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)

Subject Code	Subject	Teaching Scheme		Examination Scheme				Credits
		Lect.	Pract	Paper	TW	Or	Total	
Sem – I								
502801	Applied Numerical Methods and Computational Techniques	03	-	100	-	-	100	03
502802	Mechanical & Electronic Measurements	03	-	100	-	-	100	03
502103	Technology and Financial Management	03	-	100	-	-	100	03
502804	Elective – I	03	-	100	-	-	100	03
502805	Elective – II	03	-	100	-	-	100	03
502806	Lab. Practice – I	-	06	-	50	-	50	03
502807	Seminar- I	-	04	-	50	-	50	02
	Total	15	10	500	100	-	600	20
Sem – II								
502808	Microcontrollers	03	-	100	-	-	100	03
502809	Industrial Automation	03	-	100	-	-	100	03
502810	Drives & Actuators	03	-	100	-	-	100	03
502811	Elective – III	03	-	100	-	-	100	03
502812	Elective – IV	03	-	100	-	-	100	03
502813	Lab. Practice – II	-	06	-	50	-	50	03
502814	Seminar – II	-	04	-	50	-	50	02
	Total	15	10	500	100	-	600	20

Sem – III

Subject Code	Subject	Teaching Scheme		Examination Scheme				Credits
		Lect.	Pract.	Paper	TW	Or	Total	
602815	Seminar – III	-	04	-	50	-	50	02
602816	Project Stage – 1	-	18	-	50	-	50	06
	Total	-	22	-	100	-	100	08

Sem- IV

Subject Code	Subject	Teaching Scheme		Examination Scheme				Credits
		Lect.	Pract.	Paper	TW	Or	Total	
602817	Project Stage – II	-	18	-	150*	50	200	12
	Total		18	-	150	50	200	12

*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

CODE	**Elective – I**	CODE	**Elective – II**
502804 A	Design of Machine Elements	502805A	Control Systems
502804 B	Digital Signal Processing	502805B	Theory of machines and Mechanisms
502804 C	Advance Material Science	502805 C	Instrumentation & Automatic Control

CODE	**Elective – III**	CODE	**Elective – IV**
502811 A	Computer Aided Design	502812 A	Embedded Systems
502811 B	Robotics	502812 B	Fuzzy Logic and Neural Networks
502811 C	Automotive Electronics	502812 C	Open (self study)**

** 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

(Review of Gauss – Elimination of Gauss- Seidel) ,LU Decomposition, Thomas algorithm for TDM.(Review of Bisection method, Newton –Raphson method), multivariable Newton- Raphson method .

2 Curve Fitting

a) Least square regression:-

i)(Review of Linear Regression, multiple linear regression)

ii)Non-linear regression – Gauss –Newton Method, steepest Descent Method, Marquardt Method, multiple non linear regression.

b) Interpolation & Extrapolation :- Review of quadratic, Lagrange's Interpolation), spline Interpolation, Double Interpolation, Extrapolation.

3 Eigen values of matrices, Differentiation and Integration

Power method, Householder & Given's method, Ritishauser method for arbitrary matrices.(review of divided difference formulae), Romberg integration, Gauss quadrature for double & triple integration.

4. Ordinary differential equations

Review of Euler's method, Heun's method, Mid- point method, Runge-Kutta Method , system of equations, Multi step method, Explicit Adams, Moulton Technique, Stiff equations, Adaptive step size control, Adaptive RK method, Embedded RK method, Step size control. Higher order ODE –Shooting method. Non Linear ODE, collocation technique.

5. Partial Differential equations

Solution of Parabolic, hyperbolic equations, Implicit & explicit schemes, ADI methods, Non linear parabolic equations- Iteration method, solution of elliptic equations- Gauss, Seidel & SOR method. Richardson method.

6. Finite element methods

Weighted residual methods, Variational methods, Finite element Linear, triangular, Rectangular ,quadrilateral, Introduction to Tetrahedron, & Hexahedron elements.

7. Fourier Transform methods

Fourier Transform, Vibration Analysis, Vibration conditions under step acceleration and ramp up acceleration. Stastical methods and normal process, averages$\pm 3\sigma$ 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 :

1. Numerical methods for Engineers : Steven C.Chapra, & Raymond P. Canale, TMH, Fifth edition.
2. Applied Numerical methods, Alkis Constantinides, McGraw Hill
3. Numerical solution of differential equations : M.K.Jain, 2nd Edition, Wiley Eastern.

