### Computer Applications (1 Cr. Hr.)

**Prereq. (1901102)**


### Engineering Graphics (3 Cr. Hrs.)

**Prereq. (None)**


### Electrical Circuits (1) (3 Cr. Hrs.)

**Prereq. (0302102)**

0903212 | Electrical Circuits (2) | (3 Cr. Hrs.)
---|---|---
**Prereq. (0903211)**  

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

0903221 | Signal Analysis & Systems | (3 Cr. Hrs.)
---|---|---
**Prereq. (0903201 & 0903211)**  

0904221 | Engineering Mechanics | (3 Cr. Hrs.)
---|---|---
**Prereq. (0301101 & 0302101)**  
Force systems; resultant, moment of a force, equivalent force-couple system. Particle and rigid body equilibrium in one plane. Trusses and Frames. Beams; shear force and bending moment diagrams. Center of gravity and centroid. Area moment of inertia. Planar kinematics and kinetics (Newton's second Law and work-energy method) of particles and rigid bodies in rectilinear and curvilinear motion (normal and tangential coordinates).

0907231 | Digital Logic | (3 Cr. Hrs.)
---|---|---
**Prereq. (1900100)**  

| 0904233 | Machine Drawing | (1 Cr. Hr.) |

**Prereq. (0904131)**
Mechanical engineering drawing conventions and abbreviations, various systems of size description, including precision dimensioning, fastening elements, standard organization and preparation of engineering drawings, assembly and detailed drawings, design applications.

| 0907234 | Digital Logic Lab. | (1 Cr. Hr.) |

**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.

| 0907235 | Assembly Language and Microprocessors | (3 Cr. Hrs.) |

**Prereq. (0907231)**

| 0904248 | Thermal and Fluid Science | (3 Cr. Hrs.) |

**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.
### Thermal and Fluid Science Lab. (1 Cr. Hr.)

**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.

### Electronics (1) (3 Cr. Hrs.)

**Prereq. (0903211)**

### Engineering Numerical Methods (3 Cr. Hrs.)

**Prereq. (0301202)**

### System Dynamics and Vibrations (3 Cr. Hrs.)

**Prereq. (0301202)**
Modeling of mechanical systems (using Newton's second law and energy method). Modeling of electrical, thermal, fluid and mixed systems. Examples and applications of block diagrams system representation and simulation (Simulink or Labview). Review of Laplace transforms, Laplace based analysis of first, second and higher order systems (transient and steady state) in time and frequency domains (frequency response functions). Case studies: base motion, rotating unbalanced, suspension system … etc.

### Dynamics and Vibrations Lab. (1 Cr. Hr.)

**Prereq. (0904312)**
oscillations of single and two rotors system. Vibration of a rigid body spring system. Undamped vibration absorber. Dunkerley’s equation.

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<tbody>
<tr>
<td>0904331</td>
<td>Mechanics of Machinery (3 Cr. Hrs.)</td>
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**Prereq. (0904312)**

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<tr>
<td>0907333</td>
<td>Embedded Systems (3 Credit Hrs.)</td>
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**Prereq.: (0907231 & 0907261)**

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<tr>
<td>0907334</td>
<td>Embedded Systems Lab. (1 Credit Hrs.)</td>
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**Prereq./Coreq.: (0907333)**
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.

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<td>0907337</td>
<td>Microprocessor Lab. (1 Cr. Hrs.)</td>
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**Prereq. (0907235)**
Writing, assembling, executing, and debugging various x86 programs to cover the basic concepts of microprocessor usage. Designing, implementing and troubleshooting various microprocessor-based applications. Experiments in building and programming microprocessor-based systems. Microcomputer interfacing experiments

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<tr>
<td>0908341</td>
<td>Engineering Measurements and Instrumentation (3 Cr. Hrs.)</td>
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**Prereq. (0903261 & 0904312)**
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. Mechanical variables
measurements: solid, fluid, and thermal. Electrical instrumentation for measuring: current, voltage, power, resistance, capacitive, and inductive quantities.

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<tr>
<td>0903361</td>
<td>Electronics (2)</td>
<td>3 Cr. Hrs.</td>
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**Prereq. (0903261)**


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<tr>
<td>0903368</td>
<td>Electronics Lab.</td>
<td>1 Cr. Hr.</td>
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**Prereq./Coreq. (0903361)**


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<tr>
<td>0904372</td>
<td>Strength of Materials (1)</td>
<td>3 Cr. Hrs.</td>
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**Prereq. (0904221)**

Axial loading, Material properties obtained from tensile tests, Stresses and strains due to axial loading, Thermal Stresses, Elementary theory of torsion, Solid and hollow shafts, Thin-walled tubes, Rectangular cross-section, Stresses in beams due to bending, shear and combined forces. Composite beams, Analysis of plane stress, Mohr’s Circle, Combined stresses, Thin-walled pressure vessels, Deflection of beams, buckling of columns, Energy Methods.

