B.Tech. Mechanical Engineering with Specialization in Mechatronics Engineering

Programme Electives

Sl. No.	Code	Course	L	T	P	C
1	1152ME148	MICROPROCESSOR AND MICROCONTROLLER	3	0	0	3
2	1152ME149	EMBEDDED SYSTEM & DEVICE DRIVERS	3	0	0	3
3	1152ME130	SENSORS AND ACTUATORS	3	0	0	3
4	1152ME131	DRIVES AND CONTROLS FOR AUTOMATION	3	0	0	3
5	1152ME132	INDUSTRIAL ROBOTICS	3	0	0	3
6	1152ME133	AUTOMOTIVE ELECTRONICS	3	0	0	3
7	1152ME134	MICRO ELECTRO MECHANICAL SYSTEMS	3	0	0	3
8	1152ME135	FACTORY AUTOMATION	3	0	0	3
9	1152ME136	FLEXIBLE MANUFACTURING SYSTEMS	3	0	0	3
10	1152ME137	INTELLIGENT MANUFACTURING TECHNOLOGY	3	0	0	3
		TOTAL CREDITS (Students should earn 18 credits from the above)				**18**

*** Students should earn 18 credits from the above programme electives to received degree in Mechanical Engineering with Specialization in Mechatronics Engineering**

COURSE CODE	MICROPROCESSOR AND MICROCONTROLLER	L	T	P	C
1152ME148		3	0	0	3

1. Preamble

The Purpose of the course is to provide students with the Knowledge of Microprocessors and Microcontroller. To solve real world problems in an efficient manner, this course also emphasis on architecture, Programming and system design used in various day to day gadgets.

2. Pre requisite

Basic electronic engineering

3. Links to other courses

Mechatronics system

4. Course Educational Objectives

Students undergoing this course are expected to:

- Gain knowledge on the basic concepts of Microprocessor and Microcontroller.
- Understand the concept of embedded systems.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Develop an ALP in 8085 microprocessor for the given problem statement	K2
CO2	Describe the architecture and functional block of 8051 microcontroller	K2
CO3	Write an embedded C and ALP for the internal components in 8051 microcontroller for the given design specification	K2
CO4	Describe various peripherals devices such as 8255, 8279, 8251, 8253,8259 and 8237	K2
CO5	Explain microcontroller application and basic architecture of PIC, ARM and ATMEGA processors.	K2

(K2-Understand)

6. Correlation of COs with Programme Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			L	M								M		
CO2			L	M								M		
CO3			L	M								M		
CO4			L	M								M		
CO5			L	M								M		

H- High; M-Medium; L-Low

7. Course Content

UNIT I: 8085 CPU **L - 9**

8085 Architecture – Pin diagram-Memory interfacing – I/O interfacing- Timing Diagram- Instruction Set-Addressing modes – Assembly language programming- 8086 Architecture, comparison of 8 bit (8085) and 16 bit (8086)processors.

UNIT II:8051 Architecture **L - 9**

Architecture – memory organization –I/O ports and circuits-Timers - Interrupts –serial communication - Interfacing of External memory-Interfacing LCD & Keyboard-RTC.

UNIT III: 8051 Programming **L - 9**

Addressing modes -instruction set -Assembly language programming and C Programming–Timer Counter Programming – Serial Communication Programming- Interrupt Programming.

UNIT IV: Peripheral Devices **L - 10**

Parallel peripheral Interface (8255) - Timer / Counter (8253) - Keyboard and Display Controller (8279) - USART (8251) - Interrupt Controller (8259)- DMA Controller (8237).

UNIT V:Microcontroller Applications & Advanced Processor **L - 8**

Temperature control system- Motor speed control system – Traffic light System – Elevator system-Data Acquisitions system - Introduction to architecture of PIC, ARM, ATMEGA processors.