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**
   DSO- block diagram, functioning, specifications, applications, various probes & its applications, bandwidth, sampling speed, depth of memory, FFT Analyzer and match functions. Logic analyzer- block diagram Specification, triggering methods, applications. Spectrum analyzer block diagram Specification, various functions available in high and SA, and their importance RTS, ETS, applications.

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.
3. Study of Digital Storage Oscilloscope.
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
4. A.K.Sawheney : A course in Electrical ,Electronic Measurement & instrumentation :Dhanpat Rai & Publications.
5. Liptak B.G. Instrument Engineers Handbook (Measurement), Chilton Book Co.1994.
6. Eckman D.P. “Industrial Instrumentation” Wiley Eastern Ltd.
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
3) Collin Drury, Management & Cost Accounting, English Language Book Series, Chapman & Hall, London [ISBN 0412 341204]
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
10) Fred Luthans, McGraw Hill Publications, Organizational Behaviour
11) Robbins S P, Prentice Hall Publications, Organizational Behaviour

Design of Machine Elements
Elective – I (502804 A)

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

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 safely, shear stress & strain. Stress due to bending moment, due to torsional moment, principal stress, theories of failure, fluctuating stress fatigue, design for finite & in finite 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:

1. Shigely J.E & Mischke C.R- mechanical Engineering, design, McGraw Hill Pub. Co.
2. Juvinal R.C- Fundamental of machine Components Design, John Wiley & Sons.
3. Spott M.F & Shoup T.E- design of machine Element, Prentice Hall International.
4. V.B. Bhandari- design of Machine Elements, Tata McGraw Hill.

Digital Signal Processing
Elective – I (502804 B)

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

1. Introduction To Signals & Systems
Definition of signal, classification of signals, continues & discrete time, Analog & Digital, Periodic and non periodic, Deterministic & non deterministic, Energy & power. Basic signals, & operations on signals, impulse. System: Definition, classification , Linear & nonlinear, Time variant & time invariant, casual & non casual, static &dynamic, Stability.

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.

REFRENCES

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
8. Application notes of Helwett Packard –Application note-243, Fundamentals of signal analysis.
9. Application notes of Helwett Packard –Application note-243-I, Dynamic signal analysis

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**
   Study of Equilibrium diagrams for Fe-C systems, Cu - Bronze alloys i.e. Cu:Zn, Cu:Sn, Cu:Al etc., Developments in metallic materials like HSLA state, maraging steels, dual phased steels, creep resisting steels, materials for high and low temperature applications, Nimerics, Inconels, Haste Alloys etc., Al, Ni alloys, Ti, Mg alloys.

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

1. Engineering Metallurgy, R. A. Higgins, Viva Books Pvt. Ltd.
2. Elements of Material Science and Engineering, Lawrence H., Van Vlack Addison-Wesley Publishing Company
3. Principles of Material Science and Engineering, William F. Smith, McGraw-Hill Book Co.
4. Material Science, R. B. Gupta, Satya Publications, New Delhi.
5. A Text Book of Material Science and Metallurgy, O. P. Khanna, Dhanpat Rai and Sons, New Delhi.

6. Material Science and Engineering an Introduction, William D. Callister, Jr., John Wiley and Sons Inc.
7. Smithells Metals Reference Book, E. A. Brandes and G. B. Brook, Butterworth Heinemann.
8. Biomaterials and Bioengineering Handbook, Donald L. Wise, Marcel Dekker Inc.

Control systems
Elective – II (502805A)

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

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**

   Time domain analysis of linear control system. First order & second order system. Error constant, steady state error, transient response specifications. Stability of control system. Routh Hurwitz criteria & root locus technique.

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
2. Nagrath I.J., & Gopal M, "Control system Engineering." Wiley Eastern Reprint
3. Kirk D.E., " Optimal Control Theory- An Introduction" Prentice Hall
4. Franklin G.F., J. David Powell, Michel Worfeman, " Digital Control Of Dynamic Systems"
5. Chalam V.V., "Adaptive control systems" INC New York
6. Gopal M., " Modern Control theory" Wiley Eastern Ltd.
7. Stanley M. Shinners, "Modern Control system theory and design" John Wiley & sons.
8. M.Gopal , "State variables and digital control methods" Tata McGraw Hill
9. B.C.Kuo, " Digital Control Systems" Oxford university Press

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, Grubleler'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. Jagdishlal. -Theory of Machines
3. Shigley J.E.& Uicker -Theory of Machines& Mechanisms
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

1) Doebelin E.O: Measurement Systems-Application and Design, McGraw Hill Publication Co.

