



The University of Jordan

School of Engineering

Department of Mechatronics Engineering

B.Sc. Curriculum

In Mechatronics Engineering

2014

Mechatronics Engineering Department

B.Sc. Course Description

0904131	Engineering Graphics	(3 Cr. Hrs.)
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Prereq. (None)

Drawing equipment and use of instruments. Lettering, Geometric construction, Sketching and shape description. Basic descriptive geometry, Developments and intersections. Axonometric, oblique and perspective drawings, Multiview projection, Principal views, Conventional practice, and sectional views. Auxiliary views. Dimensioning techniques. Parallel: Introduction to computer drawing, Drawing aids, Geometrical construction, and the appropriate commands of text, editing, plotting, sections, layers, pictorial views, and dimensioning. Auxiliary views.

0903211	Electrical Circuits (1)	(3 Cr. Hrs.)
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Prereq. (0302102)

Units, definitions, and simple circuits. Circuit analysis techniques. Inductance and capacitance. Source-free RL and RC circuits. The application of unit-step forcing functions. The RLC circuits. The sinusoidal forcing function. The phasor concept. The phasor relationships for R, L, and C. Impedance/admittance. The sinusoidal steady state response. Circuit analysis using matlab and SPICE.

903212	Electrical Circuits (2)	(3 Cr. Hrs.)
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Prereq. (0903211)

Average power and rms values. Polyphase circuits. Three phase Y and Δ connections. Complex frequency. The damped sinusoidal forcing function. Frequency response. Parallel and series resonance. Magnetically coupled circuits. General two port networks. Impedance, admittance, hybrid and transmission parameters. Principles of basic filtering. Basic passive and active filters.

0903219	Electrical Circuits Lab.	(1 Cr. Hr.)
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Prereq./Coreq. (0903212)

DC circuits. KVL. Network theorems. Transient analysis in RL, RC, and RLC circuits. Impedance concept. Power and P.F. Series and parallel resonance. Quality factor. Three phase circuits. power measurement. Parameters of two-port networks. Coupled circuits. Filters.

0904248	Thermal and Fluid Science	(3 Cr. Hrs.)
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Prereq. (0302102)

Introduction; basic principles of thermodynamics, fluid mechanics and heat transfer. Thermodynamics concepts and definitions, properties of pure substances, first law of thermodynamics, system and control volume analyses, second law of thermodynamics. Basic principles of fluid dynamics, conservation laws, basics of dimensional analysis, external and internal flows. Heat transfer modes; conduction, convection and radiation.

0904249	Thermal and Fluid Science Lab.	(1 Cr. Hr.)
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Prereq. (0904248)

Heat pump, Bomb calorimeter, Marcet boiler, Thermal conductivity measurement, Heat exchanger, Crossflow heat exchanger with refrigeration unit, Flow measurements, Impact of water jet, Pump characteristics.

0904314	Dynamics and Vibrations Lab	(1 Cr. Hr.)
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Prereq./Coreq. (0908242)

Static and dynamic balancing. Centrifugal force. Simple and compound pendulums. Bifilar suspension. Center of percussion. Kater's reversible pendulum. Torsional oscillations of single and two rotors system. Vibration of a rigid body spring system. Undamped vibration absorber. Dunkerley's equation.

0904331	Mechanics of Machinery	(3 Cr. Hrs.)
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Prereq. (0908242)

Mechanisms and applications, mobility and linkages. Cams, gears and gear trains. Velocity and acceleration analysis in mechanisms. Inertia forces. Principles of balance in rotating & reciprocating masses.

0907231	Digital Logic	(3 Cr. Hrs.)
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Prereq. (1902099)

Number Systems and digital waveforms. Basic gates and logic functions. Boolean algebra, Boolean expressions. Logic minimization techniques. VHDL basics. Design, simulation and synthesis tools for programmable logic devices. Combinational logic building blocks including decoders, encoders, multiplexers, demultiplexers, magnitude comparators. VHDL for combinational circuits. Digital arithmetic, adders, subtractors. VHDL for arithmetic circuits. Basics of sequential circuits. Basic latches and flip-flops. Timing parameters and diagrams. Counters, shift registers. Basic PLDs, CPLDs and FPGAs architectures. VHDL for binary counters and shift registers. State machines. System design with state machines using VHDL. Memory devices and systems including RAM, ROM, FIFO, LIFO and dynamic RAM.

