

## COURSE STRUCTURE FOR M. TECH. IN MECHATRONICS ENGINEERING

### FIRST SEMISTER

<b>A. THEORY</b>							
Sl. No.	Code	Subjects	Contacts (Period / Week)				Credits
			L	T	P	Total	
1.	ME101	Advanced Engineering Mathematics	3	1	0	4	4
2.	ME102	Industrial Management	4	0	0	4	4
3.	ME103	Sensors & Actuators	4	0	0	4	4
4.	ME104	Mechatronic Systems	4	0	0	4	4
5.		Elective - I	4	0	0	4	4
Total of Theory						20	20

<b>B. LABORATORY / PRACTICAL</b>							
Sl. No.	Code	Subjects	Contacts (Period / Week)				Credits
			L	T	P	Total	
6.	ME191	Sensors & Signal Conditioning Lab	0	0	4	4	2
7.	ME192	Mechatronic Systems Lab	0	0	4	4	2
8.	ME193	Seminar - I	0	2	0	2	1
Total of Practical						10	5
<b>Total :</b>						30	25

**Elective – I: One subject to be chosen from the following subjects.**

Code	Subjects
ME105	Signal Conditioning and Data Acquisition System
ME106	Wireless Communications
ME107	Advanced Electrical Drives

## SECOND SEMESTER

<b>A. THEORY</b>							
Sl. No.	Code	Subjects	Contacts (Period / Week)				Credits
			L	T	P	Total	
1.	ME201	Application of Mechatronic Systems	4	0	0	4	4
2.	ME202	Advanced Microprocessor and Microcontrollers	4	0	0	4	4
3.	ME203	Industrial Automation	4	0	0	4	4
4.		Elective – II	4	0	0	4	4
5.		Elective – III	4	0	0	4	4
Total of Theory						20	20

<b>B. LABORATORY / PRACTICAL</b>							
Sl. No.	Code	Subjects	Contacts (Period / Week)				Credits
			L	T	P	Total	
1.	ME291	Seminar - II	0	2	0	2	1
2.	ME292	Machatronics Lab	0	0	4	4	2
		Total of Practical	-	-	-	6	3
Total :						26	23

**Elective – II: One subject to be chosen from the following subjects.**

Code	Subjects
ME204	Advanced Control System
ME205	Micro Mechatronics Systems
ME206	Digital Signal Processing

**Elective – III: One subject to be chosen from the following subjects.**

Code	Subjects
ME207	Product Design
ME208	Digital Image Processing & Machine Vision
ME209	VLSI Technology

**THIRD SEMESTER**

<b>A. THEORY</b>							
<b>Sl. No.</b>	<b>Code</b>	<b>Subjects</b>	<b>Contacts (Period / Week)</b>				<b>Credits</b>
			<b>L</b>	<b>T</b>	<b>P</b>	<b>Total</b>	
3.	ME301	Pre-submission Defense of Dissertation	0	0	0	0	4
4.	ME302	Dissertation (Part - I)	0	0	0	24	18
Total :						24	22

**FOURTH SEMESTER**

<b>B. THEORY</b>							
<b>Sl. No.</b>	<b>Code</b>	<b>Subjects</b>	<b>Contacts (Period / Week)</b>				<b>Credits</b>
			<b>L</b>	<b>T</b>	<b>P</b>	<b>Total</b>	
1.	ME401	Dissertation (Completion)	0	0	0	24	18
2.	ME402	Post-submission Defense of Dissertation	0	0	0	0	6
3.	ME403	Comprehensive Exam (Viva-Voce)	0	0	0	0	4
Total :						24	28

## SYLLABUS FOR MECHATRONICS ENGINEERING

### FIRST SEMISTER

#### ME 101 ADVANCED ENGINEERING MATHEMATICS

Total Contact Hrs: 40

Internal Assessment – 30  
Examination – 70  
Total Marks: 100

- 1. Statistics** **10L**  
Elements of statistics; frequency distribution; Concept of mean, median, mode and different types of distribution; Standard deviation and variance; Curve fitting by least square method; Correlation and Regression; Testing of hypothesis; Basic types of factorial design and Analysis of Variance.
- 2. Matrix Operation** **8L**  
Matrix operation; Eigen value and Eigen Vector by iterative methods; Diagonalisation of a square matrix.
- 3. Laplace Transform, Fourier Transform; Fourier Integral** **6L**  
Laplace Transform, Fourier Transform; Fourier Integral and their Applications;
- 4. Numerical Methods** **10L**  
Interpolation by Polynomials; Error Analysis; Solution of System of linear equation by Gauss-Seidel iterative method; Newton Rapson method; Numerical Integration by Gauss-quadrature; Solution of ordinary differential equation by Rayleigh-Ritz method.
- 5. Ordinary Differential Equation** **6L**  
i) 2nd Order homogeneous Equation ii) Euler Cauchy Equation, iii) Non homogenous linear equation. Partial Differential Equation : i) Wave equation – one dimension and two dimension, ii) Heat equation – one dimension and two dimension.

