Courses offered by the
Section of Mechanical Design and Control Systems

(2.3.01.1) Mechanical Engineering Drawing I [1st (O)], & II [2nd (O)]
(2.3.01.2)

Introduction to mechanical engineering drawing. Types of mechanical engineering drawings. Free hand sketching. International standardization. Paper sizes. Drawing scales. Types of lines and their use. Multiview projection. Sectional and auxiliary views. Dimensioning of the engineering drawings. Threads and screws. Drawing of the basic machine elements. Tolerances and fits. Surface roughness assignment. Mechanical assembly drawings. Drawings of welded structures. Introduction to computer aided design/drafting (CAD).
The course is combined with free hand sketching and conventional drawing exercises, drawing of real machine components and assemblies, CAD applications, machine tool workshop practice.

S. Diplaris

(2.3.02.1) Introduction to Computer Science [1st (O)]

Introduction to Computing. Numbering Systems. Binary arithmetic and coding. Boole Algebra. Logic arithmetic & Circuits. Computer Architecture. Microprocessor architecture and operation.
Typical microprocessors. Peripheral Devices. Assembly Languages. Introduction to computing languages and compilers. Introduction to operating system principles. Computer communications & Networks. Introduction to Scientific computations using the MATLAB™ environment. Computing applications in Mechanical Engineering. Laboratory sessions: (a) Introduction to the Windows™ environment and applications (b) Introduction to MATLAB™.

K. Kyriakopoulos

(2.3.03.4) Mechanisms and Introduction to Machine Design [4th (O)]

Mechanisms and their accession in machines. Structure and modelling of mechanisms. Kinematical analysis of classical mechanisms using modern methods. Dynamic response of simple mechanical systems with specific properties. Dynamic response of simple mechanical systems with specific properties. Elements of mechanisms, cams. Generalization of mechanism' s concept in flexible mechanisms (with pneumatic and electrical elements). Three-dimensional mechanisms. Applications. Design of machines through the principle of structural composition. Tetrahedron theory-constituents. Design-structural components of mechanisms. Bibliography. Laboratorial exercise 1: Modelling of complex mechanism. Laboratorial exercise 2: Analysis of mechanism (in MATLAB environment).

K. Spentzas

(2.3.04.3) Machine Elements I [3rd (O)]

Introduction, loads, stresses in simple machine elements, critical section - Static and dynamic strength of machine elements, theories of failure used in the design of machine elements, combined loads and equivalent stresses, designing machine elements subjected to variable loads - Shafts – Welding - Bolts and screws, prestressing of bolts, power screws - Springs and their combination - Elements and methods for torque transmission, keys, pins and splines - Belt and chain drives.

S. Diplaris

(2.3.05.4) Machine Elements II [4th (O)]

Gearing and speed reducers. Drives and power transmission by gears. Cylindrical spur and helical gears. Bevel, helical and worm gears. Epicyclic and planetary gear trains. Gear loading and power transmission. Tooth compliance, load distribution and optimum conjugate gears. The kinds and causes of gear failures. Tooth flank modifications Gear measurements. Lubrication, sealing and maintenance of gearboxes. Gearbox rating and characteristics. Rolling and journal bearings. Clutches and couplings. Applications of gear design and power transmission in mechanical drives. Laboratory. Application of photoelasticity to gear stresses. Measurement of gear geometry. Wear, lubrication and maintenance in gear transmissions. Applications of Industrial software to toothed mechanical drives.

Th. Kostopoulos

(2.3.06.5) Machine Dynamics I [5th (O)]

Dynamics and its role to the behavior of machines, structures and installations. Modeling of engineering structures as lumped mass systems. Introduction to Finite Element Modeling (one dimensional structures). Elements of experimental dynamic analysis of mechanical systems and sensors. Vibration transmission from solids to air and acoustical problems. Measurement and suppression of industrial noise.

I. Antoniadis

(2.3.07.7) Hydraulics and Pneumatics [7th ΚΜΜ (O), ΜΜΠ, ΜΜΜΜ]

Basic pninciples and technology of hydraulics and pneumatics. Principle of operation, technology and design criteria of positive displacement pumps, motors and cylinders. Fluid power control: pressure control valves, flow control valves, directional control valves. Hydraulic accumulators, reservoirs, filters and measuring equipment. Nonsteady duct flow problems in power hydraulics. Hydraulic and pneumatic circuits and symbols. Troubleshooting in industrial hydraulics. Pneumatic drives for transmission and sequential control of motion. Aplications in hydraulic and pneumatic drives.
Laboratory: Hydraulic systems (conventional and computerized). Pneumatic system (programmable). Applications of Industrial software in hydraulic and pneumatic drives.