2) Beckwith TG. N. Lewis Buck and Marangoni R.D: Mechanical Measurements, Narosa Publishing House, New Delhi
3) Liptak B.G. Instrument Engineers' Handbook
4) Bolton W, Mechatronics-Electronics Control Systems in Mechanical and Electrical Engg.
5) Modern Electronic Instrumentation and Measurement Technique by A.D. Helfrick and W.D. Cooper
6) Johnson C.D., Process Control Instrumentation
7) J.P.Holman: Experimental Methods For Engineers, McGraw Hill International Edition, Seventh Edition

Microcontrollers
(502808)

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

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 key board, ADC and DAC, memory Interfacing, Stepper motor, I^2C 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
Introduction to ARM controllers. Comparison between RISC & CISC processor. Versions & variants of ARM processor. Register model of ARM processor. Modes of operation. Applications of ARM processor.

6. Buses and protocols
Buses and protocols, RS 232 C, RS485, I^2C, 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) I^2C 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 stoarage 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:

1. Kennith Ayala, “8051 Microcontroller”, Thomas Learning.
2. Predko, “Programming and customizing 8051 microcontroller”, TMH.
3. Peatman “Programming PIC microcontrollers”, Pearson Education
4. A.V.Deshmukh “ Microcontrollers Theory & Applications ” McGraw Hill
5. Rajkamal “Microcontrollers, Architecture &Programming” Pearson Education
6. M.A. Mazidi &J.G.Mazidi “ The 8051 Microcontroller & Embedded systems”, PHI.
7. .ArmProcessor Hand book “Domnic Symens”

Industrial Automation
(502809)

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

1. Automation strategy
Plant wide control systems and Automation strategy. Evolution of instrumentation and control. Role of automation in industry. Benefits of automation. Introduction of automation tools PLC, DCS, SCADA, Hybrid DCS/PLC. Automation strategy evolution, control system audit, performance criteria, development of user requirement specification (URS) for automation, Functional design specifications (FDS) for automation tools.

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 PLCGarry Dunning, Thomas learning
5. Distributed control systems for Industrial Automation Popovik Bhatkar, Prentice Hall of India
6. Computer based process controlKrishna Kant, PHI India.
7. CAD/ CAM theory and practice by Ibraham 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
Stator & rotor control Drives. V/F control: Principle of operation. VSI &CSI fed drives. Braking methods for induction drives. Rotor resistance control. Slip power recovery scheme. Comparison of induction motor with servo motor, DC motor to DC Brushless, commutation- physical versus Electronic, Pneumatic/ Hydraulic valves, control elements, Actuator and drive selection Intelligent drive.

5. Control of stepper motors:
Stepper motor- Driver circuit – control algorithm – PID Laws- self tuning strategies .

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.
(3) Study of stepper motor drives.
(4) Study of different control valves.

References:

(1) Thyristorised D.C. Drives " Sen P.C. – John Wiley & sons.
(2) Thyristor control of AS.C. Motors, Murphy J.M.D. & Turnbull F.G. – Pergamon press.
(3) B.K.Bose, " Power Electronics & A.C. Drives " Prentice Hall Publication.
(4) M.Rashid " Power Electronics" Tata Mc GRAW Hill Publications.
(5) Dubey G.K., " Power semiconductor Drives ",Prentice Hall Publication.
(6) N.K.De and P.K.Sen," Electric Drives" , Prentice Hall Publication.
(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.

Surface Modeling : Representation of curves, in implicit & explicit forms, Polynomial & spline curves, Benzir curve & surfaces, surface modeling &volume modeling.

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
5. Rapid Prototyping : J.A. McDold, C.J. Ryall, D.I. Winpenny , John Wiley & Sons.

ROBOTICS
Elective-III (5028011 B)

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

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

Matrix representations of coordinate transformation, world, tool, use frames, teaching frames, transformation about reference frame and moving frame, Forward & Inverse Kinematics. Examples of 2R, 3R & 3P manipulators. Specifying position and orientation of rigid bodies, RPY and Euler's angle. Homogeneous coordinate transformation and examples, D-H representation of kinematics linkages. Forward and Inverse kinematics of various manipulators using D-H representations, Inverse Kinematics : geometric and algebraic methods .closed/ open loop kinematics, TCP/ Tool offset/ orientation X,Y Z and W,P,R

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

Introduction, Image acquisition, Illumination Techniques, Image conversion, Cameras, sensors, Camera and system interface, Frame buffers and Grabbers, Image processing. Applications – case study.

