Electro-mechanical Systems
This course equips graduate students with the skills and knowledge to utilize Computer-Aided Design (CAD) software for the design and development of complex electro-mechanical systems, including instruction to CAD, electron-mechanical systems modeling, design optimization, as well as advanced topics (depending on the course), such as finite element analysis, kinematic and dynamics, or electromagnetic simulations, and practical student projects to apply CAD skills.
Credit Hour(s): 5
Lecture Hour(s): 3
Semester: Fall
Instruction Type(s): Lecture, Online Lecture, Laboratory
Prerequisite(s): Understanding of mechanical systems, MeRo 6031 System Dynamics and Mechanism

MeRo 6031 – System Dynamics and Mechanism (Modeling)

This course provides an exploration of modeling multi-domain engineering systems, focusing on a level of detail appropriate for design and control system implementation. Key topics covered include network representation, state-space models, multiport energy storage and dissipation, nonlinear mechanics, transformation theory, Lagrangian and Hamiltonian forms, and control-relevant properties. Practical application examples encompass a wide range of systems, such as electro-mechanical transducers, mechanisms, electronics, fluid and thermal systems, compressible flow, chemical processes, diffusion, and wave transmission.

Credit Hour(s): 5
Lecture Hour(s): 3
Semester: Fall/Spring (TBD: Elective)
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s): MeRo 5030 Engineering Math, Some familiarity with physical system modelling
Reference: Brown, Forbes T. *Engineering System Dynamics*. New York, NY: CRC, 2001. ISBN: 9780824706166.

MeRo 6020 – Introduction to Artificial Intelligence (AI)

This course is designed for students to explore natural language processing, deep learning techniques, and gain a comprehensive understanding of AI's ethical and legal considerations.

Credit Hour(s): 5
Lecture Hour(s): 3
Semester: Fall (elective)
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s): MeRo 5030 Engineering Math, MeRo 5020, and programming languages like Python or other relevant languages
Reference: Wolfgang Ertel (translated by Nathanael Black), *Introduction to Artificial Intelligence 2ND edition*, Springer, 2017.

MeRo 6050 – Power converter modeling and control

This course is an advanced course of power electronics, covering the nonlinear modeling of power conversion circuits of DC-DC converter and DC-AC inverter in theories and simulations. During the course, practical applications and case studies will be presented as well.

Credit Hour(s): 5
Lecture Hour(s): 3
Semester: Fall (elective)
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s): MeRo 5030 Engineering Math, MeRo 5050 Power Electronics, MeRo 5011 Linear Control Systems for Mechatronics

MeRo 6011 – Robotic Systems and control

This course provides the fundamentals of robotic systems and robot control systems, including robot sensors and perception, robot motion planning and pathfinding, and programing and simulation in a virtual environment or based-on case studies of robotic applications in various fields. This course will enable students to work with Robot Operating System (ROS) or similar robotic middleware.

Credit Hour(s): 5
Lecture Hour(s): 3
Semester: Spring
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s): Strong foundation in linear algebra, calculus, and mechanics. Familiarity with programming languages (e.g., Python, C++) is recommended.
Corequisite(s):

MeRo 6012 – Advanced Control of Mechatronics Systems
This course focuses on advanced techniques for controlling mechatronic systems. Key topics include digital signal processing, system inversion-based control algorithms, robustness properties, Youla parameterization, optimal feedforward compensators, repetitive and learning control, adaptive control, and real-time control applications. The course combines theoretical lectures with practical laboratory sessions to provide a comprehensive understanding of these advanced control methods.
Credit Hour(s): 5
Lecture Hour(s): 3
Semester: Fall (elective)
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s): MeRo 5011 Linear Control Systems; MeRo 5041 – Mechatronics and Robotic Systems, and Applications

Research / Thesis Criteria

MeRo 7000 - Research and Development (R&D) Methods for Engineers
This course aims to provide engineering graduate students with the skills and knowledge necessary to conduct thorough and impactful research in their field. It offers an overview of the research process, including formulating hypotheses and research objectives in engineering. Additionally, students are introduced to various research designs and methodologies that contribute to the final outcomes of their research. Engineers also need to be aware of ethical issues and integrity, including plagiarism, text reuse, and data falsification.
Credit Hour(s): 5
Lecture Hour(s): 3
Semester: Fall
Instruction Type(s): Lecture, Online Lecture
Prerequisite(s): G 5005: Technical Writing Essentials for Engineers
Corequisite(s):

MeRo 7001 – Research
Research work for projects and thesis as a degree requirement.
Credit Hour(s): up to 28
Lecture Hour(s): N/A
Semester: 1st, 2nd, 3rd, 4th semester
Instruction Type(s): Independent research work, project related research, Thesis preparation
Prerequisite(s):
Corequisite(s):

MeRo 7002 – Internship
Internship at a company to gain hands-on experiences as a degree requirement.
Credit Hour(s): 3
Lecture Hour(s): N/A
Semester: Spring(2nd)
Instruction Type(s): Research, Online research, laboratory
Prerequisite(s):
Corequisite(s):

Prc 7003 – Practice
Educational and pedagogical practice for graduation requirements.
Credit Hour(s): 9
Lecture Hour(s):
Semester: Fall/Spring
Instruction Type(s): research, Online research
Prerequisite(s):
Corequisite(s):

MeRo 7010 – Dissertation
Master's dissertation work as a degree requirement.
Credit Hour(s): 9
Lecture Hour(s):
Semester: Fall/Spring
Instruction Type(s): research, Online research
Prerequisite(s):
Corequisite(s):

MeRo 8000 – State Examination
State examination as a degree requirement.
Credit Hour(s): 3
Lecture Hour(s):
Semester: Spring(4^{th})
Instruction Type(s):
Prerequisite(s):
Corequisite(s):

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Revision History

Rev.1.2 : MeRo 5041 Description and course semester changed.