FACULTY OF ENGINEERING

Syllabus for the

M.E. (Mechanical – Mechatronics)

(w.e.f. 2008-2009)

UNIVERSITY OF PUNE
# Program Structure for M.E. Mechanical (Mechatronics) (For 2008 Course) (w.e.f. June – 2008)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
<th>Credits</th>
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<tr>
<td></td>
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<td>Lect.</td>
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<td>Paper</td>
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<td>Applied Numerical Methods and Computational Techniques</td>
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<td>502802</td>
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*The term work of project stage II of semester IV should be assessed jointly by the pair of internal and external examiners, along with oral examination of the same.
Note- The Contact Hours for the calculation of load of teacher
Seminar- 1 Hr/week/student  Project - 2 Hr / week / student

<table>
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<tr>
<th>CODE</th>
<th>Elective – I</th>
<th>CODE</th>
<th>Elective – II</th>
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<tr>
<td>502804 A</td>
<td>Design of Machine Elements</td>
<td>502805A</td>
<td>Control Systems</td>
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<tr>
<td>502804 B</td>
<td>Digital Signal Processing</td>
<td>502805B</td>
<td>Theory of machines and Mechanisms</td>
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<td>502804 C</td>
<td>Advance Material Science</td>
<td>502805 C</td>
<td>Instrumentation &amp; Automatic Control</td>
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<th>Elective – III</th>
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<th>Elective – IV</th>
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<tr>
<td>502811 A</td>
<td>Computer Aided Design</td>
<td>502812 A</td>
<td>Embedded Systems</td>
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<tr>
<td>502811 B</td>
<td>Robotics</td>
<td>502812 B</td>
<td>Fuzzy Logic and Neural Networks</td>
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<tr>
<td>502811 C</td>
<td>Automotive Electronics</td>
<td>502812 C</td>
<td>Open (self study)**</td>
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** Open elective subjects- BOS Mechanical Engineering will declare the list of subjects which can be taken under open elective.
Applied Numerical Methods and Computational Techniques (502801)

Teaching Scheme: 3Hours/week  
Examination Paper: 100 Marks
Theory Paper: 3Hours

1. Linear and Non Linear algebraic equation

2. Curve Fitting
   a) Least square regression:-
      i) (Review of Linear Regression, multiple linear regression)

3. Eigen values of matrices, Differentiation and Integration
   Power method, Householder & Given’s method, Ritziauser method for arbitrary matrices. (review of divided difference formulae), Romberg integration, Gauss quadrature for double & triple integration.

4. Ordinary differential equations

5. Partial Differential equations

6. Finite element methods

7. Fourier Transform methods
   Fourier Transform, Vibration Analysis, Vibration conditions under step acceleration and ramp up acceleration. Stastical methods and normal process, averages± 3σ methods, calculation templates.

(Important Note: Review topics, derivations, computer programs will not be asked in examination.)
Laboratory Practice: Solve any three assignments from the following based on each of the above mentioned using software like MATLAB/ Mathematica.

1. LAE :- Implement Thomas algorithm to solve Tri-Diagonal matrix in Finite Element method in application problem for static & thermal loading.
2. Simultaneous non linear equations (SNLE)- Heat transfer problem in which thermal conductivity is given as a function of temperature OR deflection of non linear system.
3. Curve Fitting: Use of double interpolation to calculate field variables (Temperature/ Displacement) at non nodal / grid points.
4. Eigen values & Eigen vector of matrices – Calculate principle stresses & their position vectors is stress tensor is given.
5. Differentiation & Integration: Calculate deflection of non-prismatic beam.

References:

Mechanical & Electronic Measurements
(502802)

Teaching Scheme: 3Hours/week  Examination Paper : 100 Marks
Theory Paper :3Hours

1. **Fundamentals in Measurement**
   Accuracy, resolution, fraction, linearity, sensitivity of the instruments, static characteristics, types of errors and compensation, auto zero, auto ranging, various display resolution techniques, specifications.

2. **Standards & Calibration**
   Primary, secondary, working standards, ISO/IS /JIS/ NMTBA need of calibration, procedure, systematic expectations and technical expectations, traceability and its requirements, statistical analysis, mean mode, deviation, variance and probability of error, regression analysis, standards for time, length, volt, ampere and ohm meter.

3. **Measuring Instruments**

4. **EMC in Mechatronics**
   EMI, RFI, noise, need of EMC, standards, techniques to achieve EMC on circuit level, board level, enclosure level and system level, techniques of EMI measurement, CE & radiated EMI.