#### ME 102 INDUSTRIAL MANAGEMENT

Total Contact Hrs: 40

Internal Assessment – 30  
Examination – 70  
Total Marks: 100

- 1. Classification and Importance of Operations Management** **3L**  
Operations Management in corporate profitability & competitiveness; Operations strategy; Types & characteristics of manufacturing systems & service systems;
- 2. Operations Planning and Control:** **7L**  
Forecasting for operations; Inventory planning & control; Materials requirement planning; Planning production in aggregate terms; Operations scheduling;
- 3. Quality Assurance:** **10L**  
The quality assurance system; choice of process and reliability; control of quality.
- 4. Maintenance Function:** **6L**  
Preventive maintenance; Overhaul and replacement.
- 5. Management Information System:** **6L**  
Need & structure of MIS; Data Processing Systems; Data Sources & Management.
- 6. Management Information System:**  
Concept and evolution; Manpower planning; recruitment and selection; Motivating personnel; Leadership.

## ME 103 SENSORS AND ACTUATORS

Total Contact Hrs: 40

Internal Assessment – 30  
Examination – 70  
Total Marks: 100

- 1. Overview of measurement systems** **2L**  
Measurement devices; Difference between sensor, transmitter and transducer; Smart device;  
Primary measuring element selection and characteristics: Range; Response time; Accuracy; Precision; Sensitivity; Dead band; Dead time; Costs; Installation Problems.  
Signal transmission: Types of signal: Pneumatic signal; Hydraulic signal; Electronic Signal. Standard signal ranges: Electronic transmitter adjusted range; Pneumatic transmitter adjusted range; Transmission system dynamics; transmission Lag; Transmitter Gain; Smart transmitters.
- 2. Principles of Sensors** **2L**  
Classification of sensors. Characteristics and calibration of different sensors.
- 3. Displacement, position and motion sensors** **4L**  
Principles of variable resistance, variable inductance, variable reluctance, variable capacitance type sensors. Position and Motion sensors: Limit switches; Proximity sensors: Pneumatic Proximity sensor; Optical Proximity sensor; Inductive Proximity sensor; Capacitive Proximity sensor; Ultrasonic Proximity sensor.  
LVDT: construction; Working principle; signal conditioning; use of LVDT. The Tachogenerator: DC tachogenerator; Digital Tachogenerator; Optical type and magnetic type. Synchros and resolver. Encoders: types of encoder; Hall sensors: Working principle; Hall effect gear tooth sensor. Distance sensors.  
Light Sensor : Photovoltaic; Photoconductive (Photo resistors).  
Accelerometer : Definition; General Construction; Working Principle; Types of Accelerometer; Servo Type; Piezo Resistive Type; Capacitive Type; Variable reluctance type; Errors;  
Variable reluctance circuit Geometry; Auto null sensor amplifier; force balance servo sensor.
- 4. Force, Torque, Tactile** **5L**  
Different types of load cells and its application, Piezoelectric transducer, Torque measurement: Tactile sensors : Types, construction and working principle of Tactile sensors. magnetic, Piezoelectric, Photoelectric, capacitive and ultrasonic methods, Manometer, elastic elements.
- 5. Strain Gauges** **5L**  
Working principle; construction; poisson's ratio; Gauge factor, Piezo resistance Coefficient; strain sensing alloys; characteristics; gauges length, rosettes;  
Types of Strain Gauge : Bonded; Unbonded; Metallic; Semiconductor.  
Strain Gauge Measurement : Wheatstone bridge measurement; Advantage between full bridge, half bridge and quarter bridge; ppm; disadvantage of .bridge circuit; linearity error; lead error, bridge constant; temperature compensation; practical implementation of strain gauge (Installation method).
- 6. Pressure sensor** **5L**  
Few Definition on pressure; static, head, dynamic pressure. Classification of pressure;  
Pressure Measurement method : Manometric : U Tube manometer, well type; inclined tube manometer; dead weight; electric strain method.  
Mechanical pressure measuring elements: Bourden tube : Types – C Type; Spiral; Helical; Twisted; Bellows; Diaphragm. Design and construction of different types of pressure sensing elements. Application of Diaphragm: Capacitance Type, Reluctance Type, Strain Gauge Type and Inductive Type. Application of Bellows : Differential pressure; Pneumatic Servo mechanism type.  
Electrical and Piezoelectric pressure transducers, McLeod gage, Pirani gage and Ionisation gage.

