

Philadelphia University

Faculty of Engineering

Mechatronics Engineering Department

Course Description 2012

| Course number | Course name | Credits | Description | Prerequisites |
|---------------|------------------------------|---------|---|---|
| 610211 | Electric Circuits 1 | 3 | Basic concepts (charge, current, voltage, power energy). Circuit elements (independent and dependent voltage and current sources. Resistors. Capacitors. Inductors). Kirchof Voltage and Current Laws (KVL and KCL). Mesh and Nodal circuit analysis. Network theorems. Transient analysis of RL, RC, and RLC circuits. Introduction to AC circuits. | Applied physics (211104) |
| 610212 | Electric Circuits 2 | 3 | Periodic waveforms. Phasor analysis, RMS and average values, maximum power transfer, sinusoidal analysis of inductive and capacitive reactance, impedance, phase angle, series and parallel AC circuits. AC power analysis. AC response of RL, RC and RLC circuits. Impedance concept. Resonance. Steady state analysis of AC circuits. Coupled circuits. Three Phase circuits. Fourier analysis. Laplace analysis. Two-Port networks. Circuit analysis in computers. | Electric Circuits1 (610211) |
| 610216 | Electric Circuits Lab | 1 | Experiments that work with DC circuits and implement/analyze theoretical results for KVL and KCL. Mesh and Nodal. Transient analysis of RL, RC and RLC circuits. AC circuits. | Electric Circuits1 (610211) |
| 610550 | Engineering Entrepreneurship | 3 | Basic Concepts of macro & micro economics, economy architecture, production process, the effect of science and technology on production, the use of science and technology in production, skills, free business, services and commodities production, methods of project propagation, marketing studies, export, import and interior market consumption, project forming, project requirements, economic appraisal studies, project financing, banking, companies, cost studies, project management, marketing. | Engineering Skills (640253) + 120 hours |
| 620131 | Engineering drawing | 3 | Instruments and their use. Graphic geometry. Lettering. Orthographic and isometric drawing and sketching. Sectional views. Introduction to descriptive geometry. Surface intersections and Developments. Computer (ACAD) | None |
| 620171 | Engineering Workshop (1) | 1 | Development of basic skills in fields of: hand filing, turning, welding, piping and plumbing, carpentry, sand casting, glass works, sheet metal fabrication, metal forming. | None |

| | | | | |
|--------|---|---|---|-----------------------------------|
| 620172 | Engineering Workshop (2) | 1 | Household electric circuits. Florescent lamps circuits, parallel and series circuits, switches and fuses installations, electronic welding, electronic devices maintenance and circuit-boards design. | Engineering Workshop (1) (620171) |
| 620211 | Statics | 3 | Introduction to mechanics of rigid bodies. Basic concepts; force and displacement vectors, force systems, equivalent force systems, static equilibrium, analysis of simple structures, friction, geometric properties; centroids and moments of inertia. | Calculus (1) (250101) |
| 620239 | Mechanical Drawing | 1 | Auxiliary views, temporary fasteners (threaded members, keys, feathers, splines, rivets, cotters and springs), their construction and standard, power screws and welding symbols, dimensioning, tolerances, limits and fits (ISO system), detailed and working drawing, assembly drawing. 3-D drawing. | Engineering Drawing (620131) |
| 620333 | Machine Theory | 3 | Kinematic analysis of mechanisms, velocity and acceleration polygons, static and inertia, force analysis of machinery. Dynamic analysis of cams, gears, gear trains, balancing of machines, governors. | Dynamics and Vibrations (640233) |
| 630211 | Logic Circuits | 3 | Number Systems: decimal, binary, octal and hexadecimal. Boolean Algebra: basic identities and algebraic manipulation. K-map simplification. Combinational circuits design with MSI components. Sequential circuits analysis and design. Counters and registers, flip flops. | Programming Languages (630263) |
| 630262 | Engineering Analysis II | 3 | Matrices, determinants, solution of linear and nonlinear equations. Direct and iterative solutions. Interpolation and curve fitting. Numerical integration and differentiation. Numerical Solution of differential equations. | Engineering Analysis I (650260) |
| 630263 | Programming languages | 3 | C and C++ Programming Environment: compiled language, program creation, structure of programs, problem solving techniques, elements of C++ programming language, operands of C++, expressions, program design process, control structures, looping, functions, C++ stream input/output, structured types, data abstraction and classes, arrays, pointers, dynamic data and reference types, file processing, templates. | None |
| 630512 | Real-Time Systems | 3 | Introduction to real-time systems. Time handling. Objects. Real-time applications. Real-time system lifecycle. Structured design approaches. Petri Net models. Language support and restriction. Verification & Validation of real-time software. Real-time operating systems. Allocation & Scheduling Applications. | Automatic control (640344) |
| 640221 | Programming for Mechatronics Laboratory | 1 | Building, Simulating, and Testing C++ programming and MATLAB/Simulink exercises. Emphasize is given to mechatronics systems. | Programming languages (630263) |