5. **Mechanical Measurement**
   Techniques in measurement and calibration of displacement, speed, flow, weight, viscosity, humidity, level, acceleration, temperature, pressure, Vibration and Force, CMM, Interferometer, precision measuring instruments, load cells, Hall sensors, straightness and flatness, angle, surface finish and Noise measurement, process control charts.

6. **Signal Conditioning :**
   Principle of signal conditioning, Linearization, filtering, impedance matching, AC & DC bridge circuits, RC filters, shielding, twisting, Line filters, Earth loops, isolation, voltage versus current as a mode of communication, instrumentation amplifier and its Characteristics. Analog to digital and digital to analog converter such as Dual Slope, Successive approximation, R-2R and Binary Weighted resistors.
Laboratory Practice

Perform any two practicals
1. Measurement of Pressure, Temperature, velocity, vibration etc.
2. Measurement of displacement, speed, flow, weight etc.
4. Study of Logic Analyzer
5. Study of Spectrum Analyzer

References
1. Cooper : Electronic Measurements
2. Olliver/ Cage : Electronics Measurement
3. Patranabis: Principle of Industrial Instrumentation
7. C.D Johnson “Process control and Instrumentation”
Technology and Financial Management  
(502103)

Teaching Scheme: 3Hours/week                          Examination Paper : 100 Marks
Theory Paper :3Hours

1. Finance
   -Functions
   -Source of finance
   -National & International finance
   -Benefits & Limitations
   -Budgets & Budgeting Control

2. Costing
   -Significance of engineers
   -Traditional absorption costing
   -Marginal costing
   -Contract costing
   -Activity based costing
   -Process costing

3. Engineering Economic Analysis
   -Basic concepts & price theory
   -Supply & Demand
   -Consumer behaviour
   -Law of reducing returns
   -Competition- types, equilibrium
   -Inflation & unemployment
   -Foreign trade
   -Balance of payment

4. Quality Management
   -Fundamentals of TQM, Deming, Juran
   -Kaizen
   -JIT
   -ISO 9000
   -ISO 14000

5. Project Management
   -Project life cycle
   -CPM
   -PERT
   -BOT
   -Public Private Participation
6. HR Management
   - Difference between personnel management & HR management
   - Role of HR Manager
   - Manpower planning
   - Merit rating
   - Training & Development
   - Retirement & Separation
   - Organizational Development & Behaviour
   - Management by objectives

Books:
1) S C Kuchal, Indian Economics
2) Prasad N K, Cost Accounting, Book Syndicate Pvt. Ltd., Kolkata 700 009
4) E Dessler, Human Resource Management
5) R S Dwivedi, Managing Human Resporces
6) Chase Operations Management for Competitive Advantage
7) B S Sahay, World Class Manufacturing
8) Juran, Quality Control Handbook
9) K Ishikawa, Guide to Quality Control
1. **Introduction to Design Engineering Materials:**
   General considerations, Aesthetic & ergonomics considerations, use of standards in design, preferred sizes. Selection of material, various engineering materials, heat treatment process, weight point method.

2. **Design Against Static & Fluctuating Load:**
   Modes of failure, factor of safety, shear stress & strain. Stress due to bending moment, due to torsional moment, principal stress, theories of failure, fluctuating stress fatigue, design for finite & in infinite life.

3. **Design of shaft, Keys & Coupling:**
   Shaft design on strength basis & torsional rigidity basis, ASME code for shaft design, design of square, Kennedy key. Design of rigid & flexible coupling.

4. **Springs:**
   Various types of springs & their applications. Design for static & fluctuating loads, optimum design of helical spring, composite springs, leaf spring, nipping & shot penning of leaf spring, helical torsion springs.

5. **Bearings:**
   Sliding contact-Hydro static & Hydrodynamics bearing, sintered metal bearings, rolling contact bearing, static & dynamic load carrying capacity, selection of bearings from industrial catalogue. Design for cyclic loads & speeds. Bearings with probability of survival other than 90%. Selection of materials, Bearing life, over design factor, safety factor, duty cycle, FMEA/FEMAP.

6. **Gears:**
   Classification, selection of types of gears, design of spur gears, gear design for maximum power transmitting capacity. Corrected gears-S gearing & So gearing etc.

**Term Work**
1. Design of mechanical system consisting of above components such as simple gear box,
2. Optimum design of machine components.

**Reference Books:**

4. V.B. Bhandari- design of Machine Elements, Tata McGraw Hill.
1. Introduction To Signals & Systems

2. System analysis
Basic elements of DSP & its requirements, advantages of digital over analog signal processing, sampling theorem. Introduction to LTI system, Block diagram& system terminology, Impulse response. Convolution, properties of convolution, system interconnection, correlation, auto correlation.