Th. Kostopoulos

(2.3.08.6) Introduction to Automatic Control Systems [6th (O)]

Introduction, brief history, control system principles, mathematical models of physical systems, transfer functions, state equation, functional block diagram, properties of feedback control systems, transient response, basic feedback controllers, methods for control system design, root locus, frequency response, compensation, applications.

M. Krikelis

(2.3.09.6) Analysis of Mechanical Structures I [6th (O)]

Mechanical structures, materials, isotropic and anisotropic structures, structures made of composite materials. Geometrical modeling of 2D and 3D structures, mesh generation techniques. One-, two- and three-dimensional finite elements. Two-dimensional structures (membrane, plate, shell). Elasticity and thermoelasticity problems. Acoustic problems. Practical.

Ch. Provatidis

(2.3.12.8) Design For Manufacturing & Cost I [8th ΚΜΜ (O), 8th ΜΜΠ]

Product design specification. Conceptual, embodiment and detail design. Design principles. Principal design guidelines. Variant design. Value engineering analysis. Mechanical engineering design in conjunction with the technical characteristics of the manufacturing processes. Design of cast, forged, formed, machined and welded components. Design for accuracy and interchangeability. Tolerance analysis and synthesis. Tolerances and machining accuracy. Tolerancing methods. Accuracy and surface integrity and quality. Design for assembly. Design for manufacturing / assembly cost reduction. DFC indices. Machining and sheet metal fabrication economics. Design of part families.
Case study assignment. Laboratory applications and demonstrations.

S. Diplaris

(2.3.14.7) Control Systems and Machine Regulation [7th ΚΜΜ (Υ), ΜΜΠ, ΜΜΜΜ (O)]

Modeling of dynamical systems, power state variables, bond graphs, derivation of state space equations, linear systems analysis, solution of state space equations, controllability and observability, classical and modern control, state feedback control, optimal control, the general optimal control problem, linear-quadratic optimal control problem, optimal regulator, relation to the classical control, optimal control and reference input tracking systems, state reconstruction – observers, applications.

N. Krikelis

(2.3.16.8) Lightweight Structures [8th ΜΜΜΜ (O)]

Selected elements in theory of elasticity. Torsion of solids sections (Prandtl stress function solution, the membrane analogy, warping function solution, torsion of a narrow rectangular strip). Stress equilibrium of thin plates in bending, torsion and plane-stress. Analytical solutions for typical boundary conditions; relevant finite elements. Elements of shell theory. Analytical solutions; relevant finite elements. Bending, shear and torsion of open and closed thin-walled beams. Stress analysis of aircraft components. Distribution of shear stresses (build-in end, shear lag). Stress concentration. Boundary element methods in elasticity problems; application to crack-propagation analysis. BEM analysis of noise from vibrated plates and shells.

Chr. Provatidis

(2.3.17.7) Analysis of Mechanical Structures II [7th semester [7th ΚΜΜ (O), ΜΜΜΜ (O)]

Isoparametric finite elements: Numerical integration; architecture of a typical finite element code. Practical-1: Software development by the students. Optimization: objective functions and constraints; special and general optimization methods; fully stresses design; optimality criteria methods; several other optimization techniques. Practical-2: Optimization of a typical structure (e.g., ten-bar truss).

Chr. Provatidis

(2.3.19.4) Industrial Electronics [4th (O)]

Analog Circuits: Diodes (Zener, Photo-diodes, applications: inversion). Bipolar Transistor (CB, CC, CE).

Low frequency Amplifiers. Operational Amplifiers (Applications to signal conditioning and control) Digital Circuits: Gates (hardware realization, Boole Algebra). Medium Scale Integration Circuits (decoders, multiplexers, adders, ROM, PLAs). FLIP-FLOP. Sequential Circuits (Introduction, counters). Applications: Signal Conditioning & Transmission, TRIAC & Thyristors. Industrial control systems. Laboratory sessions: a) operational amplifiers in control b) inversion

K.Kyriakopoulos

(2.3.20.8) Conveyors and Lifting Machinery [8th ΚΜΜ (Υ), 8th ΜΜΠ (Ο)]

Introduction - The general conveying problem - Material properties - Steel structures for conveyors and elevators - Belt conveyors - Belt elevators - Chain conveyors and elevators - Screw conveyors – Screw feeders - Vibrating feeders - Low pressure air conveyors - Duct collectors – Ropes - Winches - Skip hoists – Cranes – Electric and Hydraulic lifts.