- 7. Flow sensors** **5L**  
 The flow pioneers; Reynolds numbers; principle of flow measurement.  
 Types of Flow meter : Differential pressure type; positive displacement type; velocity type; mass meter type.  
 Differential pressure type : orifices; venturi tubes; flow tubes; flow nozzles; pitot tubes; elbow-tap meters; target meters and variable area meters.  
 Positive displacement type : Piston; Oval-gear; Nutating disk & Rotary-vane types.  
 Velocity meters : Turbine; Vortex shedding; Electromagnetic and Sonic designs.  
 Mass meters : Coriolis and Thermal types.  
 Head type flow meter, Electromagnetic flow meter, Rotameter, Anemometer, Ultrasonic flow meter.
- 8. Temperature sensor** **4L**  
 Mechanical and Resistance type temperature sensors, Thermocouples, Thermistor, Optical pyrometer.
- 9. Smart Sensor** **2L**  
 Methods of internal compensation, information coding, integrated sensor principles, present trends.
- 10. Sensors in Robotics** **2L**  
 Potentiometers, Synchros and Resolvers, Optical encoders, Tactile and Proximity sensors, Non-contact ranging sensors, Ultrasonic transducers, Opto-electric sensors, Geomagnetic sensors, Gyroscopes.
- 11. Actuators** **4L**  
 Definition of Actuators : Example; selection; Types of Actuators; linear; Rotary; Logical and Continuous Actuators.  
 Pneumatic Hydraulic system: Pneumatic actuator; Electro-Pneumatic actuator; cylinder, rotary actuators, Mechanical actuating system: Hydraulic actuator; Control valves; Construction; Valve coefficient or valve sizing; valve characteristics; types of valves; valve selection.  
 Electrical actuating systems: Solid-state switches, Solenoids, Voice Coil; Electric Motors; D.C. motors, Classifications; Application; Brass less DC Motor; Working principle and its application; AC motors, Single phase Motor; 3 Phase Motor; Induction Motor; Synchronous Motor; Stepper motors; half stepper; full stepper; linear motor, Piezoelectric actuator.

**ME104 MECHATRONIC SYSTEMS**

**Total Contact Hrs: 40**

**Internal Assessment – 30**  
**Examination – 70**  
**Total Marks: 100**

- 1. Electrical Systems** **8L**  
 Mathematical modeling of Electro Mechanical Systems, RLC Circuits, active and passive electrical circuits, PMDC Motor, Stepper motor, three phase squirrel cage induction motor, three phase permanent magnet synchronous motor, servo motor.
- 2. Mechanical Systems** **10L**  
 Introduction to various systems of units, mathematical modeling of mechanical systems, Newton's laws, moment of inertia, forced response and natural response, rotational systems, spring mass system, free vibration, spring mass damper system, mechanical systems with dry friction, work energy and power, passive elements and active elements an energy method for deriving equations of motion, energy and power transformers.
- 3. Fluid and Thermal systems** **6L**  
 Mathematical modeling of liquid level system: Resistance and capacitance of liquid level systems with interaction. Mathematical modeling of pneumatic systems: Resistance and capacitance of pneumatic systems, mathematical modeling of a pneumatic systems, liberalization of non-linear systems. Mathematical modeling of hydraulic systems: Hydraulic circuits, hydraulic servo-meter and mathematical model of hydraulic servo motor dashpots. Mathematical modeling of thermal systems: Thermal resistance and

thermal capacitance mathematical modeling of thermal systems.

4. **Design of Mechanical Elements** **12L**  
The phases of design, Design considerations, codes and standards, optimum design process, design variables, cost functions, design constraints, optimum design. Springs, rolling contact bearing, journal bearing, Spur and helical gear, bevel and worm gears, shafts, axes and spindles, Flexible Mechanical Elements, Belts, timing belts, chain and sprocket, flexible shafts, brakes, clutches, cams, four bar mechanism.
5. **Design of Hydraulic System** **4L**  
Hydraulic circuit design, Actuator design, selection of pumps, selection of valves, design of control circuits.

#### **ELECTIVE - I**

#### **ME 105 SIGNAL CONDITIONING AND DATA ACQUISITION SYSTEM**

**Total Contact Hrs: 40**

**Internal Assessment – 30**  
**Examination – 70**  
**Total Marks: 100**

1. **Analog Signal Conditioning** **15L**  
Introduction, Principles of Analog Signal Conditioning, Signal-Level Changing, Linearization, Conversions, Zero adjustment, Span adjustment, Filtering and Impedance Matching, Passive Circuits, Divider Circuit, Bridge Circuits, RC Filters, Operational Amplifiers, Characteristics, Op Amp Circuits in Instrumentation, Voltage Follower, Differential Amplifier, Instrumentation Amplifier, Active Filters, Voltage-to-Current Converter, Current-to-Voltage Converter, Linearization, Special Integrated Circuits (ICs), Industrial Electronics, Silicon-Controlled Rectifier (SCR), TRIAC.
2. **Digital Signal Conditioning** **15L**  
Review of Digital Fundamentals, Busses and Tri-State Buffers, Converters, Comparators, Digital-to-Analog Converters (DAC), Analog-to-Digital Converters (ADCs), Sample and Hold, Multiplexer and De-multiplexer, decoder and encoder, Pulse modulations, Digital recorder, Programmable Logic Controller.
3. **Data Acquisition System** **10L**  
Introduction, Analog and Digital Data Acquisition Systems, Block diagram, Components, CPU, Memory, Input / Output, Sensors, ADC, DAC, Sample and Hold, Multiplexing, De-Multiplexing, Modulation, Display, Recording, Alarm, Programming, Voltage, Current, Frequency, Temperature, Displacement, Pressure measurement using Data Acquisition System (DAS), Application of Data Acquisition System in Power plant, Process control plant and Automation, Data Logger.