3. Signal analysis
Discrete Fourier transforms, properties of IDFT, Linear filtering methods based on DFT, FFT algorithms. Frequency analysis of discrete time signals, power intensity, Energy density, Application of FFT, DTMF, Spectral Analysis, power spectral density Definition of Z transform and relation between Z transform & Fourier transform.

4. Filters
Introduction to analog & digital filters, (explanation of different analog filters e.g. LPF, HPF,BPF,BSF ) Transfer function for FIR & IIR filters, comparison between FIR & IIR filters. Filter structures. Windowing methods for FIR filter.

5. Digital signal processors and applications
Harvard architecture and modified Harvard architecture. Introduction to fixed point & floating point processors, architectural features. Computational , Bus architecture & memory architecture. Selection of DSP processor for particular application. Analyzer, FFT in modal analysis, Time & frequency domain analysis of gear box, vibration analysis using sum and difference frequency. Applications of DSP in Mechatronics like vision systems, pattern recognition, dimensioning..

Laboratory Practice:
1. Case study I on DSP application.
2. Case study II on DSP application.
REFERENCES

1. Roberts M.J.- Signals & systems- TMH
2. Simon Haykin- Signal &systems- PHI
3. J.G.Proakis, D.G. MANOLIKIS “ Digital signal processing” PHI
4. S.K. Mitra “Digital signal processing” TMH
5. Ifeachaor,Jervis “Digital signal processing” Peterson
6. Steven Smith “ Engineer & Scientists guide to DSP”
7. Texas Instruments & Analog Devices DSP Chip manuals
Advance Material Science
Elective –I (502804-C)

Teaching Scheme
Lectures: 3 Hrs per week

Examination Scheme:
Paper: 100 Marks
Paper Duration: 3 Hrs.

1. Aspects of Physical Metallurgy
   Crystal structure, systems and Barvias lattices, Indexing of lattice planes (Miller’s Indices), Indexing of lattice directions, Co-ordination Number (Ligency), Density calculations and imperfections in crystals

2. Equilibrium diagrams

3 Heat Treatment
   Heat Treatment of Non ferrous alloys, Heat Treatment of Tool steels

4 Materials
   Orthodental materials, Bio material, Prosthetic materials, Nano materials, super conducting materials, sports materials. Composites, ceramics, cermets, shape memory alloys their manufacturing techniques, advantages and limitations.

5. Surface coating
   Surface coatings and their tribological aspects. PVD, CVD, IVD ion implantation method.

6. Chemical analysis
   Chemical analysis, strength/ structural evaluation, material defects, special process, machinability before and after special process, lubrication and wear characteristics, typical values for various applications, ASME standards for material inspection.

Lab Practices

1. Study of effect of various coatings rates on steel samples by microscopy (Min. 4 studies)
2. Study of effect of various heat treatments on microstructures of non ferrous alloys (Min. 4 samples)

Reference Books

2. Elements of Material Science and Engineering, Lawrence H., Van Vlack Addison-Wesley Publishing Company
8. Biomaterials and Bioengineering Handbook, Donald L. Wise, Marcel Dekker Inc.
1. **Introduction to linear & nonlinear control systems.**
   Open loop & closed loop. Feedback & feed forward systems. Any real time application should be discussed. Transfer function using block diagram representation & signal flow graph using Mason’s gain formula. Role of error and zero error system. Position control systems.

2. **Time domain analysis**

3. **Frequency domain Analysis**
   Frequency domain specifications, Bode plot Gain margin and phase margin, Mapping theorem and Nyquist plot.

4. **State variable analysis and Design**
   State variable representation of SISO, MIMO, Conversion of state function into transfer function. State models- solution of state equations.- controllability, observability. Common types of nonlinear phenomena- Linearization, Singular points,

5. **Recent trends in control system**
   Optimal control, Adaptive control – Classification of MRAC systems, self tuning regulator, Analysis and design of digital controllers, Inferential control, System identification, DMC & IMC algorithm, MIMO control systems.

6. **PID Controllers**
   On/off controller, continues controllers, P, I, D, PI, PD, PID actions, tuning of PID Controllers, self tuning controllers.
**Laboratory Practice**: Perform any two practicals from the following list of practicals.

1. Study of any parameter (for example flow, level etc.) using PID controller.
2. Analysis of first/second order non linear system using MATLAB.
3. Any one Industrial Application of model reference control –A survey.
4. Case Study: position control in old CNC
5. Digital position control in new CNC.
6. Analog versus digital performance comparison in servo positioning
7. Single axis (stand alone), multiple axis (simultaneous) servo position control system.