Total: 45 Periods

8. Text Books

1. Ramesh S Gaonkar, Microprocessor Architecture, Programming and application with 8085, 6th Edition, Penram International Publishing .
2. Muhammad Ali Mazidi, Janice GillispieMazidi and Rolin D McKinlay, The 8051 microcontroller and embedded systems using assembly and C, second edition Pearson education Asia.
3. Mohamed Rafiquzzaman, Microprocessor and Microcomputer based system design, second edition, CRC press.

9. References

1. Kenneth J Ayala, The 8051 Microcontroller Architecture Programming and Application, third Edition, Penram International Publishers.
2. A.K Ray & K.M. Burchandi, Advanced Microprocessor and peripherals Architectures, Programming and interfacing “, second edition, Tata McGraw-Hill.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	20	20	20
Understand	30	30	20	30	30
Apply	50	50	60	50	50
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand	20	10
Apply	40	40
Analyze	40	50
Evaluate		
Create		

COURSE CODE	EMBEDDED SYSTEM & DEVICE DRIVERS	L	T	P	C
1152ME149		3	0	0	3

1. Preamble

The Purpose of the course is to provide students with the basic knowledge of embedded operating systems and device drivers. This course emphasizes knowledge on operating system used in embedded system.

2. Prerequisite

Microprocessor & Microcontroller

3. Links to other Courses

Mechatronics systems

4. Course Educational Objectives

After successful completion of this course, students will be able to

- Understand the concepts related RTOS and embedded systems.
- Understand the basic techniques in embedded systems.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain structure of the operating system Write code to create process and task	K2
CO2	Explain different synchronization mechanisms used in RTOS Write small codes to demonstrate synchronization concepts	K2
CO3	Explain different boot loaders technique used in embedded system	K2
CO4	Discuss about the kernel memory optimization techniques used in an embedded system	K2
CO5	Explain how a device driver can be written using Linux	K2

(K2-Understand)

6. Correlation of Cos with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1			L	M								M		
CO2			L	M								M		
CO3			L	M								M		
CO4			L	M								M		
CO5			L	M								M		

H- High; M-Medium; L-Low

7. Course Content

UNIT I: Introduction to Operating Systems **L-9**

Basic Principles -Operating System structures –System Calls –Files –Processes –Design and Implementation of processes –Communication between processes –Introduction to Distributed operating system –Issues in distributed system: states, events, Clocks-Distributed Scheduling-Fault &recovery-

UNIT II: Overview of RTOS **L-9**

RTOS Task and Task state –Multithreaded Preemptive Scheduler-Process Synchronization-Message queues–Mail boxes -pipes –Critical section –Semaphores –Classical synchronization problem –Deadlocks

UNIT III: Boot Loaders **L-9**

Board Support Packages: Inserting BSP in Kernel Build Procedure- Boot loader Interface–Memory Map – Interrupt Management-PCI Subsystem –Timers-UART- Power Management, Embedded Storage –MTD – MTD Architecture-MTD Driver for NOR Flash- Flash Mapping Driver -Embedded File Systems

UNIT IV: Embedded Kernel & Device Drivers **L-9**

Embedded Kernel: Optimizing storage Space-Tuning kernel memory
Embedded Drivers: Embedded Systems Model and Device Drivers–Classes of Devices Building reusable device drivers for microcontrollers, Ethernet Driver-I2C Subsystem, Watchdog Timer – Kernel Modules.

UNIT V: Linux Device Drivers **L-9**

Modules-Building and Running Modules, Linux Serial Driver, I2C Subsystem on Linux-USB Gadgets Debugging Techniques-Concurrency and its Management-Semaphores & Mutexes.

Total: 45 Periods

8. Text Books

1. Raj Kamal, “Embedded Systems -Architecture, Programming and Design” Tata McGraw Hill,2006.
2. P. Raghavan, Amol Lad, Sriram Neelakandan “Embedded Linux System Design and Development” Auerbach Publications 2005.