| | | | | |
|--------|------------------------------------|---|---|---|
| 640233 | Dynamics and Vibrations | 3 | Newton's laws. Kinematic of particles, equilibrium of particles, kinetics of particles, work and energy, rotational motion, impulse and momentum. Kinematics of rigid bodies, kinetics of rigid bodies, equilibrium of rigid bodies, rotational motion, work and energy, impulse and momentum. Vibration principles, vibration types, free and forced vibrations (harmonically excited motion, rotating and reciprocating unbalance), vibration measurements. | Statics (620211) |
| 640235 | Mechanics of Engineering Materials | 3 | Introduction to various stresses, principal stresses, Mohr circle, properties of materials, stress and strain curves, axial stress, shear stress, bending stress. Structure of metals and crystallized. Materials used in engineering applications. The collapse of material during loading, thermal treatment processes. Structure of alloys. Plans for the balance of iron and equivalent carburetor, heat treatment of steels. | Statics (620211) |
| 640242 | Instruments and Transducers | 3 | Measurements and statistics (error, sensitivity, accuracy, resolution, and precision); signal conditioning (amplifiers, filters, and bridge circuits); analog sensors (proximity, thermal, pressure, flow and strain gauges); analog-to-digital conversion; digital encoders (position and speed); optical and ultrasonic sensors. | Electronics1 (650242) |
| 640253 | Engineering Skills | 3 | Introduction to engineering, problem solving skills, engineering design, engineering skills (personal and analytical), technical report writing, communication skills (presentation skills), engineering ethics, project management. | English 2 (130102) |
| 640312 | Power Electronics and Drive | 3 | Steady-state characteristics of SCR devices. Triggering Circuits, SCR commutation methods. Controlled Rectifiers. AC voltage controllers. DC choppers. AC to DC Converter (Inverter), cycloconverters applications. Triac devices and applications. DC drives, AC drives. | Electronics 1 (650242) |
| 640314 | Electric Machines for Mechatronics | 3 | Single-phase and three-phase transformers. DC motors and generators. Single-phase & Three-phase AC motors (Induction and Synchronous). Special machines (stepper motors and universal motors). Electromagnetic theory. | Electronics 1 (650242) |
| 640327 | Modeling Simulation and Interface | 3 | Modeling definition. Modeling of different physical systems (mechanical, fluid, thermal and electrical). Differential and Laplace equations. State Space representation, state model from linear graphs Computer simulation techniques (applications using MATLAB Program). System response and analysis. PC Interface through DAQ cards | Dynamics & Vibrations (640233) + Instruments & Transducers (640242) |