**References**

1. Ogata K., “Modern Control Engineering” Prentice Hall of India
5. Chalam V.V., “Adaptive control systems” INC New York
7. Stanley M. Shinners, “Modern Control system theory and design” John Wiley & sons.
Theory of Machines and Mechanisms
Elective-II (502805 B)

Teaching Scheme: 3Hours/week Examination Paper : 100 Marks
Theory Paper : 3Hours

1. Introduction
Link- binary, ternary, quaternary; kinematics pair, classification; Constraints-complete, incomplete, successful; Kinematics chain-four bar, single slider and double slider; mechanisms, inversions of above kinematics chains, Grashof’s Law, machine, Straight Line Mechanism. Degree of freedom (Mobility) Kutzbatch criteria, Grubler’s criteria

2. Velocity in Mechanisms
Definition of velocity, rotation of a rigid body, velocity difference between points of a rigid body, velocity determination by graphical method, apparent velocity of appoint in moving co-ordinate system, apparent angular velocity, direct and rolling contact. velocity determination by analytical method for slider crank mechanism velocity determination by complex algebra method, chance solution, loop closure equation (method of kinematics coefficient) vector method for finding velocity. Instantaneous centre of velocity, Arnold Kennedy theorem of three centers, velocity analysis using instant centers, angular velocity ratio theorem, relationships between first order kinematic coefficient and instant centers. Fraudenstein’s theorems, indices of merit, centrodes

3. Acceleration in Mechanism
Definition of Acceleration, angular acceleration, acceleration difference between points of body, acceleration polygon, apparent acceleration of a point in moving coordinate system (Corioli’s component of acceleration), apparent angular acceleration, direct contact and rolling contact. Analytical method for acceleration for acceleration determination in slider cranks mechanism, complex algebra method of kinematics coefficient. Chance solution. Instant centre acceleration Euler-Savary equation. Bobillier construction, Radius of curvature of a point trajectory using kinematics coefficient, the cubic of stationary curvature.

4 Introduction to Synthesis of Linkages
Type, Number and Dimensional synthesis, Function generation, Path generation and body guidance, two-position synthesis of slider crank mechanism. Two-position synthesis of crank and rocker mechanism, crank rocker mechanism with optimum transmission angle. Three rocker mechanism. Four position synthesis, point position reduction. Precision position, structural error, Chebychev spacing, Overlay method for synthesis of a function generator, Coupler curve synthesis.

5 Free Vibration of Longitudinal and Torsional systems:
Introduction to vibration, elements of a vibratory system, S.H.M. degrees of freedom, modeling of a system, Concept of linear and non-linear systems. Equivalent spring damper and inertia for linear and tensional systems.

Undamped free vibrations: Single degree of freedom-Natural frequency by Equilibrium and Energy methods, natural frequency of tensional vibrations.
Damped free vibrations- Single degree of freedom-Different types of damping, free vibrations with viscous damping, -over damped, critically damped and under damped systems, initial conditions, logarithmic decrement. Dry friction or Coulombs damping-frequency and rate of decay of damped vibrations.

6 Cams And Follower

Types of cams and followers, Analysis of Standard motions to the follower, Determination of cam profiles for given follower motions, Analysis of cams with specified contours-circular arc cams, tangent cam, eccentric cam, kinematically equivalent system, jump phenomenon, introduction to advanced cam curves

Laboratory Practices

1. Selection of optimum prime mover for a servo positioning application
2. Selection of optimum prime mover for a conveyrised transmission.
3. Types of (families) standard components available in the market for integrating into the machines.
4. Control system features, which can make mechanical design simple, cost effective and flexible.
5. Effect of step acceleration – Jerk and vibrations ways of minimizing through mechanical design and control features.
6. Hypothetical mechanism for automated handling of a ‘Rubic cube’

Reference Books

1. Beven T. -Theory of Machines
2. Jagdishal. -Theory of Machines
4. Grower G.K. – Mechanical Vibrations
5. Rao S.S. - Mechanical Vibrations
6. Hannah& Stephans- Mechanical Vibrations
7. A.Gosh & Malik- Theory of Machines& Mechanisms
Instrumentation & Automatic Control
Elective – II (502805-C)

Teaching Scheme
Lectures: 3 Hrs per week

Examination Scheme:
Paper: 100 Marks
Paper Duration: 3 Hrs.

1) Introduction
Introduction to measurements for scientific and engineering application need and goal. Broad category of methods for measuring field and derived quantities.

2) Principles of measurement
Parameter estimation, regression analysis, correlations, error estimation and data presentation, analysis of data.

