توصيف مفردات المقررات

Numerical Analysis
Review of determinants and matrices. Algorithms to solve linear and non-linear equations. Solution of simultaneous linear equations using various methods: Gaussian elimination, Gauss-Jordan and LU decomposition method. Iteration methods for linear systems: Jacobi and Gauss-Siedel method. Interpolation and approximation. Curve fitting. Numerical differentiation and integration. Numerical solution of differential equations. Eigenvalue problems. Numerical error analysis. Applied examples from various areas of engineering. Discussion.

Engineering Graphics
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.

2-1Electrical Circuits I
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.

2-2 Electrical Circuits II
Average power and rms values. Polyphase circuits. Three phase Y and _ 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.

2-1,2 Electrical Circuits Lab. (3 1)
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.

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2-2 Signal Analysis & Systems

Signal and system model and classification. Continuous time signals. Signals and vectors. Generalized Fourier series representation.. Amplitude and phase spectra of signals. Energy and power content of signals. Bandwidth of signals. The Fourier Transform and applications. Sampling of signals. Convolution of signals. Power and Energy spectral densities. Correlation functions. Time-domain analysis of continuous time systems. The system impulse response. Communication channels. Filters: LPF, HPF and BPF. Discrete time signals. The discrete Fourier transform (DFT) and the Fast Fourier transform (FFT). Spectral analysis of DFT systems. Unit sample response and response to arbitrary input sequences. Introduction to the Z-transform. Computer project.

1-2 Engineering Mechanics

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).

Digital Logic

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. 15 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.

Digital Logic Lab.

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.

2-2 Assembly Language and Microprocessors

Introduction to microprocessors and microcomputers. Evolution, architecture, and software model. Introduction to Real-mode and protected-mode memory addressing. Addressing modes. The PC and its DEBUG program. Move, stack, load-effective address, and string instructions. Arithmetic instructions. Addition, subtraction and comparison. Multiplication and division. Logic instructions. Shifts and rotates. Counters and time delays. String comparisons. Jump instructions. Code conversion. Stacks and subroutines. Program and machine control instructions. Software interrupts. Program development. The microprocessor and its bus architecture. Introduction to memory and I/O interface. Discussion, one hour weekly.

2-1Thermal and Fluid Science

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.

2-1Thermal and Fluid Science Lab.

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.

2-2 Electronics I

Introduction to Semiconductors. Conduction in metals. Intrinsic and extrinsic semiconductors. Electrical properties of semiconductors. Diffusion process in semiconductors. The PN Junction Diode. Open-circuited junction. Forward, reverse biased junction. VI static characteristics. Temperature effects. Small and large-signal models. Junction capacitance and switching times. Diode types and applications. Rectification. Rectifier filters. Clipper and clamper circuits. Voltage multipliers. Zener, varactor and Schottky diodes. LED and Photodiode applications. Bipolar Junction Transistors: Ebers-Moll mode. CB and CE characteristics. DC biasing and analysis. BJT as a switch, diode and amplifier. Small-signal models. Transistor ratings. Field-effect Transistor: VI characteristics of JFET and MOSFET. FET as a switch and amplifier. Small-signal models. The MESFET. Transistor ratings.

System Dynamics and Vibrations

Modeling of mechanical systems (using Newton's second law and energy method). Modeling of electrical, thermal, fluid and mixed systems. Examples and applications of bock 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.

Static and dynamic balancing. Centrifugal force. Simple and compound pendulums. Bifilar suspension. Center of percussion. Kater’s reversible pendulum. Torsional Mechatronics Engineering Department 2005-2006 17 oscillations of single and two rotors system. Vibration of a rigid body spring system. Undamped vibration absorber. Dunkerley’s equation.

Mechanics of Machinery

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.

Embedded Systems
Embedded systems characteristics. Microprocessors versus micro controllers. Micro controller characteristics. General-purpose micro controllers. Examples of micro controller architectures. Interrupts, counters/timers, Input/output ports. Micro controller 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.

Embedded Systems Lab.
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.

Microprocessor Lab.
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

Measurements and Instrumentation
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 18 measurements: solid, fluid, and thermal. Electrical instrumentation for measuring: current, voltage, power, resistance, capacitive, and inductive quantities.

Electronics II
Amplification. Biasing of transistor (BJT and FET). Single-stage amplifier. Cascaded BJT and FET amplifiers. Composite transistor stages. Operational amplifiers and applications. Differential amplifier. Operational amplifier architectures. Gain with active load. DC level shifting. Output stage. Offset voltages and currents. Frequency response of amplifiers. The high-frequency response of all amplifier configurations. The low frequency response of all amplifier configurations. The frequency response of cascaded stages. Feedback Amplifiers. Properties of negative-feedback amplifiers. Properties of feedback amplifier topologies. Analysis of feedback amplifiers.