0907234	Digital Logic Lab.	(1 Cr. Hr.)
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Prereq. (0907231)

Experiments on basic TTL and CMOS logic gates, including simulations to explore functionality and timing parameters. Experiments using both simulation and practical hardware implementation on CPLDs or FPGAs, using VHDL for combinational and sequential circuits including multiplexers, demultiplexers, decoders, encoders counters, shift registers, latches and memory. Experiments in logic design using state machines. Design project using CPLDs or FPGAs.

0908200	Introduction To Engineering	(2 Cr. Hrs.)
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Prereq. (None)

This course covers several topics including the history of engineering, Mechatronics engineering: evolution and relationship with other disciplines mainly planning and management, types of engineering, engineering design, engineering ethics, the proper use of

engineering tools including computers and computer simulations, as well as tools for inventive problem solving, creative and critical thinking including mind mapping, team work skills and an introduction to project management.

0908243	Engineering Materials and Manufacturing Technology	(3 Cr. Hrs)
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Prereq. (0302101)

Fundamental of mechanical behavior of material, Structure and manufacturing properties of metal-Phase diagrams and heat treatment, Casting processes, Bulk deformation processes: forging, drawing, rolling, and extrusion. Sheet metal forming processes: blanking, piercing. Metal removal processes: Turning, drilling, milling, shaping, broaching.

0908231	Computer Applications for Mechatronics	(1 Cr. Hr.)
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Prereq. (1931102)

Introduction to Matlab; Script files (m); Variables; Strings; Arrays and vectors; Operators, expressions and statements; Decisions (if statements); Loops (for statements); Logical operators; Complex numbers; Operations on matrices; Plotting (two dimensional and three dimensional); Inputs and outputs; Functions; Engineering applications: practical exercises will be given on Matlab, with other softwares as necessary (e.g. Simulink, labVIEW); Introduction to simulink.

0908351	Systems Dynamics	(3 Cr. Hrs.)
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Prereq. (0301202+0908231)

This course provides the student the knowledge of the mechatronic systems engineering: mechanical, electrical and electronics components. Analytical and adaptive dynamics as the basis for the control algorithm development and a mechatronic system design. This course provides the mechatronic students with Mathematical descriptions of physical systems' behavior including mechanical, electrical, thermal, and fluid systems and their combinations; system descriptions using state variable and transfer functions; analysis of system responses: convolution integral, frequency response, numerical simulations, Laplace transform methods, Block diagram and signal flow representation ; systems concepts: input-output, causality, and analogies; general process descriptions including first-order, second-order, and time delayed, Advanced topics in analytical and adaptive dynamics are presented in the course including direct and inverse dynamic problems, stability of mechatronic systems, others.

0908241	Statics and Strength of Materials	(3 Cr. Hrs.)
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Prereq. (0302101)

Force vectors, force system and resultants, equilibrium, structural analysis, geometric properties and distributed Loadings, internal Loadings, stress and strain, mechanical properties of materials, axial load, torsion, bending, transverse shear, combined loadings, stress and strain transformations, design of beams, buckling of Columns.

0908242	Dynamics and Vibrations	(3 Cr. Hrs.)
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Prereq. (0908241)

Kinematics of particles, kinematics of rigid bodies, kinetics of particles, kinetics of rigid bodies, free and forced vibration of systems with a single degree of freedom, vibration of systems with two or more degrees of freedom, vibration of continuous systems.

0908311	Engineering Numerical Methods	(3 Cr. Hrs.)
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Prereq. (0301202+0908231)

Mathematical preliminaries, numerical errors and loss of significance and error propagation. Review of linear algebra. Numerical solution of nonlinear algebraic equations. Numerical solutions of systems of linear and non-linear algebraic equations. Interpolation and approximation and curve fitting. Numerical differentiation and integration. Numerical solution of differential equations. Eigen value problems. Introduction to numerical solution of partial differential equations. Engineering applications.

0908352	Measurements and Signal Processing	(3 Cr. Hrs.)
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Prereq. (0908222)

Review of Mechanical and Electrical Engineering units. Overview of metrology and measurement. Errors & error analysis, uncertainty analysis, statistical methods and least square method. Instrumentation: characteristics (statics and dynamics), operational modes, measurement accuracy, and measurement standards. Electrical instrumentation for measuring: current, voltage, power, resistance, capacitive, and inductive quantities. Signal processing techniques: operational amplifiers, signal conditioners, modulation, filters, A/D, and spectrum analysis. Overview of Data acquisition systems.