9. References

1. Jonathan Corbet, AllesandroRubini& Greg Kroah-Hartman “Linux Device Drivers” O’Rielly 3rd Edition 2005.
2. Silberschatz, Galvin, Gagne” Operating System Concepts, 6th edition, John Wiley,2003Jindal U.C. “Strength of Materials” Asian Books Pvt Ltd, New Delhi 2007.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I%	Unit Test-II%	Mid Term Test II %	
Remember	40	40	40	40	20
Understand	60	40	60	40	60
Apply		20		20	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand	20	10
Apply	40	40
Analyze	40	50
Evaluate		
Create		

COURSE CODE	SENSORS AND ACTUATORS	L	T	P	C
1152ME130		3	0	0	3

1. **Preamble**

This course provides the concept of sensor and how to interface the sensor in real time system with the concept of micro actuator, micro valves, micro sensor and microbots.

2. Pre-requisite

Industrial Robotics

3. Links to other Courses

Mechatronics system

4. Course Educational Objectives

Students undergoing this course are expected to gain knowledge in

- Understand the various types of sensor and its application.
- Understand the concept of micro actuator, micro valves, micro sensor and microbots.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Discuss about the concept of Linear and angular measurement sensors.	K2
CO2	Discuss about the concept of Straightness and Roundness measurement sensor.	K2
CO3	Discuss about the various type of sensor and its types	K2
CO4	Discuss about the concept of micro actuator and micro valves	K2
CO5	Discuss about the concept of micro sensor and microbots.	K2

(K2-Understand)

6. Correlation of Course Outcomes with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			L	M								M	L	
CO2			L	M								M	L	
CO3			L	M								M	L	
CO4			L	M								M	L	
CO5			L	M								M	L	

H- High; M-Medium; L-Low

7. Course Content

UNIT I LINEAR AND ANGULAR MEASUREMNTS L-9

General concepts of measurements – Definition, Standards of measurement – Errors in measurement, Accuracy, Precision. Length standard – Line and end standard – Slip gauges, Micrometers, Vernier, Dial gauges – comparators, types, principle and applications – interferometry – Angular measuring instruments – bevel protractor, levels, clinometers – Sine bar, angle dekkor – auto collimator.

UNIT II FORM MEASURMENTS AND COMPUTER AIDED METROLOGY L-9

Straightness, Flatness and roundness measurement, surface finish measurements, Tool makers microscope, various elements of threads – 2 wire and 3 wire methods – gear elements – various errors and measurements. Co-ordinate measuring machine – construction features – types – application of CMM – Computer aided inspection – Machine vision – Non contact and in-process inspection, Laser Interferometer and its application

UNIT III SENSOR L-9

Principles and Applications of displacement sensor – position sensors, linear and angular – velocity sensors – Torque sensors. Principle and applications of pressure sensor, flow sensors, temperature sensors, acoustic sensor and vibration sensors.

UNIT IV MICRO ACTUATORS AND MICRO VALVES L-9

Micro Actuators: Actuation principle, shape memory effects-one way, two way and pseudo elasticity. Types of micro actuators- Electrostatic, Magnetic, Fluidic, Inverse piezo effect, other principles. **Micro valves**: Electromagnetic, Piezoelectric, Electrostatic, Thermo pneumatic, Bimetal. Linear actuators-magnetic, electrostatic, piezoelectric.

UNIT V MICRO SENSORS AND MICROBOTICS L-9

Micro Sensors: Principles and examples, Force and pressure micro sensors, position and speed micro sensors, acceleration micro sensors, chemical sensors, biosensors, temperature micro sensors and flow micro sensors.

Microbotics: Drive principle, classification, application, micro assembly with the help of microbots, flexible microbots, Automated desktop station using micromanipulation robots.

TOTAL: 45 periods

8. Text Books

1. Jain .R. K., *Engineering Metrology*, Khanna Publishers, 1994.
2. Patranabis.D, *Sensors and Transducers*, Wheeler publisher, 1994.
3. Sergej Fatikow and Ulrich Rembold, *Microsystem Technology and Microbotics* First edition, Springer –Verlag NEwyork, Inc, 1997.