Electronics Lab.

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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.

2-2 Strength of Materials

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.

Electrical Machines (Mechanical & Mechatronics Eng.)

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.

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Electrical Machines Lab. (Mechanical & Mechatronics Eng.)

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

Design of Machine Elements

Review of stress, analysis. Theories of failure. Power transmission shafts. Tension and shear. Connections and selection of bolts. Helical tension and compression spring design. Weld analysis and design. Selection of rolling element bearings. Gears geometry, Force and stress analysis. Mechanical couplings. Flexible power transmission elements.

Control Systems

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.

Modern Control Systems.
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-tranformation, discretization of systems. Discrete systems response using z-transforms. Stability analysis. System identification. 20 Realization of digital controllers. State space representation of discrete systems, simulation techniques of systems.

Transducers
Measurements of: Spatial variables, time and frequency, Electromagnetic variables, optical variables, radiation, chemical. Signal processing techniques: amplifiers, signal conditioners, modulation, filters, A/D, and spectrum analysis. Overview of Data acquisition systems. Displays.

Measurements and Control Lab.
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.

Power Electronics
Basic elements of PE systems. Applications of PE. Classification of PE controllers. Power semiconductor devices (PSD). Classification of PSD. V-I characteristics of the major PSD. Switching characteristics of PSD. Basic drive circuits of PSD. Line commutated converters. Single-phase H.W. rectifiers. Single-phase F.W. rectifiers configuration. 3-phase H.W and F.W rectifiers. Single-phase and 3ph semiconverters. Inversion mode of operation. Performance characteristics of line commutated rectifiers. Introduction to AC switching controllers. Introduction to DC-to-DC converters. Introduction to DC-to-AC converters.

Design of Hydraulic and Pneumatic Systems
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.

Modeling and Simulation of Dynamic Systems
Mathematical modeling of Physical Systems (Mathematical, Electrical, Fluid, Thermal Systems, Power Transmission Systems, Automobile Suspension Systems) – Sate-Space

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representations of Dynamic System – Computer Simulation with MATLAB and DYNAST Software Packages – Case Studies.

Robotics

Basic of robotics, Analysis and design of robotic systems including arms and vehicles, kinematics, Inverse kinematics and Dynamics of robots (stationery and mobile robots), algorithms for describing, planning and commanding, robotic control systems, Position, Speed and force control of robot Grippers, Examples on various practical applications of robots

Introduction to Mechatronics

Overview of Mechatronics: What is Mechatronics? – Evolution of Mechatronics – Importance of Mechatronics for different applications – Examples of Mechatronics products – The role of mechatronics engineer. The role of Modeling and Simulation of Mechatronics System – Examples of different simulation software packages for Mechatronics (Dynast, 20sim, Mat lab, automation, studio…). Mechatronics Components: Sensors, Actuators, Microprocessor /Microcontroller, the role of control in mechatronics system. Examples of Mechtronic Systems: Hard disk drive, Automatic garage door opener, inverter Pendulum System, Camcorder, Vehicle suspension system, Anti Brake skidding System (ABS).

Introduction to Robotics

Introduction to Robotics – History of Robotics – Robot Actuators (Electric actuators, hydraulic actuators, pneumatic actuators) – Robot Sensors (position displacement, speed, force, optical sensors) – Robot end-effectors (hydraulic, magnetic, electric, pneumatic) – Robot programming – Robot applications in flexible manufacturing systems – Reliability maintenance and safety of robots – Robot Applications in hazardous environment (chemical, ect).

Mechatronics Laboratory I

Interfacing a microprocessor to a stepper motor – position control of DC motor – Microcontroller position control of a 2-axis manipulator – Computer Numerically Controlled machine (CNC) – Motion programming of a 5-axis SCARA robot.

Mechatronics Laboratory II

PLC control of a 2-axis manipulator, Microcontroller / PLC control of flow process, Dynamic response of an electro hydraulic position servo, Digital control of a tilting platform, Programming a 5-Axis SCARA Robot for an Assembly Task, Magnetic Levitation Systems.

Mechatronics Project

The purpose of this project is to give the student the chance to gain practical skill in designing and implementing simple components/equipment in related applications that

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need to integrate mechanical, electrical and/or electronic. The project is oriented to train students to work in team.

