E-JUST
EGYPT-JAPAN UNIVERSITY OF SCIENCE & TECHNOLOGY
エジプト日本科学技術大学

Egypt-Japan University of Science and Technology

School of Innovative Design and Engineering

Department of Mechatronics and Robotics Engineering

Postgraduate Program

جامعة بحثية مصرية ... ذات شراكة يابانية

EGYPTIAN RESEARCH-ORIENTED UNIVERSITY
WITH JAPANESE PARTNERSHIP

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M.SC. Program:

M.Sc. students must complete a total of at least 36 - credit hours, within the following guidelines:

- Course work of 18- credit hours, including 6- credit hours as core course, 9-credit hours as elective courses, and a 3-credit hour Laboratory/Project-Based Learning course.
- Thesis work of 18 credit hours

M.Sc. students have to pass successfully six courses with three credit hours each.

Core courses:

MTR 501- Advanced Mechatronics Systems Design
MTR 502- Optimal Control

Elective Courses:

Students select the 9-credit elective courses , from the set Mechatronics and Robotics elective courses. Students can also select, with the aid of their academic advisors, elective courses from other interdisciplinary graduate programs.

MTR 503- Advanced Control Systems
MTR 504- Micro Electro-Mechanical Systems (MEMS)
MTR 505- Mobile Robots and Vision Systems
MTR 506- Advanced Topics in Mechanical Systems Design
MTR 507- Intelligent Robots
MTR 508- Robot Kinematics, Dynamics and Control
MTH 501- Advanced Mathematics and Statistics I

Project-Based Learning Course:

Master of Science students in Mechatronics have to attend successfully the Project Based Learning course to improve their design and professional skills. Students have to present concepts and competitive solutions through the team work spirit. The total credit hours of the course are three.

MTR 701- Project Based Learning in Mechatronics and Robotics

M.Sc. Thesis:

The M.Sc. candidate should prepare and defend a Thesis based on a high-valued research work in one research topic in the fields of Mechatronics and Robotics.

MTR 801 - M. Sc. Thesis

Ph.D. Program

Ph.D. students must complete a total of at least 48 credit hours, within the following guidelines:

- Course work of 18 credit hours, including 12-credit hours as elective courses and 6- credit hours as research seminar course work.
- Thesis work of 30 credit hours.

Students have to attend successfully six courses with three credit hours each (four elective courses and two seminar courses).
Students have to select four courses from the following group (one of them can be from any other graduate program) according to the recommendations of the main supervisor.

Elective Courses:

MTR 601- Intelligent Control Systems
MTR 602- Advanced Robotics
MTR 603- Advanced Bio-Engineering Systems
MTR 604- Bio-Mechatronics Systems
MTR 605-Smart Sensors and Actuators
MTR 606- Nonlinear Control Systems
MTR 607- Learning Algorithms and Neural Networks
MTR 608 Advanced Micro Electromechanical Systems
MTR 609 Fundamentals of Microfluidics and its Applications
MTH 601- Advanced Mathematics and Statistics II

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Advanced Research Seminar Courses:

Ph.D. students have to participate in two seminar activities, which are based on self-learning, and presentations of new advanced topics in her/his discipline. The total credit hours of the seminar are six. The seminar MTR 702 will be conducted by distinguished Japanese and Egyptian Professors, while seminar MTR 703 will be conducted by students through presentations of their research progress or recent journal papers.

MTR 702– Seminar on Advanced Mechatronics and Robotics Systems
MTR 703 –Seminar on Mechatronics and Robotics Recent Research Topics

Ph.D. Thesis:

The Ph.D. candidate should prepare and defend a Thesis based on a high-valued research work in one research topic in the fields of Mechatronics and Robotics.
The Thesis should present a new contribution (s) in the respective field of research.
MTR 802- Ph.D. Thesis

Courses:

MTR 501- Advanced Mechatronics Systems Design

Critical thinking about mechatronic products with case studies. The mechatronic design philosophy applied to real product design cycle. Identification of the need and its types. Transducers, Sensors, and Sensor Fusion, Actuators, and Mechanical Drives, Smart actuators, Motion Control, Modeling and Control of Mechatronic Systems, Comparison between computing devices for mechatronic systems. Designing and building intelligent machines as team projects with open end solutions with emphasis on final group project and building critical thinking skills.

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MTR 502- Optimal Control

An in-depth understanding of the problems in optimal control theory and their applications. Calculus of variations, Pontryagin‘s maximum principle, linear quadratic regulator design, dynamic programming, time-optimal, and output feedback regulating and tracking optimal control techniques for continuous-time systems. Theory of sufficient conditions and the Hamilton-Jacobi-Bellman equations. Discrete-time techniques for calculus of variations, linear quadratic tracking, output feedback optimal control, and time-optimal control. Optimal observers and Kalman filtering.

MTR 503 - Advanced Control Systems

Stability of linear control systems. PID controller design and tuning. State space modeling. Controllability and Observability. State feedback controller and observer design. Least squares system identification. Introduction to nonlinear systems. The Describing function method. The Phase plane method. Introduction to Lyapunov stability theory. Case studies applied to Inverted Pendulum and Magnetic levitation using Matlab and Labview.

MTR 504 –Micro Electromechanical Systems (MEMS)

Micro fabrication: Fabrication technologies for MEMS (surface, bulk micromachining, and LIGA). MEMS Material. structural mechanics. Basic sensing and actuation principles. MEMS packaging, assembly and testing. MEMS markets and applications. Design: MEMS Initial design considerations. Fabrication process design. Mechanical design. Design of micro fluidic network systems with a case study. Computer-aided design in MEMS and Microsystems. Introduction to Coventor Ware for micro device design, fabrication and analysis.

