Courses offered by the Department of Mechatronics Engineering

Must Courses		
E 101	**Fundamentals of Engineering**	**(1-0)1**
History of Engineering, Definition of Engineering, Engineering and Science, Engineering and Mathematics, Engineering and Society, Methodologies of Science and Engineering, Functions of Engineers, Philosophy of Engineering, Engineering Ethics, Report Writing in Engineering, Case Studies.		
MECE 102	**Fundamentals of Mechatronics Engineering**	**(1-1)1**
History of Mechatronics Engineering, Fundamental Concepts in Mechatronics Engineering, Mechatronics Technology, Applications of Mechatronics Engineering, Mechatronics Engineering Education, Case Studies in Mechatronics Engineering, Research Topics and Development Trends in Mechatronics Engineering, Industrial Trips.		
MECE 104	**Computer Aided Engineering Drawing**	**(2-2)3**
CAD systems. Elements of computer aided drawing. Geometric constructions. Orthographic drawing. Sectioning and conventions. Workshop drawings and assembly drawings. Screw threads, threaded fasteners. Locking devices, keys, springs. Gears. Tolerances and surface quality marks.		
MECE 202	**Principles of Mechatronics Design**	**(2-2)3**
Fundamentals of Engineering Design, Concepts in Engineering Design, Methodology of Engineering Design, Methods of Technology Development, Phases of Engineering Design, Case Studies in Mechatronics Design, Elements of Mechatronic Components, Engineering Design Education, Trends and Approaches in Engineering Creativity; Definitions, Concepts, and Methodologies, Presentation of Engineering Design, Elements of Project Management, Ethics of Engineering Design, Case Studies in Mechatronics Design Projects. Term Projects are assigned to practice engineering design with special emphasize on open ended creative mechatronics design topics.		
MECE 203	**Engineering Mechanics I**	**(2-2)3**
Idealizations and principles of mechanics. Vector quantities. Classification and equivalence of force systems. State of equilibrium. Elements of structures, trusses, beams, cables and chains. Friction. Variational methods, principles of virtual work and minimum potential energy. Concepts of stress and strain. Simple loading; tension, torsion and bending. Deflections with simple loadings, superposition techniques. Statically indeterminate members, thermal stresses. Combined stresses, Mohr's circle, combined loadings. Buckling. Energy methods.		
MECE 204	**Engineering Mechanics II**	**(2-2)3**
Introduction to dynamics. Kinematics and kinetics of particles and system of particles. Plane kinematics and kinetics of rigid bodies. Methods of work energy and impulse-momentum. Method of virtual work.		
MECE 205	**Engineering Materials**	**(3-0)3**
Introduction and classification of materials; Atomic structure and interatomic bonding. Crystalline and non-crystalline materials. Imperfections in solids. Structure of crystalline solids; Diffusion and rate equation; Mechanical properties of metals; Failure; Physical properties of materials; electrical, thermal, optical and magnetic properties. Designation of materials; Phase and phase diagrams; Iron-carbon system; Phase transformations; Thermal processing of metallic materials; Metal alloys; Structure and properties of ceramic, Polymeric and composite materials; Material selection.		
MECE 301	**Numerical Methods**	**(2-2)3**
Approximations and errors. Roots of equations. System of algebraic equations, Eigen values and eigenvectors. Curve fitting, interpolation, least squares. Numerical differentiation and integration. Ordinary differential equations.		
MECE 302	**Mechatronic Components**	**(2-2)3**
Building blocks of mechatronic products. Definition, Identification, and Classification of mechatronic components. Sensors. Classification of sensors. Proximity, angular displacement, rotational measurement sensors. Force and torque measurement sensors. Pressure sensors. Accelerometers. Gyros. Temperature and humidity sensors. Light detection and CMOS imaging sensors. Actuators. Classification of actuators. Power amplification and modulation. Typical power amplifiers. Electrical machines. DC motors. Brushed and brushless DC motors. Piezoelectric actuators. Fluid systems and hydraulic actuators. Pneumatic actuators.		
MECE 303	**Theory of Machines**	**(2-2)3**
Introduction to mechanisms: basic concepts, mobility, basic types of mechanisms. Position, velocity and acceleration analysis of linkages. Cam mechanisms. Gear trains. Static and dynamic force analysis of mechanisms.		