#### **ELECTIVE – I**

#### **ME 106 WIRELESS COMMUNICATIONS**

**Total Contact Hrs: 40**

**Internal Assessment – 30**  
**Examination – 70**  
**Total Marks: 100**

1. **Basic issues** **3L**  
Linearity and time invariance, Random processes and noise, Sensitivity, dynamic range and noise floor, Interference
2. **Modulation** **3L**  
Analog modulation, Digital modulation, Detection
3. **Multiple Access Techniques** **5L**  
Mobile RF communications, Multiple Access, Wireless standards.

- |            |   |           |
|------------|---|-----------|
| <b>4.</b>  | <b><i>Transmitter Design and Receiver Design</i></b><br>Transmitter architecture, Transmitter performance tests, Receiver architecture.   | <b>5L</b> |
| <b>5.</b>  | <b><i>Low Noise Amplifiers</i></b><br>Input matching, Stability, Performance tradeoffs.   | <b>3L</b> |
| <b>6.</b>  | <b><i>RF Mixers</i></b><br>Designs of mixers, Performance of mixers, Noise in mixers.   | <b>5L</b> |
| <b>7.</b>  | <b><i>Oscillators</i></b><br>Basic LC oscillators, Voltage controlled oscillators, Design of oscillators, Quadratic signal generation, Single sideband conversion, Phase noise.             | <b>3L</b> |
| <b>8.</b>  | <b><i>Frequency synthesis</i></b><br>Phase locked loops, RF synthesizer architecture, Frequency dividers, Spurious responses, Direct Digital Synthesis.                                     | <b>3L</b> |
| <b>9.</b>  | <b><i>Power Amplifiers</i></b><br>Class A, B, AB, C, D amplifiers, High efficiency power amplifiers, Linearization techniques.  | <b>2L</b> |
| <b>10.</b> | <b><i>Antennas and Propagation</i></b><br>Electromagnetic radiation, Polarization, Friis equation, Small antenna designs, dipoles, monopoles, patch antennas, Path loss and fading.         | <b>3L</b> |
| <b>11.</b> | <b><i>Filters</i></b><br>Filter specification and design, Filter types, Filter technologies: LC, crystal, mechanical, SAW, & digital, DSP tradeoffs, software Defined Radio considerations. | <b>3L</b> |
| <b>12.</b> | <b><i>System Design Considerations</i></b><br>Packaging, Power, Heat dissipation, Parameter tradeoffs.  | <b>2L</b> |



## ME 107 ADVANCED ELECTRICAL DRIVES

Total Contact Hrs: 40

Internal Assessment – 30

Examination – 70

Total Marks: 100

- 1. Introduction to Electrical Drives** **2L**  
Electrical Drives, Parts of Electrical Drives, Dynamics of Electrical Drives, Components of Load Torques, Classification of Load Torques, Time and Energy-Loss in Transient Operations, Steady State Stability, Load Equalization.
- 2. Control of Electrical Drives** **4L**  
Modes of Operation, Speed Control and Drive Classifications, Closed-Loop Control of Drives, Current-limit control, Closed-loop torque control, Closed-loop speed control, Closed-loop speed control of multi-motor drives, Speed sensing, Current sensing, Phase-locked-loop (PLL) control, Closed loop position control.
- 3. DC Motor Drives** **8L**  
DC Motors and Their Performance, dc servo motors, Starting & Braking, Regenerative braking, Dynamic braking, Plugging, Transient Analysis, Speed Control, Transformer and Uncontrolled Rectifier Control, Controlled Rectifier Fed dc Drives, Single-phase fully-controlled and half-controlled, Three-phase fully-controlled and half-controlled rectifier control of dc motor, Dual-converter control of dc motor.
- 4. Induction Motor Drives** **12L**  
Three-Phase Induction Motors, Analysis and performance, Starting, Soft start using saturable reactor starter, Braking, Transient Analysis, Starting and plugging, Speed Control, Rotor Resistance Control, Static rotor resistance control, Slip Power Recovery, Static Scherbius drive, Static Kramer drive, Variable Speed Constant Frequency Generation, Squirrel-cage induction machine and Cycloconverter scheme, Wound-rotor induction motor and Cycloconverter scheme, Single-Phase Induction Motors: Starting, Braking, Speed Control, Linear Induction Motor and its Control, PWM voltage source inverter (VSI) induction motor drives, Load commutated inverter fed synchronous motor drives, CSI squirrel-cage induction motor drive, PWM VSI squirrel-cage induction motor drive, Load commutated inverter (LCI) fed Induction motor drive.
- 5. Synchronous Motor** **7L**  
Synchronous Motors, Starting, Braking, Synchronous Motor Variable Speed Drives, Variable frequency control, Modes of variable frequency control, Variable frequency control of multiple synchronous motors, Self-controlled synchronous motor drive employing load commutated thyristor inverter, Self-controlled synchronous motor drive employing a Cycloconverter, Starting Large Synchronous Machines.
- 6. Brushless dc Motor, Stepper Motor & Switched Reluctance Motor Drives** **7L**  
Brushless dc Motors Unipolar brushless dc motor, Bipolar brushless dc motor, Speed control of brushless dc motors, Important features and applications, Stepper (or Stepping) Motors, Variable reluctance, Permanent magnet important features of stepper motors, Torque versus stepping rate characteristics, Drive circuits for stepper motors, Switched Reluctance Motor.