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
5. Case study: Fanuc robot program, syntax. Robot applications in welding, Pick and place.

References.

1) S.R.Deb, " Robotics Technology and Flexible Automation ", Tata McGraw Hill
2) M.P.Groover, M. Weiss R.N. " Industrial Robotics McGraw, Hill 1996
3) K.S.Fu, R.C.Gonzalez and C.S.G.Lee, " Robotics : Control , sensors , vision and
4) inintlligence ", MCGraw-Hill.1987.
5) J.J.Craig , Introduction to Robotics , Pearson Publications
6) Klafter , Richard D., et al " Robotics Engineering",PHI,1996.
7) Zuech,Nello, "Applying Machine Vision", John Wiley and sons, 1988.
8) R K Mittal and I J Nagrath "Robotics and Control T M Hill
9) Mark W Spong, et at" Robot Dynamics and Control" Wiley Publications
10) Saeed B Niku , "Introduction to Robotics, Analysis, Systems, Applications , PHI.

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. Electro magnetic 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.

<u>Laboratory Practice</u> :

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

References

1. William B. Riddens, “Understanding Automotive Electronics”, 5th Edition, Butterworth Hennimann Woburn, 1998.
2. Young A.P. & Griffiths, “ Automotive Electrical Equipment” , ELBS & New Press-1999.
3. Tom Weather Jr. & Cland c. Ilunter, “ Automotive computers and control system” Prentice Hall Inc., New Jersey.
4. Crouse W.H., “ Automobile Electrical Equipment” , Mc Graw Hill Co. Inc., New York ,1995.
5. Robert N. Brady, “ Automotive Computers & Digital Instrumentation” , Prentice Hall , Eagle woods Cliffs, New jersey, 1988.
6. Bechhold, “ Understanding Automotive Electronic”, SAE,1998.
7. Robert Bosch,” Automotive Hand Book”, SAE (5TH Edition),2000

Embedded Systems
Elective-IV (5028012 A)

TeachingScheme:3Hours/week **Examination Paper : 100 Marks**
Theory Paper :3Hours

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, I^2C .

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 : RF ID, 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

1. Frank Vahid & Tony Givargis : " Embedded System Design- A Unified Hardware/software introduction" Wiley Publication.
2. Rajkamal " Embedded Systems" TMH Publication
3. Dr.K.V.K.K. Prasad " Embedded Real time systems"
4. David Simon, " An embedded software Primer" Pearson Education
5. John J. Labrosee, " Embedded system Building blocks complete and ready to use modules in C"
6. Wayne Wolf, "Computers as components: Principles of Embedded System" Morgan Kaufman Publication.
7. Arnold S.Berger, " Embedded System Design"

FUZZY LOGIC & NEURAL NETWORKS
Elective-IV (5028012 B)

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

1. Introduction and different architectures of neural networks :
Artificial neuron - MLP – Back propagation –Hope field networks – Kohonen self organizing maps – adaptive resonance theory.

2. Neural network for controls
Schemes of neuro-control –Identification and control of dynamics systems – adaptive neuro controllers –case study.

3. Introduction to fuzzy logic.
Fuzzy sets – fuzzy relations – fuzzy conditional statements – fuzzy rules – fuzzy algorithm.

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
Optimization of membership function and rules base of fuzzy logic controller using neural networks –generic algorithm – Fuzzy neuron – Adaptive Fuzzy systems – case study.

6. Fuzzy modeling and control
Fuzzy sets –fuzzy set operators –Fuzzy reasoning –Fuzzy prepositions – Linguistic variables -Decompositions and Defuzzification- Fuzzy systems –case studies.

7. Neural controllers :
Introduction: Neural networks- supervised & unsupervised learning – neural network modes – single & multilayer –back propagation – learning & training, Neural controllers, case studies.

Laboratory Practice

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

References

1. Zimmermann H.J. , Fuzzy set theory & Applications , Allied Publications
2. Laurance Fausett, Fundamentals of Neural Networks , Prentice Hall
3. Rolstan D.W., “Principles of Artificial and Expert systems Development”, McGraw Hill Book Company.
4. Kosko B, “ Neural Networks & Fuzzy Systems”
5. Tsoukalas L.H. & Robert Uhrig ,“ Fuzzy & Neural Approach in Engineering " John Wiley & Sons.
6. Klir G.J. & Yuan B.B. ,“ Fuzzy sets & Fuzzy logic” Prentice Hall of India
7. Milion W.T., Sutton R.S. &Webrose P.J. , “ Neural network for controls” MIT Press.