MECE 304	**Mechanical Machine Elements**	**(2-2)3**
3-D Stress Analysis. Static design criteria; stress concentration, factor of safety, theories of failure for ductile and brittle materials. Fatigue design criteria under mean and combined stresses. Definition, Identification, and Classification of mechanical machine elements. Design of shafts. Design of permanent joints; riveted joints, welded joints. Design of detachable joints, bolted joints, power screws, pins. Design of springs. Design of sliding bearings; journal and thrust bearings. Antifriction bearings; types, selection criteria and calculation procedure. Power transmission. Design of gear drives; spur gears, helical gears, bevel gears, worm gears. Design of couplings, clutches and brakes. Design of belt drives; flat belts, V-belts.		
MECE 305	**Digital Systems**	**(2-2)3**
Number systems, Boolean algebra, logic networks and their simplification. Logic design with gates. MSI and LSI technologies. Combinatorial circuits; sequential circuits. Counter, shift registers, computer organization, arithmetic logic, memory and control units, mini and microcomputer systems.		
MECE 306	**Control Systems**	**(3-0)3**
Laplace Transform, Transfer Functions, Stability, Steady-State Error Analysis, Frequency Response Analysis, Root-Locus Technique, Design in State Space, Controllability and Observability, Pole Placement and Observer Design.		
MECE 308	**Microcontrollers**	**(2-2)3**
Basic components of single board computers. Introduction to microcontroller hardware. Internal architecture, address, data, control busses and bus timing. Assembly language programming concepts, assembling, linking and debugging. CPU architecture and instruction set. Interrupts and interrupt programming. Timer, counter, capture and Pulse Width Modulation (PWM). Analog-to-digital converter. UART port. I2C bus and peripherals. Parallel I/O and I/O port expansion. Debugging systems and ICP module. High-level embedded programming languages and mixed language programming. Real-time operating systems.		
MECE 310	**Thermodynamics and Heat Transfer**	**(3-0)3**
Conservation of energy. Conservation of mass. Work and heat. First law of thermodynamics. Properties of liquids and gases, equations of state. Second law of thermodynamics. Thermodynamic relations. 1-D steady heat conduction, thermal resistances, extended surfaces. 2-D steady heat conduction, shape factor, finite difference methods. Convection and Radiation.		
MECE 399	**Summer Practice I**	**NC**
Students are required to do a minimum of four weeks (twenty working days) summer practice at the shop floor of a suitable factory. The students are expected to practice on mechatronics technology, all of the steps of technology production, and related manufacturing technologies, and mechatronics design to limited extend. A written report is to be submitted to reflect the work carried out personally by the student, and a seminar presentation is to be given to the students.		
MECE 401	**Mechatronic Design I**	**(1-4)3**
Review of engineering design concepts. Phases of engineering design, feasibility study, preliminary design, and detail design. Design for X. Presentation tools for engineering design. Types of engineering design. Modeling of engineering design. Case Studies. Open ended capstone term projects will be assigned to the teams of students practice engineering design.		
MECE 402	**Mechatronic Design II**	**(1-4)3**
Design optimization. Recent topics in engineering design. Reverse engineering. Introduction to modularity in design, engineering reliability, and system approach in design. Case Studies. Teams continue their open ended capstone projects that they have started in MECE 401.		
MECE 403	**Mechatronic Instrumentation**	**(1-4)3**
Sensors. Signal types. Signal characteristics. Sampling and quantization. Aliasing. A/D conversion. Actuators. Drive characteristics. D/A conversion. PWM. Power amplifiers. Mathematical modeling of various systems. Controller design. Classical controllers. State-space approach to control problems. Design of a state-space controller. Parameter and state estimation. PC based data acquisition boards. Rapid prototyping of control systems. Software-in-the-loop and hardware-in-the-loop systems. PC based control systems. Controller hardware. Various embedded controllers. Communication systems. System Integration.		
MECE 404	**Intelligent Mechatronics**	**(3-0)3**
Artificial Neural Networks (ANN), Fuzzy Logic (FL), Genetic Algorithms (GA). The use of ANN, FL and GA in control, estimation, planning, diagnosis, imaging, and heuristic search methods.		
MECE 407	**Undergraduate Research Project I**	**(0-4)2**
Student teams will work on a special research project in this course. The topic of the research is determined together with the faculty and student teams. Teamwork is strongly encouraged and required. Research projects are offered by the department faculty and students express their intent to		