S. Diplaris

(2.3.22.9) Flight Dynamics [9th ΜΜΜΜ (Ο)]

Origin of force fields on the aircraft. Atmospheric gusts. Dynamics under steady elevators. Dynamics under elevator control. Automatic pilots.

I. Antoniadis

(2.3.24.9) Design For Manufacturing & Cost II [9th ΚΜΜ]

Dimensional and geometrical accuracy and interchangeability. Coordinate tolerancing. Tolerance transfer principle. Taylor's axiom of interchangeability. Maximum material condition and envelope requirement. Geometrical similarity and product modelling. Product size range design. Modular design. Cost criterion for modular design. Manufacturing cost evaluation of geometrically scaled products. Taguchi's tolerance assignment approach. Design and manufacturing form features. STEP data representation standard. Rapid prototyping and tooling. Reverse engineering.
Case study assignment. Laboratory applications and demonstrations.

S. Diplaris

(2.3.27.2) Introduction to Electric Circuits and Systems (2nd (Ο)]

Models of circuit discrete elements. Resistors and energy storage elements. Sources. Systems of elements. Transformers. Linear circuit analysis via the linear graph method. Voltage division. Kirchhoff laws. Thevenin and Norton theorems. Linear system properties. Superposition. Stability. Circuit time response and sinusoidal steady state response. Frequency response. Transfer functions, filters. Three-phase networks. Average and reactive power. Balanced and unbalanced loads. *Lab exercises*: circuit time and frequency response, parameter identification.

E. Papadopoulos

(2.3.28.3) Electromechanical Power Conversion Systems [3rd (Ο)]

Fundamental principles of electromagnetism. Magnetic circuits and permanent magnets. Electromechanical power conversion, development of torque and voltage. Elecromagnetic actuators, electromagnets, voice coils. Generators, motors and loads. Torque-speed characteristics. Basic equations, equivalent circuits, characteristic curves, power flow, efficiency and losses in electric machines. DC generators and motors. Synchronous generators and motors. Three-phase and single-phase induction motors. Stepper, universal, and brushless motors. Introduction to drives and motor control. *Lab exercises*: motor response, parameter identification and characteristics of motors/generators.

E. Papadopoulos

(2.3.29.8) Vehicles Design II [8th ΚΜΜ, ΜΜΜΜ]

Theory: Advanced tire mechanics, tire models. Vehicle's centre of mass and moments of inertia. Vehicle dynamics, equations of motion, external forces and moments, linear 2 degrees of freedom model, control and stability, non-linear 6 degrees of freedom model. Kinematics and dynamics of four-wheel-steering vehicles. Bibliography. Computer simulation: Case studies in vehicle dynamics by computer simulation.
Laboratory: Experimental study of the dynamic behaviour of a vehicle moving in the Polytechnioupolis road network, installation of the CORRSYS measurement instruments aboard a vehicle, data collection, treatment of the collected data on a digital computer.

K. Spentzas

(2.3.30.7) Vehicles Design I [7th ΜΜΕΜΜ (Ο)]

Introduction, vehicle's definition, classification of vehicles. Tire mechanics. Accelerating vehicle's performance. Braking vehicle's performance. Vehicle's ride and passengers comfort. Vehicle's handling. Vehicle's road behaviour. Vehicle's ability to negotiate bad roads and off-road grounds. Bibliography.

K. Spentzas

(2.3.32.7) Machine Dynamics II [7th KMM (O)]

The concept of the signal. Frequency analysis, Fourier series, spectra. Fourier transform, convolution, cross- and autocorrelation. Modulated signals, demodulation. Discrete signals. Sampling Theorem. Discrete and fast Fourier transform. Restrictions of the Discrete Fourier Transform, aliasing, leakage, resolution.
Vibrations and fault diagnosis. Vibration measurements, and international standards. Fault diagnosis: basic principles, unbalance, misalignment, looseness, impacts, fault detection in bearings and gears.
Experimental modal analysis – Introduction. Theoretical concepts. Determination of natural frequencies and mode shapes in the frequency and time domains.

I. Antoniadis

(2.4.18.7) Industrial Installations I [7th KMM]
(2.3.33.7)

Introduction to industrial installations. Classification of the industrial installations. Plant functional requirements. Industrial buildings issues. Mechanical and electrical outfitting of industrial buildings. Industrial networks classification, design and implementation. Failures of industrial networks. Industrial water supply. Industrial heat exhaust sources and industrial heat removal systems. Facilities for industrial pollution and waste disposal control. Fixed path material handling and transport facilities. Material and product industrial warehousing, storage. Principles of mechanical equipment installation and commissioning. Machine foundations, setting up, vibration isolation. Industrial noise control.
Case study assignment.