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MTR 505 - Mobile Robots and Vision Systems

Mobile Robots, Kinematic models, Trajectory planning, Navigation Techniques, Simultaneous Localization and Mapping, Behavior Based control structure. Structure of vision systems, Hardware and Software. Camera design, Image formation, Basic Image processing, Stereo Vision, 3D reconstruction methods.

MTR 506- Advanced Topics in Mechanical Systems Design

Modeling of Electro-Mechanical Systems. Electro-Magnetic Bearing Design and Modeling, Nonlinear –Friction, stick-Slip Friction modeling, Mechanical Power transmission systems, Vehicles – Road Dynamics, Parallel Mechanisms,Case studies using ADAMS software.

MTR 507- Intelligent Robots

Design and development of intelligent machines with emphasis on sensor-based control of mobile robots- mechanics, kinematics, and components- sensor characterization, sensory perception- motor sizing, motor control, and simple reactive behaviors-Combining multiple sensory inputs and multiple behaviors-Robot control, perception, localization, planning, mapping, navigation, and learning approaches- Control architectures for cooperative robots- Project.

MTR 508- Robot Kinematics, Dynamics and Control

Analysis and design of robotic systems including arms and vehicles. Kinematics, Inverse Kinematics, and Dynamics of robots. Trajectory planning, motion control and force control of robot. Case studies for solving real problems.

MTR 601- Intelligent Control Systems

Fuzzy control systems, PID + Fuzzy control, Learning and Neural network. Adaptive Neuro-Fuzzy inference system ANFIS. Genetic and evolutionary algorithms for optimization, Case studies for application of

intelligent approaches on control systems design.

MTR 602- Advanced Robotics

(Prerequisite: MTR 508) Static force and compliance, robot dynamics redundancy, trajectory planning, robot control, robot sensing. Sensing systems for grippers including tactile and force sensing. Environmental perception applying sensors and computer vision.

MTR 603- Advanced Bio-Engineering Systems

Bioprocess engineering, Computational bio-systems, Cell and tissue engineering, Nano-biotechnology and biomaterials, Biomedical devices and technologies, Drug development practices and neuroscience.

MTR 604- Bio-Mechatronics Systems

Bio-mechatronics, Bio Interfaces for diagnostics and control. Active and passive prosthetic limbs and joints. Bio electrical signal processing. Haptic Devices. Robot-based surgery. Medical Imaging. Rehabilitation and assistive devices.

MTR 605- Smart Sensors and Actuators

Classification of smart materials: electrostrictive, piezoelectric ceramics, shape memory alloys. Magnetostrictive materials, and electrorheological fluids. Characteristics of smart sensors and actuators. The applied driving forces: electrical, thermal, and magnetic fields – Working principles of the different smart materials.

MTR 606- Nonlinear Control Systems

Mathematical models of nonlinear systems, differences between the behavior of linear and nonlinear systems. Equilibrium points, limit cycles and general invariant sets. Phase plane analysis, Lyapunov stability, Input-to-state stability, Input-Output stability, Passivity analysis the Describing Function Method. Nonlinear control design, including

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Lyapunov-based control, Energy-based control, Cascaded control, Passivity-based control, Input-Output linearization, Variable structure control systems and sliding mode control. Case studies with Matlab and LabView.

MTR 607- Learning Algorithms and Neural Networks

Introduction to Neural Networks, artificial and human neurons, an engineering approach, a simple network layers, perceptrons, the learning process, transfer functions, teaching process, back propagation algorithm for training, recurrent networks, associative memory, applications to speech, vision and control problems. Supervised and unsupervised networks, reinforcement learning.

MTR 608- Advance Micro Electromechanical Systems (MEMS)

MEMS Initial design considerations. Mechanical design, including using the finite element method, Computer-aided design in MEMS and Microsystems (Introduction to Coventor Ware for micro device design). MEMS assembly, packaging, and testing. Design of Passive Micromachined Mechanical Structures. Design of Sensors and Analysis Systems: case study (Pressure Sensors- Acceleration Sensors - Angular Rate Sensors and Gyroscopes - Micromachined Valves and Micropumps).

MTR 609- Fundamental of Microfluidics and Its Applications

Advantages of Microfluidics. The physics and advantages of miniaturization, diffusion, mixing, and separation. The basics electrodynamics of microsystem (the electric-double layer (EDL)). Electro-osmotic flow. Pressure driven and secondary flows in microchannels. Introduce droplet actuation mechanisms. And calculations of electrodynamic forces on a sessile droplet. Microfabrication, materials, soft lithography techniques for microfluidics and digital microfluidic devices. Applications of Lab-on-a-chip, point-of-care, microreactors, and

particle and cell manipulation. Digital microfluidics. Future trends in microfluidics. Simulation of electro-osmotic and pressure driven flows in microchannels using CoventorWare™ CAD.

MTR 701- Project Based Learning in Mechatronics

Students will attend laboratory to do a set of predefined experiments exposingmechatronics devices that will be met during his research work. Students will be grouped into teams to tackle real world projects to solve open ended problems, carefully selected, in which they design the system, select the suitable controller, implement it and evaluate the performance. Students have to present concepts and competitive solutions through the team work spirit and innovative solutions to the assigned projects.

MTR 702- Seminar on Advanced Mechatronics and Robotics

Students will attend lectures given by distinguished professors and study in depth new published papers.

MTR 703- Seminar on Mechatronics and Robotics Recent Topics

Students will read recent papers, present and discuss it with faculty and colleagues recent topics.

MTR 801 – M.Sc. Thesis
MTR 802 – Ph.D. Thesis