work on a narrower area in mechatronics engineering. Extensive laboratory work, analytical modeling, and design experiences is expected.		
MECE 408	**Undergraduate Research Project II**	**(0-4)2**
Student teams will continue working on the special research project that they have started in MECE 407. Teamwork is strongly encouraged; however individual contribution is also required. Extensive laboratory work, analytical modeling, and design experiences is expected.		
MECE 499	**Summer Practice II**	**NC**
Students are required to do a minimum of four weeks (twenty working days) summer practice in a suitable factory or an engineering design and consultancy office. They are expected to get acquainted with a real business environment by studying various managerial and engineering practices through active participation. A report is to be submitted to reflect the students' contributions.		
Undergraduate TE Courses		
MECE 411	**Digital Control**	**(2-2)3**
Z-Transform, Discretization, Stability Analysis, Steady State Analysis, Root Locus, Design in Discrete Time, State Space and Structural Properties of DT Systems, Lyapunov Theory and Observer based Design.		
MECE 412	**Industrial Electronics**	**(2-2)3**
This course covers the principles of semiconductor switching devices and their application to the design of high voltage, high current industrial electronic control circuits (also known as power electronics circuits) such as controlled/uncontrolled ac-to-ac, ac-to-dc, dc-to-ac, and dc-to-dc converters, switch-mode power supplies, and some of the basics of electric drive control systems.		
MECE 421	**Applied Machine Design**	**(2-2)3**
Advanced case studies on engineering design. Topics include engineering reliability, engineering design ethics, practical design optimization, engineering safety, cost reduction, DFX at advanced level.		
MECE 422	**Advanced Theory of Machines**	**(3-0)3**
This course is an integrated course. It is divided into two parts. First part includes the synthesis of planar mechanisms for motion, path and function generation. Second part of the course is related with vibratory systems. Concepts included in this part are virtual work method, free vibration, forced vibration, and introduction to multiple degrees of freedom systems.		
MECE 441	**Artificial Intelligence**	**(3-0)3**
Introduction to artificial intelligence, State Space Search: Graph Theory, Depth-/Breadth-First, Heuristic Search, Reasoning, Logical Reasoning: Propositional Logic, Predicate Calculus, Reasoning under uncertainty, Bayes Rule, Knowledge-Based Systems: Rule-based Expert Systems, Machine Learning, Advanced Topics: Belief networks, Supervised learning methods, Neural networks, Semantic Nets, Reinforcement learning, Evolutionary methods.		
MECE 445	**Robot Vision**	**(3-0)3**
The course represents an introduction to the algorithms and mathematical analysis associated with the visual process. Topics include Binary Image Processing, Regions and Segmentation, Edge Detection, Photometric Stereo, Stereo and Calibration, Introduction to Dynamic Vision and Motion.		
MECE 451	**Mechatronics in Automotive Engineering**	**(3-0)3**
This course emphasizes systems approach to automotive design. Specific topics include automotive structures, suspension, steering, brakes, and driveline. Basic vehicle dynamics in the performance and handling modes are discussed. An individual term project is required.		
Graduate TE Courses		
MECE501	**Applied Numerical Methods**	**(3-0)3**
Polynomial fitting. Chebyshev polynomials. Integration rules and quadrature techniques. Solution of ODEs. Euler's and modified Euler's methods. Runge-Kutta methods and stability. Richardson's extrapolation. Multi-step methods. Optimization. Fundamentals of constraint optimization. Newton's methods. Nonlinear least squares problems. Theory of constraint optimization. Quadratic programming. Finite element method. Finite element discretization. Review of direct stiffness method of structural analysis. Mathematical interpretation of finite elements. Structural continuum elements. Isoparametric elements. Numerical integration.		
MECE511	**Actuators, Sensors and Interfacing (*)**	**(3-0)3**
Mechatronics. Brief history. Building blocks of mechatronic products. Sensors. Classification of sensors. Proximity, angular displacement, rotational measurement sensors. Force and torque measurement sensors. Pressure sensors. Accelerometers. Gyros. Temperature and humidity sensors. Light detection and CMOS imaging sensors. Actuators. Classification of actuators. Power		