3) Measurement of field quantities
Thermometry, heat flux measurement, measurement of force, pressure, flow rate, velocity, humidity, noise, vibration, measurement of the above by probe and non instructive techniques. Feedback elements used in various control applications such as pressure, force, torque, velocity, temperature and position measurement. Meaning of electronic gearing, Electronic cam and programmable limit switches.

4) Measurement of derived quantities
Torque, power, thermo physical properties, radiation and surface properties. Feedback and sensor device techniques used on Mechatronics techniques, Actuators used in Mechatronics equipments.

5) Analytical methods
Analytical methods and pollution monitoring, mass spectrometry, chromatography, spectroscopy

6) PID controllers
Basics of P, PI, PID controllers, pneumatic and hydraulic controllers, electronic Controllers, applications to machine tools, furnaces, material handling etc.

Laboratory Practice
1) Calibration of pressure gauge
2) Computer aided experimentation for temperature measurement.
3) Design of control system for boiler/compressor/pumps/turbines
4) Problem of analysis of data and error estimation.

Reference Books
2) Beckwith TG. N. Lewis Buck and Marangoni R.D: Mechanical Measurements, Narosa Publishing House, New Delhi
3) Liptak B.G. Instrument Engineers’ Handbook
5) Modern Electronic Instrumentation and Measurement Technique by A.D. Helfrick and W.D. Cooper
6) Johnson C.D., Process Control Instrumentation
1. **Introduction**  
Introduction to 8 bit architecture, memory and I/O interfacing, Introduction to software and hardware tools (Cross assembler, Logic analyzer, Emulator, Simulator).

2. **8051 Architecture**  
8051 architecture, comparison with microprocessor, Pin diagram, clock and oscillator, flags, PSW, Stack, Internal Memory, External Memory, Idle mode, Power down mode, SFR counter, timer, timer mode, serial I/O, and interrupt structure.

3. **Programming**  
Instruction set, addressing mode and programming of 8051. Interfacing to external world, external RAM and ROM, Display (LED/LCD) and keyboard, ADC and DAC, memory Interfacing, Stepper motor, I²C compatible,

4. **PIC Controllers**  
Architecture of PIC microcontrollers, features, interfacing of I/O devices with PIC controllers. PIC 16c6x, 16c7x. PIC memory organization.

5. **ARM Controllers**  

6. **Buses and protocols**  
Buses and protocols, RS 232 C, RS485, I²C, SPI, Modbus.

7. **Derivatives of microcontroller**  
Conceptual Study of various derivatives of 8051 microcontroller such as RD, OTP, AVR, containing PWM, RTC, Timer, EEPROM, in system programming.

**Laboratory Practice** : Perform any three practicals from the following list of practicals.

1. Interfacing of keyboard and display.
2. Interfacing of stepper motor and ADC/DAC.
3. I²C Interfacing
4. RS-232 Interfacing
5. Interfacing of displays and peripherals to ARM processors.
6. Covert a proven Rubic cube algorithm into a higher level language, cross compile and use the micro controller to guide a robot to solve the rubic cube.
(7) Implement a row column matrix of optical sensors connected with microcontroller. Implement a user friendly storage system for an assembly station where assembly operator will pick up assembly components from storage in desired sequence only (sequence on microcontroller, feedback from optical row column matrix, flashing lamps for every location for user friendly implementation.)

(8) Implement a simple PLC on a microcontroller kit.

References:

2. Predko, “Programming and customizing 8051 microcontroller”, TMH
3. Peatman “Programming PIC microcontrollers”, Pearson Education
5. Rajkamal “Microcontrollers, Architecture & Programming” Pearson Education
7. ArmProcessor Handbook “Domnic Symens”
1. Automation strategy

2. PLC
Advance applications of PLC. PLC programming methods as per IEC 61131, PLC applications for batch process and Process using SEC, Analog control using PLC, PLC interfacing to SCADA/DCS using communications links, Industrial Ethernet.

3. Distributed control systems
Distributed control systems: DCS introduction, functions, advantages and limitations, DCS as an automation tool to support Enterprise resource planning, DCS component block diagram, Architecture of different makes, DCS Specifications, Latest trends and developments, performance criteria for DCS and other automation tools. SCADA specifications for different real time applications.

4. Numerical control machines
Fundamentals of numerical control including system concept, Design features of NC and CNC machines, Devices: drivers, servomechanism, tooling specifications, feedback components, positioning control, &countering pattern.