9. References

1. Gupta. I.C., *A Text book of Engineering Metrology*, Dhanpat Rai and Sons, 1996.
2. *ASTE Hand Book of Industries Metrology*, Prentice Hall of India, 1992.
3. Thomas . G. Bekwith and Lewis Buck.N, *Mechanical Measurements*, Oxford and IBH publishing Co. Pvt. Ltd.,
4. Massood Tabib and Azar*, Microactuators Electrical, Magnetic, thermal, optical, mechanical, chemical and smart structures ,* First edition, Kluwer academic publishers, Springer,1997.
5. Manfred Kohl *, Shape Memory Actuators*, first edition, *Springer.*

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I %	Unit Test-II %	Mid Term Test II %	
Remember	20	20	20	20	20
Understand	20	20	20	20	20
Apply	60	60	60	60	60
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand	20	10
Apply	40	40
Analyze	40	50
Evaluate		
Create		

COURSE CODE	DRIVES AND CONTROLS FOR AUTOMATION	L	T	P	C
1152ME131		3	0	0	3

1. **Preamble**

This course provides various concepts of Drives used in automation industry for the continuous process.

2. Pre-requisite

Industrial Robotics

3. Links to other Courses

Factory automation

4. Course Educational Objectives

Students undergoing this course are expected to gain knowledge in

- Understand the concept of DC, Synchronous motor and induction motor drive used in automation.
- Understand the concept of how to control the various types of drives.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Discuss the types of drives and the drive specifications.	K2
CO2	Discuss about the DC drives and their performance.	K3
CO3	Discuss about the induction motor drives and their performance.	K3
CO4	Discuss about the synchronous motor drives and their performance.	K3
CO5	Discuss about the selection of drive and drive control technique	K3

(K2-Understand)

6. Correlation of Course Outcomes with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			L	M								M	L	
CO2			L	M								M	L	
CO3			L	M								M	L	
CO4			L	M								M	L	
CO5			L	M								M	L	

H- High; M-Medium; L-Low

7. Course Content

UNIT I INTRODUCTION **L-9**

Introduction to drives – Selection of Motor power rating – Drive specifications – Constant speed and constant power operation.

UNIT II DC DRIVE **L-9**

DC motor and their performance – Armature control and Field control - Ward Leonard drives – converter fed and chopper fed Drive – four quadrant operation – closed loop control.

UNIT III INDUCTION MOTOR DRIVE **L-9**

Induction motor fundamentals – voltage control and variable frequency control (AC chopper, Inverter fed induction motor drives). – Rotor resistance control – slip power recovery scheme.

UNIT IV SYNCHRONOUS MOTOR DRIVE **L-9**

Synchronous motor fundamentals – open loop, closed loop variable frequency control – voltage and current source fed synchronous motor.

UNIT V DRIVE CONTROLS **L-9**

Digital technique in speed control – Advantages and limitations – Microprocessor based control of drives – Selection of drives and control schemes for steel rolling mills, paper mills, lifts and cranes.

TOTAL : 45 PERIODS

8. Text Books

1. Dubey G.K., *Fundamental of Electric Drives*, Narosa publishing house 1995.
2. Pillai S.K., *A first course on Electrical Drives*, New Age International (p) Ltd.,1984.

9. References

1. Dubey G.K. "*Power Semiconductor Controlled Drives*, Narosa publishing house 1995.
2. Vedam Subramanian *Thyristor Control of Electrical Drives* Tata Mc Graw Hill Publications, 1996.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I %	Unit Test-II %	Mid Term Test II %	
Remember	20	20	20	20	20
Understand	20	20	20	20	20
Apply	60	60	60	60	60
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand	20	10
Apply	40	40
Analyze	40	50
Evaluate		
Create		