amplification and modulation. Typical power amplifiers. Electrical machines. DC motors. Brushed and brushless DC motors. Piezoelectric actuators. Fluid systems and hydraulic actuators. Pneumatic actuators.		
MECE514	**Microcontrollers and Interfacing (*)**	**(3-0)3**
Number systems, Boolean algebra, logic networks and their simplification. Logic design with gates. Basic components of single board computers. Introduction to microcontroller hardware. Architecture, address, data, control busses and bus timing. Assembly language programming concepts, assembling, linking and debugging. CPU architecture and instruction set. Interrupts and interrupt programming. Timer, counter, capture and PWM. Analog-to-digital converter. UART port. I2C bus and peripherals. Parallel I/O and I/O port expansion. Debugging systems and ICP module. High-level embedded programming languages and mixed language programming. Real-time operating systems.		
MECE521	**Control Engineering I**	**(3-0)3**
State space analysis of systems, state feedback, observers, Lyapunov stability theory, phase portraits, and the describing function analysis are emphasized in this course.		
MECE522	**Control Engineering II**	**(3-0)3**
Continuous and discrete-time linear control systems; state variable models; analytical design for deterministic and random inputs; time-varying systems stability. Design of PID control systems, lead compensator, lag compensator, lead-lag compensator, control systems for disturbance rejection, state-space approach, design of control systems in state-space.		
MECE523	**PC-Based Control**	**(3-0)3**
Interfacing of electro-mechanical systems to microcomputers for data acquisition, data analysis and digital control. Using of PC ports and Internet for data acquisition and control purposes. PC architecture. Serial port, parallel port, USB. Programming techniques for serial and parallel communication. ISA and PCI bus specifications. ISA bus interfacing and programming. Simple ISA card design for data aquisition.		
MECE524	**Applied Optimal Control**	**(3-0)3**
Parameter optimization. Performance measures. Variational approach to open loop optimal control, Pontryagin's minimum principle. Optimal feedback control, dynamical programming, linear systems with quadratic performance indices, matrix Riccati equation. Numerical solution techniques of optimal control problems. Lab study to apply optimal control techniques to example dynamical systems.		
MECE525	**Intelligent Control**	**(3-0)3**
Uncertainty models and information representation: types of uncertainities and uncertainty measures. Intelligent control methodologies, learning control, fuzzy control, neurocontrol, neuro-fuzzy control.		
MECE530	**Advanced Engineering Vibrations**	**(3-0)3**
Analytical and Numerical methods for solution of typical vibratory and balancing problems encountered in engines and other mechanical systems. General theory of free, forced, and transient vibrations; vibration transmission, isolation, and measurement; normal modes and generalized coordinates; method of matrix equation formulation and solution. The application of theory and methods to the analysis, measurement and design of dynamic systems. Response of single degree of freedom systems to periodic and non-periodic excitation. Lagrange equation. Proportionally and non-propotionally damped multidegree of freedom systems. Numerical methods; Rayleigh-Ritz method and transfer matrix methods. Condensation, structural coupling, structural modifications and modal synthesis. Vibration analysis using ANSYS. Vibration test devices and vibration measuring sensors. Experimental methods and modal testing, modal identification.		
MECE536	**Vehicle Dynamics**	**(3-0)3**
Mathematical modeling and simulation of vehicle dynamics are emphasized in this course. Specific topics include tire models, handling dynamics, roll dynamics, ride dynamics, and estimation of vehicle states and parameters. An individual term project is required.		
MECE537	**Vehicle Control Systems**	**(3-0)3**
Design of control systems for road vehicles and flying vehicles. Parameter and state estimation. Guidance.		
MECE550	**Theory of Engineering Design**	**(3-0)3**
Determination of the customer needs and the real design problem. Engineering creativity. Generation of innovative solution alternatives, and selection of the effective solution. Modularity in design. Collaboration in interdisciplinary design tasks. Concepts of systems, models, and strategies for purposeful activities. Design and control of design projects; organization of group interactions. A design project required.		
MECE556	**Design and Applications of Micro Systems**	**(3-0)3**
Methods of micromachining, smart structure fabrication. Design, modeling for physical, chemical, and biomedical microsensors/actuators. Electrostatic actuation, parallel-plate and comb drive actuators,		