| | | | | |
|--------|------------------------------------|---|---|---|
| 640328 | Microprocessors & Microcontrollers | 3 | General architecture for microprocessors and microcontrollers, interfacing and programming microcontroller systems, programming and downloading PIC microcontrollers using Assembly and C languages. DC motor control (position and speed). A/D interface. Timing and interrupt. | Logic Circuits (630211) + Sensors & Actuators (640242) |
| 640333 | Industrial Electronics | 3 | Solid state devices in industrial logic, PLCs (introduction), Solid state devices to control Power SCRs, UJTs, TRIACs, Power Transistors, Solid state devices for firing circuits, Photoelectronics, Input Devices, signal conditioning, circuitry, output devices, data communications. | Electrical Machines for Mechatronics (640314) + Power Electronics and Drives (640312) |
| 640335 | Thermofluids | 3 | Introduction to first and second law of thermodynamics, modes of heat transfer, one-dimensional conduction heat transfer, introduction to convection heat transfer, boiling and condensation, internal flow heat exchangers. Fluid and gas properties, Equation of: Continuity, Momentum and Energy. Introduction to boundary layer theory. Introduction to viscous fluid flow. Turbomachinery. | Statics (620211) + Engineering Analysis I (650260) |
| 640337 | Mechanics & Vibration Lab | 1 | Experiments related to Dynamics and Vibrations. Pendulum. One degree of freedom free vibration. Logarithmic Decrement. One degree of freedom harmonic excitation. Unbalance experiment. Torsion test. Thermal conductivity. Material properties and stresses. | Dynamics and Vibrations (40233) |
| 640344 | Automatic Control Systems | 3 | Mathematical background (complex variables, differential equations, Laplace transforms); Modeling of dynamic systems (mechanical and electrical systems); Block diagrams and signal flow graphs; Time domain analysis (steady state and transient response). Root locus, PID control stability. Frequency response. | Modeling and Simulation (640327) |
| 640350 | Engineering Project I | 1 | A 3rd year project where the students are taught the basic skills for simple designs and are asked to implement a project | Dynamics and Vibration (640233) + Electronics I (650242) |
| 640415 | Machines and Power Electronics Lab | 1 | Experiments for Single phase and three phase Transformers. DC Motors (Shunt, series, and compound), Single Phase & Three Phase Ac Motors (Synchronous and Induction). MISSING POWER ELECTRONICS Experiments? | Electric Machines for Mechatronics (640314) + Electronics lab (650343) |
| 640424 | Machine Intelligence | 3 | Neural networks and Fuzzy logic. Industrial applications for machine intelligence, new trends in machine intelligence. Applying Fuzzy and Neural techniques for control application using MATLAB/Simulink Toolboxes. | Automatic Control Systems (640344) + Programming languages (630263) |
| 640432 | Mechanical Design | 3 | Introduction to design processes. Fit and tolerance. Review of stress and deflection analysis. Prevention of failure due to static loads. Prevention of failure due to fatigue and dynamic loads. Threaded connections and fasteners. Welded and riveted joints. Mechanical | Machine Theory (620333) |

| | | | | |
|--------|--------------------------------|---|--|--|
| | | | springs. Design of shafts and pulleys. Rolling and sliding bearings. Gear design. Friction drives. Flexible mechanical elements. | |
| 640435 | Pneumatic & Hydraulic Systems | 3 | Fluid systems. Properties of hydraulic fluids. Components of hydraulic systems. Components of Pneumatic systems, hydraulic circuits, pneumatic circuits, electrical control of hydraulic & pneumatic circuits, PLC. Control of hydraulic & pneumatic circuits. | Thermofluid (640335) + Automatic Control Systems (640344) |
| 640441 | Digital Control | 3 | Digitization and sampling. Discrete system analysis (difference equations, discrete transfer function, Z-Transform, block diagrams, system response, and stability). Discrete equivalents (numerical integration, zero-pole mapping, and hold). Design (Root Locus, and frequency response). PID controller design. Controller realization and microcontroller implementation | Automatic Control Systems (640344) |
| 640442 | Automatic Control Lab | 1 | Experiments in servo control valve & open loop position control. Position control (PID). Speed control (PID). Pressure control (PID). DC motor control. MATLAB/Simulink applications. LABVIEW applications. | Automatic Control Systems (640344*) |
| 640445 | Programming Logic Controllers | 3 | PLC operations principles; Memory systems and I/O interaction (structure, organization, configuration, and interaction). Discrete I/O (racks, instructions, and types). Analog I/O (instructions, data representation and handling). PLC programming (ladder diagrams format, timers/counters, arithmetic and logic operations, and flow control). IEC standards. Industrial applications. | Microprocessors and Microcontroller Systems (640328) |
| 640446 | Microprocessor and Sensors Lab | 1 | Experiments in the principles of different sensors and transducers with conditioning circuits design. Microcontroller programming, simulation and download. Interfacing microcontrollers with sensors and actuators | Microprocessor and Microcontroller (640328) + Electronics Lab I (650343) |
| 640447 | Mechatronics System Design | 3 | Overview of mechatronics system. Design methodology. Actuators (review and selection). Sensors (review and selection), Control systems (overview and selection of physical controllers and control algorithms). Interconnection and interfacing Systems. Case studies | Programmable Logic Controllers (640445) + Automatic Control Systems (640344) |
| 640450 | Engineering Training | 0 | Practical training at an engineering firm for 8-weeks within Jordan and 6 weeks outside Jordan. | 90 credit hours + Department approval |
| 640458 | Reverse Engineering | 3 | System RE (RE steps, product teardown, functional models, bill of materials, subtract and operate). Mechanical RE (Rapid prototyping, CAM/CAD, conventional vs. nonconventional development). Electronic RE (Methods, PCB, electronic components, and VHDL). Software RE (applications, S/W RE basics, and RE tools) | Engineering Project I (640350) |
| 640462 | Process Control and Automation | 3 | Pressure, temperature, flow and level control. Process | Automatic Control Systems (640344) |