COURSE CODE	INDUSTRIAL ROBOTICS	L	T	P	C
1152ME132		3	0	0	3

1. Preamble

This course provides an introduction to the robots types, Laws, configurations and application; Co-ordinate frames and types, Transformations and types; Forward and Inverse Kinematics of manipulator's; all types of robotic sensors; Open loop and closed loop control systems with examples

2. Pre-Requisite

Basic Electronics Engineering

3. Links to Other Courses

1 Mechatronics Systems
2 Factory Automation

4. Course Educational Objectives

To understand an overview of robotics in practice and research with topics including control systems, motion planning, mobile mechanisms, kinematics, inverse kinematics, and sensors.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Demonstrate knowledge of robot configurations and motions.	K2
CO2	Describe the operations of robot components	K2
CO3	Describe the sensing and visioning operations of robot	K2
CO4	Describe methods for programming robot	K2
CO5	Describe industrial applications of robot.	K2

(K2-Understand)

6. Correlation of COs with Programme Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			L	M	M							M	L	
CO2			L	M	M							M	L	
CO3			L	M	M							M	L	
CO4			L	M	M							M	L	
CO5			L	M								M	L	

H- High; M-Medium; L-Low

7. Course Contents

UNIT I: INTRODUCTION **L-9**

Definition of a Robot - Basic Concepts - Robot configurations - Types of Robot drives - Basic robot motions -Point to point control - Continuous path control.

UNIT II: COMPONENTS AND OPERATIONS **L-9**

Basic control system concepts - control system analysis - robot actuation and fed back, Manipulators – director and inverse kinematics, Coordinate transformation - Brief Robot dynamics. Types of Robot and effectors -Grippers - Tools as end effectors - Robot/End - effort interface.

UNIT III: SENSING AND MACHINE VISION **L-9**

Range sensing - Proximity sensing - Touch sensing - Force and Torque sensing. Introduction to Machine vision - Sensing and digitizing - Image processing and analysis.

UNIT IV: ROBOT PROGRAMMING **L-9**

Methods - languages - Capabilities and limitation - Artificial intelligence - Knowledge representation – Search techniques - A1 and Robotics.

UNIT V: INDUSTRIAL APPLICATIONS **L-9**

Application of robots in machining - Welding - Assembly - Material handling - Loading and unloading – CIM - Hostile and remote environments.

TOTAL : 45 PERIODS

8. Text Books

1. John J. Craig, Introduction to Robotics Mechanics and Control, Prentice Hall, 3rd Edition, 2004.
2. M.W. Spong, S. Hutchinson and M. Vidyasagar, “Robot modeling and control,” John Wiley and Sons, First Edition, 2005.
3. Norman S.Nise, " Control Systems Engineering", John Wiley and Sons, 6th Edition, 2010.

9. References

1. Richard D. Klafter, Thomas. A, Chri Elewski, Michael Negin, Robotics Engineering an Integrated Approach, Prentice Hall, 1989.
2. Frank L. Lewis , Chaouki T. Abdallah , D. M. Dawson, "Robot manipulator control: theory and practice", CRC press, 2nd Edition, 2003.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I%	Unit Test-II%	Mid Term Test II %	
Remember	40	40	40	40	20
Understand	60	40	60	40	60
Apply		20		20	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand	20	10
Apply	40	40
Analyze	40	50
Evaluate		
Create		

COURSE CODE	AUTOMOTIVE ELECTRONICS	L	T	P	C
1152ME133		3	0	0	3

1. **Preamble**

This course provide the concept of various automotive electronic component system working such as electronic fuel injection, digital engine control system, vehicle motion control and stabilization systems.