## SECOND SEMISTER

### ME 201 APPLICATION OF MECHATRONIC SYSTEMS

Total Contact Hrs: 40

Internal Assessment – 30  
Examination – 70  
Total Marks: 100

- 1. Introduction** **4L**  
Definition of robot, classification of robots according to coordinate system and control method, Main components of robots – manipulator, sensors, controller etc, Robot characteristics – payload, reach, repeatability, accuracy, resolution.
- 2. Kinematics of Robot** **6L**  
Homogenous coordinates, Homogeneous transformation matrices, Direct and Inverse Kinematics of robots, Trajectory Planning.
- 3. Robot End effectors & Actuators** **6L**  
Types, mechanical grippers, other types of grippers, Tools as end effectors. Characteristics of actuating systems, Actuating System – Hydraulic devices, pneumatic devices, electric motors, other special actuators.
- 4. Sensors and Artificial Intelligence** **6L**  
Characteristics of Sensors, Position sensors, velocity sensors, acceleration sensors, force and pressure sensors, force and torque sensors, micro switches, touch and slip sensors, non-contact proximity sensors, Robot Vision System, Robot programming Languages – VAL, AML/2, ARM BASIC.
- 5. Application of Robots** **4L**  
Handling, loading, & unloading, Welding, Spray painting, Assembly, Machining, Inspection, Rescue robots, Underwater robots, Parallel robot, and Medical robot.
- 6. Mechatronic Elements of Modern CNC Machines** **8L**  
Machine Structure, Guide ways, Feed drives, Spindle and Spindle bearings, Measuring systems, Controls, software & operator interface, Ganging, Tool Monitoring.
- 7. Other Mechatronic Applications** **6L**  
Electronic Thermostat, Automatic Camera, Air fuel ratio controller in Automobiles, Digital Engine Control, Vehicle Motion Control, Mobile robots etc.

### ME 202 ADVANCED MICROPROCESSORS & MICROCONTROLLERS

Total Contact Hrs: 40

Internal Assessment – 30  
Examination – 70  
Total Marks: 100

- 1. Introduction to Microprocessor** **4L**  
8085 Microprocessor Architecture and Its Operations, Memory, Input/Output (I/O), Microcomputer System, Interfacing Devices, Basic Instructions, Programming Techniques with Additional Instructions, Counter and Timing Delays, Stack and Subroutines, Code Conversion, BCD Arithmetic and 16-Bit, Data Operations, Software Development Systems and Assemblers.
- 2. 8086 Microprocessor Architecture** **8L**  
8086 CPU Pins and Signals, Operating Modes, Minimum Mode, Maximum Mode, System Interrupt Configurations, Bus Timing Diagrams, Minimum Mode, and Maximum Mode.
- 3. 8086 Assembly Language Instruction and Programming** **10L**  
Instruction Set, Registers and Flags, General Purpose Registers, Pointer Registers, Index Registers, Segment Registers, Flags Register, How Instructions Affect the Flags Register, Addressing Modes, Program Memory Addressing Modes, Data Memory Addressing Modes, Addressing Mode Byte, Segment Override, Memory Addressing Tables, Instruction Set Mnemonics, Assemblers. Dependent Mnemonics, 8086

Instruction Groups & Programming.

4. **8051 Microcontroller** **10L**  
8051 Architecture Interfacing, 8051 Instruction Set, 8051 Application,
5. **8085 / 8086 / 8051 Interfacing** **8L**  
Interfacing Peripherals (I/O'S) & Applications, Parallel Input/Output and Interfacing Applications, Keyboard & display Interface, Interrupts Interfacing Data Converters, Programmable Interface Devices, General Purpose Programmable Peripheral Devices, Serial I/O & Data Communication Microprocessor Applications.