Mechatronics graduation Project

A significant Mechatronic Project is considered an essential part of mechatronic education. The purpose of the project is to give the student experience in designing systems that need to integrate various technologies they have learned about in the program. These projects should be based on real physical systems that come from industry, and could be conducted as a team effort. This is intended to improve student's skills in designing Mechatronics systems for solving practical problems or designing new smart components. Project planning, implementation presentation and reporting should be an integral pert of these projects.
Prerequisite: Mechatronics Project

Programmable Logic Controller (PLC)

Overview of PLC's, Central Processing Unit, I/O system, Programming, Terminal and peripherals, Relay Logic, Ladder Logic, Timers, Counters, Sequencers, Data Transfer, Mathematical Functions, Functional block diagram. Case studies using automation studio.

Process Control

Process control fundamentals, Process characteristics and transfer function identifications, Industrial transmitters (pressure, level, flow, temperature and Ph value), Actuators (electro pneumatic, DC – AC motor – stepper motors), Open – loop characteristics of P, PI, PID and PID controllers, PID – Controller design, Tunin of industrial PID controllers, Simulation of industrial control systems.

CNC Machine

Basic of CNC Machine Tools – CNC programming (Preparatory functions and Miscellaneous Functions) – Examples of CNC Machine Tools – Computer Aided programming of CNC – Case Studues.

CAD/CAM

Design process and role of CAD, defining the model, Techniques for geometric modeling, Three dimensional modeling. Use of finite Elements as a CAD Tool. Elements of interactive computer graphics, entity manipulation and data storage, application of CAD model in design. Standards for computer aided design, intelligence of CAD. Computer numerical control, computer aided management and production control, computer numerical control and programming CNC machines, Linking CAD with CAM, use of robotics in CAM.

Digital Control

Avenges of digital control, Example of digital control system, signal processing, Z-transform, Pulse carrier function, Design of digital control systems with variable structure

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method, Controllability testing, Design of digital control systems using root locus method. Design of digital PID Controller, Design of digital control systems applying state Variable Feedback.

Mechatronic Systems Design

Introduction to Mechatronics Design: Mechatronics Design philosophy Mechatronics Design Versus Traditional Design, Concurrent Design philosophy. Modeling and simulation of Mechatronic Systems: Modeling approaches of Mechatronics Systems, Simulation Software of Mechatronics System (Dynast, 20Sim, Mat lab, automation studio..). introduction to Intelligent systems in Mechatronics: Intelligent Controllers, Intelligent Sensors, Intelligent actuators. Conceptual Design Projects: Mechatronics Design of a Magnetic Levitation System, Microprocessor Position Control of XY – Table – PLC of a Level / Flow Control Process with Variable Demand, Mechatronics Design of Smart Gripper Design of a Autonomous Vehicle.
Prerequisite: Introduction to Mechatronics

Robotics and Automation

Robotics in Operations and Processes: Material handling and warehousing, Assembly of mechanical and electronics products, Inspection and testing, Maintenance and repair, Fabrication and processing, Spot, Arc, and Laser welding, Painting and coating. Introduction to automation of Discrete Dynamic Event Systems, Automation Devices and Systems.

Digital Signal Processing

Introduction to DSP. Discrete time signals and systems. Z-transform. Modeling and implementation forms of DT systems. Time and Frequency domain analysis of digital processors. Design and analysis of finite impulse response filters (FIR). Analog filter approximations. Design and analysis of infinite impulse response (IIR) filters. Digital filter networks. Digital equalizers. The DFT and FFT algorithms. DSP algorithms and applications.

Digital Electronics

Building blocks and design methodologies for constructing synchronous digital systems. Bipolar TTL vs. MOS implementation technologies. Standard logic (SSI, MSI, LSI, VLSI). Programmable logic (PLD, PGA). Finite state machine design. Digital computer building blocks. Semiconductor ROM and RAM. Timing circuits. Monostable and stable multivibrators. Analog-to-digital (A/D) and digital-to-analog (D/A) converters. Using computer-aided design software (PSpice, Verilog HDL, Xilinx, etc).

Autotronics

Basics of automobile and engine operation. Testing and measurement of automotive engines. Fuels and combustion. Pollution: measurement and control. Ignition systems. 21 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.

Computer-Aided Design

Fundamentals of Hardware and Software. Techniques for Geometric Modeling (Line, Surface and Volume Modeling). Elements of Interactive Computer Graphics. Entity Manipulation. Introduction to Finite Element Techniques. Using in-house software: Introduction to Graphics User Interface, Sketcher Environment, Parametric & Feature-Based Solid Modeling, Surface Modeling, Concept of Parent/Child Relationships, Part Construction Techniques, Patterns, Advanced Features, Cross-Sections, Parametric Relations, Component Assembly Techniques, Drafting (Drawing) Techniques, Animation, Introduction to Mechanism Design and Analysis, Introduction to Structural and Thermal Simulation.

Intelligent Control

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

Hydraulic and Pneumatic Control

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.

Industrial Process Control

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.

Automation

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.

System Integration

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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)

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

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.