2. Pre-requisite

Basic Electronics Engineering

3. Links to other Courses

Factory automation

4. Course Educational Objectives

Students undergoing this course are expected to gain knowledge in

- Understand the concept of open and closed loop systems.
- Understand the various concept of automotive electronics system.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Discuss the open and closed loop systems and current trend in automation	K2
CO2	Discuss the various types of sensor and actuators.	K2
CO3	Discuss the concept of electronic fuel injection and ignition systems	K2
CO4	Discuss the concept of digital engine control systems	K2
CO5	Discuss the concept of vehicle motion and stabilization systems	K2

(K2-Understand)

6. Correlation of Course Outcomes with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			L	M								M	L	
CO2			L	M								M	L	
CO3			L	M								M	L	
CO4			L	M								M	L	
CO5			L	M								M	L	

H- High; M-Medium; L-Low

7. Course Content

UNIT 1 FUNDAMENTAL OF AUTOMOTIVE ELECTRONICS L-9

Current trend in Automobiles. Open loop and closed loop systems -Components for electronic engine management. Electronic management of chassis system.

UNIT II SENSORS AND ACTUATORS L-9

Introduction, basic sensor arrangement, types of sensors such as -oxygen sensors, Crank angle position sensors - Fuel metering, vehicle speed sensor and detonation sensor -Altitude sensor, flow sensor. Throttle position sensors, solenoids, stepper motors, relays.

UNIT III ELECTRONIC FUEL INJECTION AND IGNITION SYSTEMS L-9

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

UNIT IV DIGITAL ENGINE CONTROL SYSTEM L-9

Open loop and closed loop control systems -Engine cranking and warm up control - Acceleration enrichment - Deceleration leaning and idle speed control. Distributor-less ignition -Integrated engine control system, Exhaust emission control engineering.

UNIT V VEHICLE MOTION CONTROL AND STABILIZATION SYSTEMS L-9

Vehicle motion control - Adaptive cruise control, Electronic transmission control. Vehicle stabilization system - Antilock braking system, Traction control system, Electronic stability program. Onboard diagnosis system.

TOTAL : 45 PERIODS

8. Text Books

1. William B.Riddens, *Understanding Automotive Electronics,* 5th Edition, Butterworth, Heinemann Woburn, 1998.
2. Tom Weather Jr and Cland C.Hunter, *Automotive Computers and Control system*, Prentice Hall Inc., New Jersey.
3. BOSCH, *Automotive Handbook,* 6th Edition, Bentley publishers.

9. References

1. Young. A.P. and Griffths.L. *Automobile Electrical Equipment*, English Language Book Society and New Press.
2. Crouse.W.H., *Automobile Electrical equipment*, McGraw Hill Book Co Inc., New York, 1955.
3. Robert N Brady., *Automotive Computers and Digital Instrumentation*, A Reston Book. Prentice Hall, Eagle Wood Cliffs, New Jersey, 1988.
4. Bechtold., *Understanding Automotive Electronics*, SAE, 1998.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I %	Unit Test-II %	Mid Term Test II %	
Remember	20	20	20	20	20
Understand	20	20	20	20	20
Apply	60	60	60	60	60
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand	20	10
Apply	40	40
Analyze	40	50
Evaluate		
Create		

COURSE CODE	MICRO ELECTRO MECHANICAL SYSTEMS	L	T	P	C
1152ME134		3	0	0	3

1. Preamble

This course provides an introduction to various Micro electro mechanical device and Study about the principles of micro sensors, valves, pumps used in Microsystems.

2. Prerequisite

Basic Electronics Engineering

3. Links to other courses

Industrial Robotics

4. Course Educational Objectives

Students undergoing this course will be able to

- Understand the various Micro electro mechanical device
- Create confidence in the study of various Microsystems.

5. Course Outcomes

The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Know the scaling laws that are used extensively in the conceptual design of micro-device and able to use materials for common micro-components and devices	K2
CO2	Select a fabrication process suitable for production of a MEMs device	K2
CO3	Choose a micromachining technique, such as bulk micromachining and surface micromachining for a specific MEMS fabrication process.	K2
CO4	Understand the working principle of micro-sensors, actuators, valves, pumps, and fluidics used in Microsystems	K2
CO5	Acquire knowledge on micro system packaging and design	K2

(K2-Understand)