5. CNC
CNC concepts, principle of operation of CNC, steps in manufacturing, construction features including drivers and structures, Advantages and limitations of CNC, axis of CNC machines, CNC programming using G codes, use of subroutines, computer aided part programming using APT programming, 2D and 3D integration and programming from CAD models and data banks. Multiple channel concepts. PLC selection, CNC selection guidelines Absolute and incremental encoders, Interface

6. Sourcing, sinking
Sourcing, sinking of PNP/ NPN digital input, outputs, PLC scan, synchronous & asynchronous events, fast acting I/O modules, sequence logic, step logic, FCs, FBs concept.

Laboratory Practice: Perform any two practicals from the following list of practicals.
1. Development of Ladder diagram/ Programming PLC for level control, position control or any application.
2. NC/ CNC programming.
3. PLC/ CNC interface
4. Low cost PLC based automation.
5. Multiple PLC/ MMI/Servo system.
Perform any two assignments from the following list of assignments.

1. Design of robotic arm as Mechatronics case study.
2. Design of coin counter as Mechatronics case study.
3. Design of wending machine as Mechatronics case study.
4. Design of strain gauge based weighing machine as Mechatronics case study.
5. Design of rotary optical encoder as Mechatronics case study.
6. Design of skip control of CD player as Mechatronics case study.

References:

1. The management of control system Justification & Technical auditing: N E Britinica, ISA
2. Computer Aided process control S.K.Singh, Prentice Hall of India
3. Programmable Logic controllers Webb & Ries, Prentice Hall of India
4. Introduction of PLC Garry Dunning, Thomas learning
5. Distributed control systems for Industrial Automation Popovik Bhatkar, Prentice Hall of India
6. Computer based process control Krishna Kant, PHI India.
7. CAD/ CAM theory and practice by Ibrahim Zaid
8. Computer aided mechanical design & analysis by Ramamurthy V.
Drives & Actuators (502810)

Teaching Scheme: 3Hours/week  Examination Paper : 100 Marks
Theory Paper :3Hours

1. Introduction
Introduction to Electric motors, Solid state motors devices : SCR, TRIAC, MOSFET, IGBT. And their characteristics. Introduction to converters, Inverters, Choppers, cycloconverters.

2. Drive characteristics
Mechanical characteristics, constant torque and constant HP applications, four quadrant operation, rating of motors, selection of Drives.

3. DC drives
Single phase and three phase converters fed drives. DC Brushless (BLDC) conduction modes( continuous and discontinuous), Operation of drives, Gate drive circuits, performance parameters of converters. Chopper fed drives : Introduction, principle and modes of operation (four quadrant mode of operation) ,Types of chopper, closed loop drives. Self tuning

4. Induction motor drives

5. Control of stepper motors:

6. Actuators
Types of actuators, electromechanical actuators, rotary output actuators, Linear output actuators, Electro hydraulic actuators, smart actuators, Electro pneumatic actuators, solenoid valves, Features &selection criteria for actuators, spring/Diaphragm actuators, piston actuators.

7. Valves
Types of valves, Ball valve, butterfly valve, digital valves, valves applications, selection criteria for valves, valve sizing.

8. Feedback
The drive perspective, Hall Resolver , pulse coder.
Laboratory Practice

Perform any two practicals from the following list of practicals.

1. Study of AC and DC drives.
2. Pneumatic and Hydraulic actuators using trainer kits.
4. Study of different control valves.

References:

7. Liptak manual “Process Control”. 
Computer Aided Design
Elective-III (502811 A)

Teaching Scheme: 3Hours/week  Examination Paper : 100 Marks
Theory Paper :3Hours

1. Introduction
Introduction, Design Methodologies, Quality Function Deployment function,(QFD) and its use in design Future trends, projection of future needs, requirement Tree, Objective tree, Design Specifications, Product life cycle, Technological product development cycle.

2. Computer Graphics:
Three dimensional generalized transformation matrix, Geometric & co-ordinate transformation, Transformation, Scaling, Rotation, Reflection, Mirror, Shear, Perspective, Inverse coordinate transformation, Rotation about arbitrary point, Line and reflection about arbitrary plane .CAD/CAM data exchange, Data base requirement, Introduction to data exchange formats, IGES,PHIGS, GKS files, Graphics standards.

3. Geometric Modeling
Wire frame, surface and Solid modeling, comparison of wire Frame, surface and solid modeling, Solid manipulations. Concept drawing, Part drawing, final assembly drawing.


Solid modeling : Advanced solid modeling techniques, C_rep, B_rep, Hybrid modeling, Primitive instancing, sweeps, Cell decompositions, Parametric modeling, Constrained based modeling, Feature based modeling. Advantages, Disadvantages, Properties of each one.