0908222	Electronics For Mechatronics	(3 Cr. Hrs.)
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Prereq. (0903211)

Solid-state theory, semiconductors, PN junctions; basic diode circuits; LEDs. Basic power supplies. Half wave and full-wave basic rectifier circuits. Basic BJT transistor, types of BJTs, BJT transistor biasing; Zener diodes and basic Zener circuit; series regulator, Series-shunt regulators. Single stage and multistage amplifiers. Operational amplifiers and applications. FET transistors. JFET drain curves, gate bias and self bias. JFET AC characteristics.

0908322	Electronics Lab for Mechatronics	(1 Cr. Hr.)
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Prereq./Coreq. (0908222)

Rectification. Regulation and clipping. BJT characteristics. Bjt biasing and large-signal amplification. BJT as an amplifier. FET as an amplifier. Cascaded amplifiers. Frequency response of amplifiers. Feedback amplifier. Differential amplifier. Op-Amp Applications. Projects.

0908323	Electrical Actuators	(3 Cr. Hrs.)
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Prereq. (0903212)

Magnetic circuits; single-phase and three-phase transformers: Principles, analysis, performance characteristics and testing; electromechanical energy conversion; principles and classification of DC generators; DC motors: analysis, performance characteristics, starting, testing and speed control; synchronous motors: analysis, performance characteristics, applications, starting, and testing; three-phase induction motors: analysis, performance characteristics, testing, starting and speed control; single-phase induction motors; special types of motors: stepper motors, universal motors, reluctance motors, burshless DC motors.

0908324	Actuators Lab	(1 Cr. Hr.)
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Prereq./Coreq. (0908323)

Transformer characteristics. Testing and operational characteristics of DC motors. Testing and operational characteristics of alternators. Testing and operational characteristics of induction motors. Modeling and simulation of electrical machines using Simulink with external mechanical loads.

0908421	Power Electronics and Drive	(3 Cr. Hrs.)
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Prereq. (0908222 + 0908323)

Principle of operation of: power semiconductor devices; single-phase and three-phase uncontrolled and controlled rectifiers feeding resistive and inductive loads; step-down (buck) and step-up (boost) DC-DC converters; AC voltage controllers; half-bridge and full-bridge single-phase and three-phase inverters feeding inductive loads; DC motor drives; AC motor drives.

0908423	Power Electronics and Drive Lab	(1 Cr. Hr.)
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Prereq./Coreq. (0908421)

Introduction to the power electronic components (SCR, Diode, IGBT). Speed and torque control of a DC motor with a load. Inverter control of an induction motor. Modeling and simulation of electrical drives systems and electrical machines using Simulink with external mechanical loads.

0908431	Microprocessors and Microcontrollers	(3 Cr. Hrs.)
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Prereq. (0907231)

Embedded systems characteristics. Microprocessors versus micro controllers. Micro controller characteristics. General-purpose micro controllers. Interrupts, counters/timers, Input/output ports. Microcontroller programming. Instruction set. Program development and use of assemblers. Memory maps and addressing modes. Digital to analogue and analogue to digital conversion in micro controllers. Data acquisition and distribution. Serial and parallel communications. Real-time system and its constraints. Interfacing to external devices. Power consumption consideration. Applications. Discussion, one hour weekly.

0908432	Microprocessors and Microcontrollers Lab.	(1 Cr. Hr.)
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Prereq./Coreq. (0908431)

Introduction to embedded systems design tools and hardware programmers. Experiments using both simulation and practical implementation of the basic building blocks of a microcontroller including timers, counters, PWM generation, I/O techniques and requirements, A/D conversion, serial communications. Experiments to explore the system design process using hardware-software co design process. Design project.

0908353	Automatic Control	(3 Cr. Hrs.)
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Prereq. (0908351)

Review of transfer functions. Response of high order systems and Dominant poles. Overview of feedback control systems, performance indices (time, complex, and frequency), testing signals, and objectives of control systems. Signal flow representation and Mason's gain formula. Linearization of nonlinear systems. Stability Analysis using: Routh-Hurwitz criterion, root locus, and Nyquist criterion. Introduction to multivariable systems. Controller design overview and configuration, feedback and feedforward, PID controller design and tuning techniques, Phase lead controller, phase lag controller, pole zero

cancellation. Applications: (first, second and higher systems) motion control, level control, environment control, stability ...etc. Design project.

0908453	Control Lab.	(1 Cr. Hr.)
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Prereq./Coreq. (0908353)

The lab consists of experiments that are related to: First and second order system analysis control experiments, Servo Systems, Stability of dynamical systems. System identification. Design and tuning of PID controller in closed-loop Systems. Simulation of systems using Simulink or Matlab.