6. Correlation of COs with Programme Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1			L	M								M	L	
CO2			L	M								M	L	
CO3			L	M								M	L	
CO4			L	M								M	L	
CO5			L	M								M	L	

H- High; M-Medium; L-Low

7. COURSE CONTENT

UNIT I INTRODUCTION TO MEMS **L-9**

Introduction to MEMS: Introduction to Microsystems and micro electronics - Market scenario for MEMS. Working principle: Trimmers scaling vector and scaling laws - scaling in geometry - scaling in rigid body dynamics- scaling in electrostatic forces - scaling in electricity - scaling in fluid mechanics - scaling in heat transfer. Materials for MEMS: Silicon as a MEMS material - Crystal structure of silicon - Miller indices - silicon compounds - SiO2, SiC, Si3N4 and polycrystalline silicon - silicon piezo-resistors - Gallium arsenide - polymers for MEMS -quartz.

UNIT II FABRICATION OF MEMS **L-9**

Clean room technology - Substrates and wafer - single crystal silicon wafer formation - ideal substrates - mechanical properties - Processes for bulk micromaching - Wet Vs dry etching - Chemical etching of Silicon - etchant systems and etching process - Reactive ion etching and DRIE - mask layout design. Processes for Surface micromaching - Deposition processes - ion implantation - Diffusion - oxidation - chemical vapor deposition -physical vapor deposition - deposition by epitaxy - photolithography and photoresists. Limitations of Bulk and surface micromachining - LIGA, SLIGA and other micromolding processes such as HeXIL

UNIT III DESIGN CONSIDERATIONS BASED ON MICROMECHANICS **L-9**

Micromechanics considerations - static bending of thin plates - circular plates with edge fixed - rectangular plate with all edges fixed - square plate with all edges fixed - mechanical vibration - resonant vibration - micro accelerometers - design theory and damping coefficients - thermo mechanics - thermal stresses - fracture mechanics - stress intensity factors - fracture toughness - and interfacial fracture mechanics

UNIT IV MEMS DEVICES **L-9**

Micro actuation techniques - piezoelectric crystals - Shape memory alloys - bimetallics - conductive polymers. Micro motors - micro grippers - Microfluidic devices - Micro pumps - mechanical and nonmechanical micropumps - micro valves - valveless micropumps - Lab on Chip. Types of micro sensors - Microaccelerometer - Micropressure sensors, MEMS switches/resonators, MEMS reliability

UNIT V MICROSYSTEM PACKAGING AND DESIGN **L-9**

Micro system packaging - materials die level device level - system level - packaging techniques - die preparation - surface bonding - wire bonding - sealing - Case studies. Design considerations - process design - mechanical design - applications of micro system in automotive - bio medical - aerospace - telecommunication industries

TOTAL : 45 PERIODS

8. Text Books

1. Mohamed Gad-el-Hak, The MEMS Handbook, CRC Press Publishers, India, 2002
2. Tai Ran Hsu, MEMS and Micro Systems Design and Manufacture, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008
3. Nadim Maluf, An Introduction to Micro Electro Mechanical System Design, Artech House Publishers, London, 2004

9. References

1. Chang Liu, Foundations of MEMS, Pearson Education, New Delhi, 2011.James J. Allen, Micro Electro Mechanical System Design, CRC Press Publishers, India, 2005
2. Julian w. Gardner, Vijay K. Varadan and Osama O. Awadelkarim, Micro sensors MEMS and smart Devices, John Wiley and Sons Ltd., England, 2002
3. E.H. Tay, Francis and W.O.Choong, Micrfluids and Bio MEMS applications, Springer, 2002
4. Bhusan, Bharat (Ed), “Springer Handbook of Nanotechnology”, 2nd Edition, 2007.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I %	Unit Test-II %	Mid Term Test II %	
Remember	20	20	20	20	20
Understand	20	20	20	20	20
Apply	60	60	60	60	60
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand	20	10
Apply	40	40
Analyze	40	50
Evaluate		
Create		