FEM modeling and simulation of MEMS devices, MEMS CAD, Dynamics, linear and non-linear systems, Stress and strain, Mechanical structures, Residual stress and stress gradients, energy methods, estimating resonance frequencies, Dissipative effects, friction, Fluid flow in MEMS structures, Design and applications of micro mechanical sensors, actuators, and structures. Smart structures and microsystems packaging/integration.

MECE562 Bio-mimetics and Design in Nature (3-0)3

Definition of biomimetics. Application areas in engineering. Biomimetics in vision application, in mobile robots, in multiple robotic systems, in optimization. Case studies and papers.

MECE563 Applied MicroMechanics and MicroEngineering (3-0)3

Application of elasticity to micro structures (microdiaghram, microbeams, microrings etc) and numerical and analytical solution of micro engineering problems in design of micro systems.

MECE572 Mechatronic Systems (*) (3-0)3

Mechatronics. Brief history of mechatronics. Basic building blocks of mechatronic products. Sensors. Classification of sensors. Interfacing of sensors. Sampling and quantization. Analog to digital conversion. Actuators. Classification of actuators. Drive characteristics. Digital to analog conversion. Analog power amplifiers. PWM signals. Switching power amplifiers. Mathematical modeling of various dynamical systems. Introduction to classical control. Laplace transform. Classical controllers. Introduction to digital control. z-transform. Analysis of control systems in z-domain. PC based data acquisition boards. Rapid prototyping of control systems. Software-in-the-loop and hardware-in-the-loop systems. PC based control systems. Controller hardware. Microcontrollers and microprocessors. Digital signal processors. Field programmable gate arrays. Real-time operating systems. Embedded high level programming. Communication systems. Case studies.

MECE573 Mechatronic Sys. Modeling, Simulation and Control Lab. (*) (3-0)3

Mathematical modelling and simulation of three or four real dynamical systems. Application of control algorithms (linear PID, state-feedback, fuzzy, neuro-fuzzy, learning algorithms,...) on these physical systems. Kalman filtering and applications. Matlab, Simulink, xPC, PC104 architecture.

MECE574 Industrial Automation and Robotics Technology (3-0)3

Principles of industrial automation systems, system approach for automated machinery and plants. Advanced topics in pneumatic and hydraulic components and systems, Design of pneumatic and hydraulic systems. Principles of industrial robots and their role in industrial automation, Mobile robots, Robot arms, AS/RS. Design issues in industrial automation and robotics technology. Case studies, Term project.

MECE 500 Graduation Project (NC)

Each student is assigned a multidisciplinary term project that includes a detailed survey of the upto-date knowled on mechatronic application. A detailed engineering report should be submitted at the end of the term.

MECE 581 Independent Study I (1-4)3

Students are assigned to work closely with one or more faculty to gain expert knowledge on a specific topic in mechatronic engineering. Each student (either individually or as a member of a team) should either complete a design project and manufacture the design product, or carry out a detailed experiment (design or use an available setup) with an engineering evaluation report.

MECE 582 Independent Study II (1-4)3

Students are normally expected to continue their work that they have started in MECE 581 at an advanced level. The work should normally end with a draft publication.

MECE 583 Special Topics I (3-0)3

Courses not listed in the catalogues. Contents vary from year to year according to interest of students and instructor in charge.

MECE 584 Special Topics II (3-0)3

Courses not listed in the catalogues. Contents vary from year to year according to interest of students and instructor in charge.

MECE 589 Graduate Seminar (NC)

Offered on a non-credit basis only for students selecting the option of “Master of Science in Mechatronics Engineering with thesis”. Student, faculty, and visiting scholar presentations of current research topics in mechatronics engineering.

MECE 599 Thesis (NC)

Program of research leading to MS degree arranged between student and a faculty member. Students register to this program upon their enrollment.

(*) Open to non-MECE graduates only