4. Finite Element Analysis
Basic concept of FEM, Historical back ground, Engineering applications, steps of FEM, Comparison with other methods, Variational methods, Rayleigh- Ritz method and weighted residual method, boundary conditions, finite element discritization, element shapes, sizes, and node locations, interpolation functions, compatibility, completeness, and convergence requirement, FEM solution, pre-processing, Post processing, Kinematics and dynamic analysis of systems.

5. Rapid prototyping :
Introduction, need for prototyping, Basic process, RP techniques, stereo Lithography(STL), Selective Laser Sintering(SLS), Laminated object manufacturing (LOM), Fused Decomposition modeling (FDM), Solid Ground curing(SGC), 3Dd Ink jet Printing, Rapid tooling- Metal spray Electroplating, cast & resin tooling, Sintered tooling, Applications of RP, Future of RP, Design for manufacturing, Design for assembly, Design for maintenance .
6. **Simulation**:
Need for simulation, concepts of systems, Model & its purpose, types of simulation approaches –Event scheduling approach, Activity scanning process Interaction approach, Steps in simulation study, Advantages, Disadvantages & pitfalls, of simulation, Simulation Languages. Work cell simulation, off line programming, various types of files, compatibility and conversion of Heavy- light issues.

**Laboratory Practice** : Perform any two assignments from the following list of assignments.

1. Formation of structures using CAD/CAM software.
2. Study of surface and solid modeling.
3. Study of Rapid prototyping and tooling.

**References**:

1. CAD/CAM Theory & practice : Ibrahim Zeid, TMH
2. Principles of CAE systems : K.Lee, TMH
3. Computer aided mechanical design and analysis : Ramamurthy V, TMH.
4. Introduction to FEM : Chadrakant S.Desai
ROBOTICS
Elective-III (5028011 B)

Teaching Scheme: 3 Hours/week
Examination Paper: 100 Marks
Theory Paper: 3 Hours

1. Introduction

Definitions, History of robots, present and future trends in robotics, Robot classifications, Repeatability, Control resolution, spatial resolution, precision, accuracy. Robot configurations, Point to Point robots, Continuous Path robots, Work volume, Applications of robots. Drives used in robots- Hydraulic, Pneumatic and Electric drives. Comparison of drive systems and their relative merits and demerits. End effectors, classification, selection & design considerations. Reach diagram

2. Manipulator Kinematics


3. Manipulator Dynamics

Velocity, Acceleration of rigid body, mass distribution, Newton’s equation, Euler’s equation, Iterative Newton – Euler’s dynamic formulation, closed dynamic formulation, Introduction to Lagrangian formulation of manipulator dynamics, dynamic simulation, computational consideration. Inverse Dynamics. Mounting configurations, collision detection, Safety issues- Emergency, fencing, bending of motions, fine positioning, continuous motion, soft floating, complaint positioning. Degrees of freedom, manual movements Joint jog / Conversion jog, Qualifying the rotary joint positions, Impossibility of access/speed, Singularity.

4. a) Trajectory planning

Introduction, general considerations in path description and generation, joint space schemes, Cartesian space schemes, path generation in runtime, planning path using dynamic model, Joint space verses Cartesian Space, point to point and continuous trajectory, 4-3-4 & trapezoidal velocity strategy for robots.

b) Robot Programming languages

Introduction, robot programming methods, robot programming languages, Examples peculiar to robot programming languages. Artificial intelligence in robotics
5. **a) Robot Sensors**
   Internal and external sensors, position- potentiometer, LVDT, optical sensors, encoders - absolute, incremental, touch and slip sensors, velocity and acceleration sensors, proximity sensors, force & torque sensors, laser range finder, camera. Micro-controllers, Digital Signal Processing, centralized controllers, real time operating systems.

   **b) Robot Vision System**

6. **a) Robot Controllers**
   Essential components- mathematical model, transfer functions, Characteristic equation, types of controllers, Control System analysis and response, Drive for Hydraulic and Pneumatic actuators, H-bridge drives for Dc motor, Overload, over current and stall detection methods, example of a micro-controller/microprocessor based robot Controller.

   **b) Futuristic topics in Robotics**
   Micro-robotics and MEMS (Micro-electro-mechanical systems), fabrication technology for Micro-robotics, stability issue in legged robots under-actuated manipulators. Introduction to Mobile / Autonomous robots.

**Laboratory Practice**:
Perform any two practicals from the following list of practicals.

1. Study of motion conversion (rotary to linear) using mechanical components.
2. To build robotic arm using mechanical component and applying motor drive.
3. To perform pick & place operation using simulation software.
4. Study of pneumatic robot or robot vision system.