## ME 203 INDUSTRIAL AUTOMATION

Total Contact Hrs: 40

**Internal Assessment – 30**  
**Examination – 70**  
**Total Marks: 100**

1. **Introduction** **4L**  
Processes; Classification of Control system; Open loop and Close loop system; elements used in feed back control system; control loop study, samples of disturbances, control actions.
2. **Basic control schemes and controllers** **10L**  
On – off Control; Time proportional control; PI Control; PD Control; PID Control.  
Controller: Block diagram; Types of controllers; Self operated controllers; Electronic controller; Analog controller; Pneumatic controller; comparison between Pneumatic & Electronic controller; Hydraulic Controller; Programmable Logic Controller (PLC).
3. **Complex Control** **10L**  
Ratio Control: Objectives; Applications; Implementation methods; Loop Diagram; Furnace Air / fuel ratio control system; Important role of ratio control system; Environmental economical and safety benefits;  
Cascade Control : Objectives; key features for cascade control to be successful; advantage of Cascade Control system; Block diagram description; Transfer function. Design of Cascade Control System in shell and tube heat exchanger and Continuous Stirred Tank Reactor (CSTR); Design a 3 level Cascade Control System.  
Feed forward Control : Distinguished between feedback; Cascade and feed forward Control System; Objectives : loop diagram; Analysis of combine Feedback and feed forward control in a boiler drum level, CSTR, Shell tube heat exchanger etc., Block Diagram Description; Mathematical Details of the algorithm.  
Control Inverse Derivative Control : Objectives and advantages; Design and Analysis of IC based Inverse Derivative Control System; Controller Tuning; Application in DC generator voltage control and pressure control of a vessel; Variable Structure control : Reasons for variable structure; Selective Control; Process example. Overwrite control : Objectives; Loop diagram description; Design and Analysis of overwrite control system of a shell and tube heat exchanger; flow control in a pumping system for a sand water slurry. Split range control : concept; design and analysis of split range control system of a gas header having two inlets of different expensive gases for purchase and distribution; Characteristic equation; few process examples.
4. **Computer Control** **8L**  
Direct Digital Control (DDC), Distributed Control Systems (DCS) : Overview of Industrial Control System; ICS operation; ICS key components; SCADA System; DCS System; PLC System : Architecture; Systematic approach in designing a process control system; Input / Output adjustment opto-isolator device; I/O Devices in a PLC; Powering Field Devices in a PLC; PLC input / output types; Sourcing and sinking concept; PLC connections with process control system;.
5. **Adaptive Control** **2L**  
Standard approaches, Self adaptive, predictive, Self tuning.
6. **Process Control System** **6L**  
Boiler Control Steel Plant Instrumentation / Control System, control in Paper Industry,

Distributive Column : Variables to be controlled; materials balances diagram; steady state materials balances; pressure control; level control; selection of appropriate distillation column strategy; composition control, Belt Conveyor Control.

## ELECTIVE – II

### ME 204 ADVANCED CONTROL SYSTEM

Total Contact Hrs: 40

Internal Assessment – 30

Examination – 70

Total Marks: 100

1. **Review of classical control technique :** **6L**  
Mathematical models of Physical systems , performance specification, root locus analysis and design, frequency domain analysis & Design.
2. **Digital Control System :** **12L**  
Types of signals, Sampling Process, Sample – and – hold, Analog to Digital converter, Digital to analog converters, quantization and quantization error, Linear difference equation, pulse response z-transform, inverse Z transform, Z – transform Techniques.
3. **Modern Control** **12L**  
Concepts of states, State variable and state models linear continuous time and discrete time, state space models, similarity transformation, transform function to state space representation, controllability and stabilizability, absorbability and detectability canonical decomposition, polo assignment by state feedback. Observers, continuing state feedback with an observer.
4. **Non-Linear Control System** **10L**  
Introduction, Common physical non-linear ties. The phase – plane method, singular points, Stability of non-linear system, Construction of phase – trajectories, System analysis by phase plane method. The describing function method, Derivation of describing function, Stability analysis by describing function method, Jump resonance, Liapunov's stability criterion, Popov's stability criterion.

## ELECTIVE – II

### ME 205 MICRO MECHATRONIC SYSTEMS

Total Contact Hrs: 40

Internal Assessment – 30  
Examination – 70  
Total Marks: 100

- 1. *Micro-Mechatronics*** **10L**  
Introduction, Micro-Mechatronics elements, Microprocessor, Micro-sensor, Micro actuator, Interface, Energy, Materials, Machining, Micro physics, Applications of Micro Mechatronics.
- 2. *Micro – Sensors*** **10L**  
Introduction, Micro-sensor measurement principle, Micro-sensor fabrication techniques, modeling, Micro pressure sensors, Micro accelerometer, sensors, Micro thermal sensors, Micro floor sensors, Micro chemical sensors, Micro optical sensors, Micro sensor for humidity and displacement, application of micro sensors.
- 3. *Micro actuators*** **8L**  
Introduction, classification of micro actuators, electromagnetic, electro static, piezo electric, optical micro – actuators.
- 4. *Case study of Micro Mechatronics systems*** **12L**  
Testing of transportation Bridge surface materials, Transducer Calibration system, Strain Gauge Weighting system, Solenoid force, Displacement Calibration System, Rotary Optical Encoder, Thermal Cycle Fatigue of a Ceramic Plate, pH control, Temperature control system, Skip control of a CD Player.