| | | | | |
|--------|------------------------------------|---|--|---|
| | | | control methods (open and closed loops). Pneumatic, electronic (Analog), and digital electronic controllers are studied and applied to specific processes. Transmitters, positioners, valve operators, and controller mechanisms which produce proportional, rate, and reset responses are studied. Techniques of obtaining optimal controller settings are studied. | |
| 640524 | Computer Manufacturing Technology | 3 | Solid modeling, transformation, rotation, scaling, windowing, simulation and animation of mechanical problems. Optimal synthesis and selection of machine elements. Applications and individual problems. Implementation of CAD package for visualization. Simulation & animation of specific types of machine units. Basic concepts of CNC and, DNC, Programming CNC milling using G code, Programming CNC lathe using G code, APT programming. | Workshop(2) (620172) + Mechanical Design (640432) |
| 640531 | Automation & Fluids Control Lab | 1 | Experiments to illustrate the following: Pressure vs. force relationship. Pressure drop vs. flow relationship. Directional and speed control of cylinders. Indirect control using Pilot-Operated valves. Pneumatic motor circuits. Basic memory and Priority electro pneumatic circuits. Time-Delay electro pneumatic applications. Counter electro pneumatic applications. PLC in electro pneumatic systems. PLC programming. | Pneumatic & Hydraulic Systems (640435*) |
| 640542 | Robotics and Automation | 3 | Robot system components; sensors and actuators; Robot manipulators (spatial descriptions and transformations, kinematics and inverse kinematics, trajectory planning and control). Robotics use in automated industrial systems; Autonomous mobile robots (locomotion, kinematics, perception, and planning and navigation) | Programmable Logic Controllers (640445) + Automatic Control Systems (640344) |
| 640543 | Signal Processing for Mechatronics | 3 | Analog signal processing (signal conditioning, design and analysis of passive and active filters); Sampling and quantization; Digital signal processing (signals and systems properties, convolution, Z-transform, and DFT/FFT); FIR and IIR filter design and implementation; DSP architectures (fixed point vs. floating point); | Digital Control (640441) |
| 640544 | Mechatronics System Design Lab | 1 | Experiments that allow students to use the knowledge gained throughout his studies in the design of mechatronic systems. This includes components selection, interface, and programming controllers. | Microprocessors and Sensors Lab (640446) + Mechatronics System Design (640447*) |
| 640551 | Engineering Project II | 1 | Students are required to design a mechatronics-related project. This includes the theoretical analysis and simulation. | Engineering Project I (640350) +120 hours |
| 640555 | Engineering Project III | 2 | A continuation of Engineering Project II where the student is asked to implement and test a mechatronics prototype | Engineering Project II (640551) + Mechatronics System Design (640447) |

| | | | | |
|--------|--------------------------------|---|---|---|
| 640593 | Special Topics in Mechatronics | 3 | New trends in Mechatronics Engineering (topics to be selected by department) | Department Approval |
| 650163 | Basic Engineering Analysis | 3 | Complex functions. Mapping. Integration in the complex plane. Taylor and Laurent expansion. Singularities and the residue theorem. Eigen values and eigenvectors | Calculus (2) (250102) |
| 650242 | Electronics 1 | 3 | Semiconductor diode circuit analysis, semiconductor diodes rectifiers, zener diodes, clippers, clampers. Bipolar junction transistor (BJT), models biasing circuits. Common emitter amplifier. Common collector amplifier. Common base amplifier. Design of BJT amplifier. Field effect transistor (FET) & MOSFET, operation. Biasing and FET amplifiers. Design of FET amplifier. Introduction to OP-AMP & its applications. | Electric Circuits 1 (610211) |
| 650260 | Engineering Analysis (1) | 3 | Differential equations. Second and higher order differential equations. Power series method, Laplace transform. | Calculus (2) (250102) |
| 650343 | Electronics 1 Lab | 1 | Experiments to illustrate diode characteristics, half and full wave rectifiers, diode applications, voltage doublers, clamper (zener diodes applications), transistor characteristics, BJT and FET, small signal analysis of CB, CC and CD amplifiers. | Electric Circuits lab (610216) + Electronics 1 (650242) |

*** Concurrent to the Lecture**