**References.**
7) R K Mittal and I J Nograth “Robotics and Control” T M Hill
Automotive Electronics
Elective-III (5028011 C)

Teaching Scheme: 3Hours/week
Examination Paper : 100 Marks
Theory Paper :3Hours

1. **Fundamentals of Automotive Electronics.**
   In automobiles electrical and Electronic systems are important. It has number of subsystems like starting system, charging system etc. Almost of the mechanical system are converted from mechanical to electronics. Current trends in Automobiles, open loop and closed loop systems - components for electronic engine management system. Electromagnetic interference suspension. Electromagnetic compatibility. Electronic dashboard instruments, onboard diagnostic system ,security and warming system. Electronic management of chassis systems- vehicle motion control.

2. **Batteries and accessories**
   Principle and construction of lead acid battery, characteristics of battery, rating capacity and efficiency of battery, various tests on batteries, maintenance and charging lighting system, insulated and earth return system, details of head light and side light, LED lighting system, head light dazzling preventive methods- Horn, wiper system and traffic indicator.

3. **Sensors and actuators.**
   Introduction, basic sensor arrangement, types of sensors such as- oxygen sensors, crank angle position sensors- Fuel metering/ vehicle speed sensors and destination sensors, Attitude sensor, Flow sensor, exhaust temperature, air mass flow sensors Throttle position sensor, solenoids, stepper motors, relays.

4. **Electronic fuel ignition and ignition systems.**
   Introduction, Feedback carburetor systems (FBC), Throttle body injection and Multi port and point fuel injection , Fuel injection systems, injection system controls, Advantages of electronic ignition systems. Types of solid state ignition systems and their principle of operation, Contact less ignition systems, Electronic spark timing control.

5. **Digital engine control system.**
   Open loop and closed loop control system, Engine cranking and warm up control- Acceleration enrichment. Deceleration learning and ideal speed control, Distributor less ignition – Integrated engine control system, Exhaust emission control engineering.

**Laboratory Practice :**

1. Case study I on automotive Electronics application.
2. Case study II on automotive Electronics application.
References

1. Introduction:
Introduction to Embedded systems, characteristics of Embedded systems, embedded systems applications, embedded system design challenges. Constraint driven design. Processor technology, IC Technology, and Hardware software co-design.

2. Hardware architecture
CPU bus, memory devices, I/O Devices, component interfacing, DMA, Interrupts, designing with microcontroller /embedded processors, introduction to system buses like CAN, MOD, USB, I²C.

3. Software architectures
Round robin, round robin with interrupts, shared data problems, function queue scheduling architecture, real time operating system architecture, task and task states, semaphore & shared data, operating system services- message queues, mail boxes & pipes, timer functions, & events, memory managements, interrupt routines.

4. Real time operating systems
Introduction to IDE, Introduction to mucos and Vxworks operating systems, features of operating systems, function calls of operating systems, applications of operating systems, Comparison between mucos & Vxworks.

5. Protocols & applications embedded systems
Wireless protocols: Bluetooth, Zigbee, wireless LAN, (802.11) Case studies : RFID, adaptive cruise control, system in a car, smart card & two dimensional robot arm.

Laboratory Practice: Perform any two assignments from the following list of assignments.

1. Case study 1: Digital camera as a embedded product.
2. Case study 2: Smart card as a embedded product.
3. Case study 3: Currency counting Machine
4. Study of real time operating systems.

References

2. Rajkamal “Embedded Systems” TMH Publication
3. Dr.K.V.K.K. Prasad “Embedded Real time systems”
5. John J. Labrosse, “Embedded system Building blocks complete and ready to use modules in C”
FUZZY LOGIC & NEURAL NETWORKS
Elective-IV (5028012 B)

Teaching Scheme: 3 Hours/week
Examination Paper : 100 Marks
Theory Paper : 3 Hours

1. Introduction and different architectures of neural networks:

2. Neural network for controls

3. Introduction to fuzzy logic.

4. Fuzzy logic control system
   Fuzzy logic controller – fuzzification interface- knowledge base- decision making logic – Defuzzification interface – decision of fuzzy logic controller – case study.

5. Neuro Fuzzy logic control

6. Fuzzy modeling and control

7. Neural controllers:

Laboratory Practice

1. Case study of automatic washing machine.
2. Case study of oven.
3. Case study of food processor.

References
2. Laurance Fausett, Fundamentals of Neural Networks , Prentice Hall
6. Klir G.J. & Yuan B.B. ,“ Fuzzy sets & Fuzzy logic” Prentice Hall of India