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<td>0903373</td>
<td>Electrical Machines (Mechanical &amp; Mechatronics Eng.)</td>
<td>3 Cr. Hrs.</td>
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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, brushless DC motors.
**0903374 | Electrical Machines Lab. (Mechanical & Mechatronics Eng.) | (1 Cr. Hrs.)**

**Prereq. (0903373)**
Transformer magnetic circuits. Testing of single and 3-phase transformers. DC generators. Speed control of DC motors. Testing and operational characteristics of alternators. Testing and operational characteristics of synchronous motors. Testing and operational characteristics of induction motors

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**0903424 | Digital Signal Processing | (3 Cr. Hrs.)**

**Prereq. (0903221)**

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**0904437 | Design of Machine Elements | (3 Cr. Hrs.)**

**Prereq. (0904372)**

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**0908441 | Control Systems | (3 Cr. Hrs.)**

**Prereq. (0904312)**
Review of transfer functions. Response of high order systems and Dominate 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.

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**0908442 | Modern Control Systems. | (2 Cr. Hrs.)**

**Prereq. (0908441)**
Realization of digital controllers. State space representation of discrete systems, simulation techniques of systems.

Prereq. (0908341)

Prereq. (0908341 & 0908441)
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 a PID controller in closed loop systems. Simulation of systems using Simulink or Matlab. Experimental methods on the following systems: pressure measurement, flow measurement, temperature measurement, strain gauges, strain rosettes. Signals display equipment and Function generators.

Prereq. (0903361)

Prereq. (0903361)

Prereq. (0903212 & 0904248)
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.

**0904484**  
**Computer-Aided Design**  
(3 Cr. Hrs.)

**Prereq. (0904331 & 0904372)**  

**0908531**  
**Mechatronics Systems Design**  
(3 Cr. Hrs.)

**Prereq. (0908341 & 0908441)**  
Mechatronics system’s design concepts (mechanics, electronics, pneumatics, hydraulics, and control). Microntroller’s based systems. Applications on motion control, Pneumatic actuator control, sensor interface …etc using microcontrollers. A Mechatronics integrated final project design and implementation (combines theoretical and practical applications with real world constraints). A detailed report should be submitted. Presentations of all group works is required.

**0904537**  
**Design of Hydraulic and Pneumatic Systems**  
(3 Cr. Hrs.)

**Prereq. (0904248 & 0908441)**  
Fluid power systems: design, control and operation. It covers the fundamentals of fluid flow, modeling and n port concepts, fluid power modulation, static and dynamic modeling of pumps, motors, control valves, transmission lines and fluid drives. It also deals with design, control and operation of mechanical and electrical hydraulic servodrives with feedback. Emphasis is placed on linear hydraulic systems behavior.

**0908541**  
**Intelligent Control**  
(3 Cr. Hrs.)

**Prereq. (0908441)**  
0908543 | Hydraulic and Pneumatic Control | (3 Cr. Hrs.)

**Prereq. (0904537)**

0908545 | Industrial Process Control | (3 Cr. Hrs.)

**Prereq. (0908441)**
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.

0908561 | Automation | (3 Cr. Hrs.)

**Prereq.: (0908442)**
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. Lab experiments concentrate on familiarizing the student with the concepts studied in class and on PLC programming and applications.

0908563 | Robotic Systems | (3 Cr. Hrs.)

**Prereq. (0908331 & 0908441)**

0908571 | System Integration | (3 Cr. Hrs)

**Prereq.: (0908531)**
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.
**Microelectromechanical Systems (MEMs)**

*Prereq. (0904312)*

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.

**Electrical Drives**

*Prereq. (0903461)*

Classification of Mechanical loads; motors: classification and selection for drive systems; the need for speed control of electric motors, methods of speed control of DC motors; methods of speed control of AC motors; DC choppers and speed control of DC motors; controlled rectifiers and speed control of DC motors, Inverters and speed control of AC motors; soft starting of electric motors.

**Selected Topics in Mechatronics**

*Prereq. Consent of Department*

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

**Project**

*Prereq. (Completing successfully 124 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.