## ELECTIVE – II

### ME 206 DIGITAL SIGNAL PROCESSING

Total Contact Hrs: 40

Internal Assessment – 30  
Examination – 70  
Total Marks: 100

- 1. *Introduction*** **5L**  
Introduction to signals and systems and representation of signals in time domain, Linear time invariant systems, impulse response and convolution sum, z transform and its properties, Inverse z-transform, Difference equation.
- 2. *Linear Shift Invariant system and realization structure*** **5L**  
Review of the Theory of LSI System, Discrete Time Fourier Transform (DTFT), Frequency Response of LSI system, Frequency response of First Order systems; Frequency Response of Second Order Systems, Realization Structures.
- 3. *Discrete And Fast Fourier Transforms*** **10L**  
Discrete Convolutions – Circular and Linear, Sectioned Convolutions, Discrete Fourier Transform and its Properties, Relation between Z-Transform and DFT, Introduction to Radix 2 FFT (Fast Fourier Transform), Properties of Radix 2 DIT algorithms, Decimation in Frequency Radix- 2 FFT, Computation of Inverse DFT Through FFT.
- 4. *Finite impulse Response (FIR) Filters*** **8L**  
Magnitude and Phase Response of FIR Filters, Linear Phase Response of FIR Filters, Linear Phase Response of Filters, Design of FIR Filters – Windowing (Fourier Series) Method, Design of FIR Filters Frequency Sampling Method.
- 5. *Infinite impulse response (IIR) Filters*** **7L**  
General Considerations, Design of Butterworth Filters, Design of Chebyshev Filters, Conversion of Analog of Digital Filters, Bilinear Transform Method.
- 6. *Programming & Application*** **5L**

Popular architectures and overview of programming Application of DSP, Speech and Audio Signal Processing, Radar Signal Processing.

### ELECTIVE – III

#### ME 207 PRODUCT DESIGN

Total Contact Hrs: 52

Internal Assessment – 30  
Examination – 70  
Total Marks: 100

1. **Introduction** **2L**  
Definition: Product development Process, Product Design; Types of design, engineering design; phases of modern product development process; Reverse engineering and redesign product development process.
2. **Product Development Process Tools & Scoping Product Developments** **4L**  
Product development team: definition, composition, team roles, Myer-Briggs type indicator, team structure, team building, team evaluation; Product Development Planning: Steps of planning, basic planning and scheduling tools; S-curves: definition, s-curves and new product development, technology forecasting; Basic method: technical questioning, mission statement; Advanced method: Business case analysis, design drivers;
3. **Customer Needs :** **5L**  
Customer satisfaction: Kano diagram, customer populations, types of customer needs, customer need models; Customer needs gathering methods: interviews, questionnaires, focus groups, be the customer need models; Customer Need Gathering Methods: Interviews, questionnaires, focus graphs, be the customer. Grouping the needs: affinity diagram method, customer sort method; determining need importance; interview data method, questionnaire method; cluster analysis method;
4. **Establishing Product Function Product Teardown & Experimentation:** **8L**  
Functional Decomposition: product function, sub function, abstraction, constraints; Modeling process: Function Analysis System Technique (FAST), Subtract and Operate procedure; Function structure: phases modeling process; Function structure decomposition; Product Teardown: phases of product teardown process; teardown methods; measurement and experimentation; Post teardown reporting; application of product teardown.
5. **Benchmarking & Establishing Engineering Specifications:** **6L**  
Benchmarking: steps of benchmarking, support tools for benchmarking; Setting product specifications: Specification process, fundamental requirements & constraints, specifications sheets, House of Quality, value analysis.
6. **Product portfolios, Portfolio architecture & Product Architecture:** **5L**  
Product portfolio architecture: definition, types, choosing an architecture type; Platform architecture: Modular family platform, functional architecting, steps of platform design method, functional architecting, non-platform based products, platform based products; Product architecture types: integral, modular; Product modularity: type of modularity, cluttering methods, advanced functional method, Architecture-based development teams.
7. **Generating Concepts, Concept Selection and Concept Embodiment** **5L**  
Concept Generating Process: basic methods, advanced methods, morphological analysis, combining solution principles; Estimating Technical Feasibility, Concept Selection Process, Pugh Concept Selection Chart, Measurement theory, Numerical Concept Scoring; Refining geometry and layout, Systems modeling.
8. **Modeling of Product Metrics** **3L**  
Model selection by performance specifications, Mathematical modeling, physical prototyping, constructing product models.