0908454	Modern and Digital Control Systems	(3 Cr. Hrs.)
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Prereq. (0908353)

State variable representation of dynamical systems. Steady state and transient response. Stability analysis, Liapunov stability criterion. Controllability and Observability concepts. Pole placement technique. Control. Sensitivity analysis. introduction to system identification. Digital Control: review of z-transformation, discretization of systems. Discrete systems response using z-transforms. Stability analysis. System identification. Realization of digital controllers. State space representation of discrete systems, simulation techniques of systems.

0908451	Transducers and Sensors	(3 Cr. Hrs.)
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Prereq. (0908352)

Classification of transducers; transducer devices for measuring: temperature, pressure, level, flow rate, stress, distance, speed, shock, and vibration.

0908452	Measurements and Transducers Lab	(1 Cr. Hr.)
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Prereq./Coreq. (0908451)

Experimental methods on the following systems: pressure measurement, flow measurement, temperature measurement, strain gauges, strain rosettes. Signals display equipment and Function generators. Sensor Technologies, Characteristics, Signal conditioning & processing, Calibration.

0908531	Artificial Intelligence	(3 Cr. Hrs.)
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Prereq. (0908353)

Introduction to Neural Networks (NN). Unsupervised Learning, Supervised Learning, Backpropagation and applications. Fuzzy systems: fuzzy set theory, fuzzification. Fuzzy inference rule. Fuzzy rule based expert systems. Defuzzification NN control. Fuzzy control. Neuro-fuzzy control. Genetic algorithms (GAs). Case studies.

0908461	Automation and Programmable Logic Controllers	(3 Cr. Hrs.)
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Prereq.: (0908353)

Introduction to production concepts, serial production lines, assembly systems and types of automation. Programmable Logic Controllers (PLC). Computer Numerical Control (CNC). Industrial Robots. Automated Material Handling Systems. Automated Storage and Retrieval Systems.

0908462	Automation and Process Control Lab.	(1 Cr. Hr.)
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Prereq./Coreq. (0908461)

Automation Lab experiment Concentrate on the concept studied in Course and other especially ; Wiring & Programming different type of PLC on different Applications, Connect some types of PLC with SCADA system , CNC , Machine Vision (Image Processing) .

0908463	Fluid Power Engineering	(3 Cr. Hrs.)
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Prereq. (0904248)

The objective of this course is to familiarize students with fluids, the flow of fluids, hydraulic and pneumatic systems and actuators and controllers from a mechatronic perspective. This course provides the student with the basic knowledge concerned with structure, modeling, and principles of the performance, function, and applications of all hydraulic and pneumatic components (valves; pumps; linear and rotary motion).

0908464	Fluid Power Engineering Lab	(1 Cr. Hr.)
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Prereq./Coreq. (0908463)

Applications of all hydraulic and pneumatic components (valves, pumps, linear and rotary motion). The students are introduced to symbols, circuits, the principle of design and construction. Modeling and design of hydraulic, electro-hydraulic, and pneumatic control circuits.

0908561	Mechatronics Systems	(3 Cr. Hrs.)
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Prereq. (0908431+0908451)

Mechatronics system's design concepts (mechanics, electronics, pneumatics, hydraulics, and control). Microcontroller's based systems. Applications on motion control, Pneumatic actuator control, sensor interface ...etc. A Mechatronics integrated final project design and implementation (combines theoretical and practical applications with real world constraints).

0908562	Mechatronics Systems Design Lab	(1 Cr. Hr.)
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Prereq./Coreq. (0908561)

Application on Mechatronics system's design concepts (mechanics, electronics, pneumatics, hydraulics, and control). Construction of Microcontroller's based systems. Applications on motion control, Pneumatic actuator control, sensor interface ...etc using microcontrollers. A detailed report should be submitted. Presentations of all groups' works are required.

0908563	Robotic Systems	(3 Cr. Hrs.)
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Prereq. (0908353+0908311)

Introduction and an overview of robot types and their applications, robotic terminologies, kinematic configuration, kinematic analysis, forward & inverse dynamical analysis. Lagrange formulation, Newton-Euler Method. Path planning and motion programming. Robot arm joint control. Overview of Robot Programming. Introduction to vision systems.

0908422	Advances Drive Systems	(3 Cr. Hrs.)
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Prereq. (0908421)

Electric drive system components; Drive system mechanical loads; Load torque and moment of inertia calculations for different types of motion; DC and AC motors

torque-speed characteristics; DC and AC motors starting, braking & reversing methods; studying dynamic characteristics of DC and AC motors; Automatic DC and AC motors starting, braking & reversing using timers; DC and AC motors speed control using power converters; closed-loop control systems.