I. Antondiadis, S. Diplaris

(2.3.35.8) Industrial Installations II [8th KMM, ΜΜΠ]

Description and documentation of industrial installations. Coding methods. Symbols for equipment and instruments. Process and instrumentation diagrams.
Elements of electrical industrial installations. Elements of electrical design. Elements of basic industrial equipment.
Description of the operation of industrial installations. Petri nets and Grafcet. Function block diagrams.
Monitoring and supervision of industrial installations. Industrial networks and SCADA systems.
Methods for availability and reliability analysis. Basic maintenance concepts.

I. Antoniadis

(2.3.36.8) Microprocessors Based Control [8th CME, IE]

Introduction to control systems using microprocessors -μP and microcontrollers –μC (ADC, DAC, Sampling & Hold–S/H). Introduction to microprocessor and microcontrollers architecture and programming. Assembly and interfacing of MC86HC11. Signal representation in digital systems, Z-transform, frequency domain analysis, state equations of sampled systems, time domain analysis. Controllability & Observability. Design and Implementation of Sampled Data control systems. State observation (observers – Kalman filtering) Model Identification. Introduction to Adaptive Control.
Laboratory sessions: a) design and simulation of a digital control system for a medium scale plant b) assembly programming for μP & μC and simple controller implementation (e.g. alarm, servo-motor control) c) on-line identification of the dynamic parameters of 2-DOF manipulator.

K.Kyriakopoulos

(2.3.37.9) Electric Vehicles [9th MMMM]

Introduction, definition and classification of electric vehicles. Battery electric vehicles. Fuel cell electric vehicles. Hybrid electric vehicles. Bibliography.

K. Spentzas

(2.3.38.8) Computer Methods in Structures [8th KMM]

Introduction in commercial CAD/CAE codes. Application to linear and nonlinear *n*-DOF systems under several excitations. Training in commercial CAD/CAE software: development of geometric models; static and dynamic analysis of the relevant structures. Practical.

I. Antoniadis, Ch. Provatidis

(2.3.39.9) Machinery Maintenance [9th KMM (O), ΜΜΠ]

The necessity of maintenance of machinery for increased reliability and trouble-free operation. The types of maintenance of mechanical equipment. The troubleshooting techniques in rotating machines. Lubricating systems and power losses in machinery. Applications in rolling and journal bearings, clutches, couplings, speed reducers, gearboxes and several drives (mechanical, hydraulic and pneumatic). Analysis

and evaluation of damages of machine elements through mounting and dismounting of machines and mechanical equipment by using industrial instumentation and software for measurement, monitoring and damage prevention.

Th. Kostopoulos

(2.3.40.9) Vehicle Project [9th MMMM]

The students must make arrangements with the professor.

K. Spentzas

(2.3.41.9) Intelligent Control Systems & Robotics [9th KMM (O), ΜΜΠ]

Advanced analysis and design techniques of automatic control systems for nonlinear engineering systems. Parameter identification and adaptive control. Neural networks. Robotic systems (manipulators, vehicles, underwater and aerial vehicles): Analysis, Control, Programming & Integration. *Laboratory exercises*: System simulation, robotic manipulator control, navigation and control of mobile robots, navigation and control of an underwater vehicle.

E. Papadopoulos, K. Kyriakopoulos

(2.3.42.9) Biomechanics and Biomedical Engineering [9th KMM]

Introduction. Current and future abilities of the Biomedical Engineering.
Bone structure. Elementary anatomical units. Cortical bones and Haversian system. Cancellous bones and trabeculae. Bone remodeling: osteoclasts and osteoblasts. Relationship between bone remodeling and principal stresses (Wolff's law) or strains (Frost's law). Mechanical behaviour of bones.
Soft tissues: Mechanical behaviour of muscles and tendons. Artificial tendons. Application to athletics, plastic surgery and ophthalmology.
Orthodontic applications: The role of the periodontal ligament. The tooth as an elastically supported rigid structure under bone remodeling. Centre of rotation, centre of resistance.
Elementary gait analysis and rehabilitation principles. Inverse dynamics.
Methods to obtain medical images from a CT scanner (raw data, DICOM, etc.). Development of a 3D-CAD model. Development of finite element models.
Application of the finite element method in implants design (total hip arthroplasty, knee, elbow, shoulder, fingers, etc.). Simplified hip model in bending. Plates for bone osteosynthesis: craniofacial, calcaneous, long bones, an so on. Dental implants. High-tech (CAD/CAM/CAE) orthodontic appliances.

Ch. Provatidis