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| 9.  | <b><i>Design for Manufacture and Environment Assembly</i></b><br>Design guidelines, Manufacturing cost Analysis.   | <b>1L</b> |
| 10. | <b><i>Design for Environment</i></b><br>Environment objectives, Basic design for environmental methods, life cycle assessment, techniques to reduce environmental impacts.   | <b>2L</b> |
| 11. | <b><i>Analytical and Numerical Model Solutions</i></b><br>Solution definition, Pareto optimality, Spreadsheet search, concept of optimization, Analytical formulations, practical optimization   | <b>4L</b> |
| 12. | <b><i>Physical Prototypes Physical Models and Experimentation</i></b><br>Physical models, Prototypes, Types of prototypes, uses of prototypes. Rapid prototyping techniques, Scale, Dimensional analysis, Similitude, Physical prototype design and planning. Design of experiments, Reduced tests, Fractional experiments, Statistical analysis of experiments. | <b>4L</b> |
| 13. | <b><i>Design for Robustness:</i></b><br>Quality design theory, Taguchi's method.   | <b>3L</b> |

**ME 208 DIGITAL IMAGE PROCESSING & MACHINE VISION**

**Total Contact Hrs: 40**

**Internal Assessment – 30**

**Examination – 70**

**Total Marks: 100**

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| 1. | <b><i>Introduction</i></b><br>Digital image representation; fundamental steps in image processing; elements of digital image processing systems: image acquisition, storage, processing and display.   | <b>4L</b>  |
| 2. | <b><i>Digital Image Fundamentals</i></b><br>Structure of the human eye; image formation; brightness adaptation and discrimination; a simple image model; uniform and non-uniform sampling and quantization; some basic relationships between pixels; neighbors of a pixel; connectivity; Labeling. Distance measures; imaging geometry.  | <b>6L</b>  |
| 3. | <b><i>Image Enhancement in the spatial domain</i></b><br>Basic gray level transformations-histogram processing-Enhancement using arithmetic/logic operations-Basics of spatial filtering-comparison between smoothing and sharpening spatial filters.  | <b>4L</b>  |
| 4. | <b><i>Image Enhancement in the frequency domain</i></b><br>1D Fourier transform-2D Fourier transform and its Inverse-Smoothing & sharpening frequency domain filters (Ideal, Butterworth, Gaussian)-homomorphic filtering.   | <b>4L</b>  |
| 5. | <b><i>Image compression</i></b><br>Fundamentals-Image compression, Error-free compression: Huffman coding, block coding, constant area coding, variable length coding; bit-plane coding; lossless predictive coding.   | <b>4L</b>  |
| 6. | <b><i>Machine Vision</i></b><br>Introduction, definition, human visual system. Active vision system, increasing of machine vision. Machine vision components, hardware's and algorithms, image function and characteristics, image formation & image sensing frequency space analysis, Fourier transform, convolution algorithms, image gaussian, image enhancement, image analysis and segmentation data reduction, feature extraction, edge detection, image recognition and decisions, m/c learning, image processing, machine vision edges detection, application in the area such as inspection part identification, industrial robot control, mobile robot application. Industrial MVs in production and services, structure of industrial m/c vision, generic standards, rules of thumb, image formation, illumination, optics, interfacing machine vision system. Vision system calibration. | <b>12L</b> |
| 7. | <b><i>2D &amp; 3D vision</i></b>   | <b>6L</b>  |

Competing technologies, principle, CCD, Videcon and other cameras, data capture. Triangulation geometry, resolution, passive and active 3-D stereo imaging, data processing.

## ME 209 VLSI TECHNOLOGY

Total Contact Hrs: 40

Internal Assessment – 30  
Examination – 70  
Total Marks: 100

1. **Introduction to VLSI Design** **10L**  
Moore's Law, Design Levels of Abstraction, Logic to transistor Level Translation, Survey of Silicon Semiconductor Technology, Bipolar, CMOS, Bi-CMOS, Ga-As Technology.
2. **CMOS Fabrication and Processing Technology** **8L**  
Crystal Growth; Water Preparation; Oxidation; Diffusion, Ion Implantation NMOS, CMOS technologies; Layout Design Rules.
3. **Circuit Characterization and Performance Estimation** **14L**  
Introduction – Review of MOS Transistor Theory, Transistor Physics – Accumulation, Depletion, Inversion, Threshold Voltage; V-I Characteristics; Body Effect, Noise Margin; Latch-up; Resistance; Switching Characteristics Power Consumption; Yield; Scaling of MOS Transistor Dimensions.
4. **Current Trends of VLSI system-on-a-chip** **8L**  
Hardware/Software Co-simulation