0908433	Field Programmable Gate Arrays (FPGA)	(3 Cr. Hrs.)
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Prereq. (0907231)

HDL (hardware description language) and FPGA (field-programmable gate array) devices allow designers to quickly develop and simulate a sophisticated digital circuit, realize it on a prototyping device, and verify operation of the physical implementation. As these technologies mature, they have become mainstream practice. We can now use a PC and an inexpensive FPGA prototyping board to construct a complex and sophisticated digital system. This course uses a “learning by doing” approach and illustrates the FPGA and HDL development and design process by a series of examples. A wide range of examples is included, from a simple gate-level circuit to an embedded system with an 8-bit soft-core microcontroller and customized I/O peripherals.

0908481	Autotronics	(3 Cr. Hrs.)
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Prereq. (0904248)

Basics of automobile and engine operation. Testing and measurement of automotive engines. Fuels and combustion. Pollution: measurement and control. Ignition systems. Fuel supply systems. Cooling system. Design and control of suspension systems passive and active, steering systems, brake systems (ABS), differential gear box, navigation systems, air conditioning and car safety equipment.

0908551	Fluid Power Control	(3 Cr. Hrs.)
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Prereq. (0908463)

Servodrives in hydraulic systems: analysis and design. Basic compressible flow equations. An overview of the Pneumatic systems analysis and design. Fundamentals of Pneumatic control: circuit diagram, sequence control, single and double acting cylinders related controls. Fluidics (logic in pneumatic systems). Pneumatic systems traditional sensors. Design of cascaded systems. Applications: Clamping fixture on a drilling apparatus, sliding door, transporting of section material, drilling and reaming of hinged parts, and elevator control. Design, simulation, and implementation in laboratory.

0908545	Industrial Process Control	(3 Cr. Hrs.)
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Prereq. (0908353)

Mathematical models of chemical systems: (CSTRs) two heated tanks, series isothermal, constant hold up, gas phase, pressurized, nonisothermal, vaporizer, reactors, distillation column, and PH systems. Overview of control instrumentation (sensors, transmitters, valves), multivariable processes, multivariable systems. PID controller design and PID tuning techniques, multivariable controller design and tuning techniques. Applications in the process control laboratory.

0908564	Integrated Systems Design	(3 Cr. Hrs)
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Prereq.: (0908561)

Engineering design methodology: Product life cycle, design models, design process, interface specifications (boundary conditions), modular design, component design/selection, implementation to form a system, design hierarchy, system verification, integration and verification problems, installation and validation, and operation and maintenance, failure mode analysis.

0908466	Micro-Electro-Mechanical Systems (MEMS)	(3 Cr. Hrs.)
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Prereq./Coreq. (0908351)

An overview of MEMS. Material and Fabrication Techniques: MEMS materials, silicon, metals and metal alloys, polymers, Fabrication Techniques, deposition, lithography, etching, bulk and surface micromachining, wafer bonding, thick-film screen printing, electroplating, LIGA, porous silicon, electrochemical etch stop, focused ion beam etching and deposition, polymeric micromachining, three dimensional microfabrication. MEMS Sensors: Mechanical transduction, piezoresistivity, piezoelectricity, capacitive techniques, optical techniques, resonant techniques, vibration excitation and detection mechanisms, resonator design characteristics, pressure sensors, force and torque sensors, inertial sensors, flow sensors. MEMS Actuators: Actuation techniques, electrostatic piezoelectric, thermal, magnetic, switches and relays, micromotors, micropumps, robots. Modeling MEMS Devices: Dimensional analysis, scaling and scaling laws, thermally driven systems, modeling elastic structures, coupled thermal-elastic systems, electrostatic-elastic systems, magnetically actuated systems, microfluidics, lumped models, limits of continuum mechanics.

0908589	Selected Topics in Mechatronics	(3 Cr. Hrs)
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Prereq. (Consent of Department)

The content of this course will be outlined after the approval of the department council.

0908598	Project	(3 Cr. Hrs)
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Prereq. (Completing successfully 120 Cr. Hrs. from the students plan)

In part one; a problem will be assigned to the student in one of the different Mechatronics engineering tracks. He will be asked to rely on himself to find a solution for the problem (which could be practical or theoretical). It is expected from the student to develop the abilities of research and independent work and to train himself to observe a time table to perform his project and to be capable to explain and express his findings in a professional manner.

In part two, student is required to finish the work he started in part one. Student is required, whenever it is possible, to use the appropriate and available software to solve his problem, simulate his solution, to build a prototype and perform all needed measurements. The student will be required to write down his final year project as a complete report (dissertation) according to the department instructions and standard.