COURSE CODE	FACTORY AUTOMATION	L	T	P	C
1152ME135		3	0	0	3

1. **Preamble**

This course provide the concept of various production, manufacturing, group technology, flexible manufacturing systems, material handling system and computer integrated manufacturing system

2. Pre-requisite

Industrial Robotics

3. Links to other Courses

Automotive electronics

4. Course Educational Objectives

Students undergoing this course are expected to gain knowledge in

- Understand the production and manufacturing system automation
- Understand the computer control system and material handling system.
- Understand the concept of computer integrated manufacturing systems.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Discuss about the various production automation strategies	K2
CO2	Discuss about the various manufacturing automation systems	K2
CO3	Discuss about the various computer control systems for automated process	K2
CO4	Discuss about the various material handling systems in automation	K2
CO5	Discuss about the concept of computer integrated manufacturing systems.	K2

(K2-Understand)

6. Correlation of Course Outcomes with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			L	M								M	L	
CO2			L	M								M	L	
CO3			L	M								M	L	
CO4			L	M								M	L	
CO5			L	M								M	L	

H- High; M-Medium; L-Low

7. Course Content

UNIT I PRODUCTION OPERATIONS AND AUTOMATION STRATEGIES L-9

Automation – Definition, levels, need, strategies principles. Types of production, functions in manufacturing, plant layout – types, organization and information processing in manufacturing, Types of flow lines, methods of transport, transfer mechanisms, ASRS system.

UNIT II GROUP TECHNOLOGY & FLEXIBLE MANUFACTRUING SYSTEMS L-9

Group Technology – Introduction, part families, parts classification and coding system – OPITZ and MI CLASS system. Production flow analysis, cellular manufacturing – advantages, disadvantages and applications. FMS – Introduction, workstations, scope, components, types, benefits, typical FMS layout configuration, function of FMS computer Control System, FMS data files.

UNIT III COMPUTER CONTROL SYSTEMS & AUTOMATED PROCESS L-9

Computer control systems – Introduction, Architecture, Factory Communication, Local Area Networks – Characteristics, factory networks, open system interconnection model. Network to network interconnections, manufacturing automation protocol, Data Base Management System – Introduction. Computer aided shop floor control. Automated process planning – introduction, structure, information requirement, CAPP, application, programs in CAPP.

UNIT IV COMPUTER CONTROLLED MACHINES & MATERIAL HANDLING SYSTEMS L-9

NC machines – Part Programming, CNC, DNC, Adaptive Control, Pallets & Fixtures, Machine centers, Automated inspection systems. Material handling systems – Introduction, Conveyors, Industrial Robots, Automated Guided Vehicles.

UNIT V COMPUTER INTEGRATED MANUFACTURING L-9

CIM – Introduction, definition, scope, benefits, elements, CIM cycle or wheel. Introduction to Jurt -in-Time (JIT), Kanban System, Business Process Re-engineering (BPR), Materials requirement planning (MRP), Manufacturing Resource Planning (MRP II), Enterprise Resource Planning (ERP), Supply Chain Management (SCM).

TOTAL: 45 periods

8. Text Books

1. Mikell Groover .P, *Automation, Production Systems and Computer Integrated Manufacturing*", Prentice Hall of India Pvt. Ltd., 2001.
2. Viswanathan .N, Navahari .Y "*Performance Modeling of Automated Manufacturing Systems*", Prentice Hall of India Pvt. Ltd., 1998.

9. References

1. Rao .P.N., *Computer Aided Manufacturing*, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2001.
2. Kant Vajpayee .S, *Principles of Computer Integrated Manufacturing*, Prentice Hall of India Pvt. Ltd., 1995.
3. Radhakrishnan .P, Subramaniyan .S, *CAD/CAM/CIM*, New Age International Limited, 1994.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I %	Unit Test-II %	Mid Term Test II %	
Remember	20	20	20	20	20
Understand	20	20	20	20	20
Apply	60	60	60	60	60
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand	20	10
Apply	40	40
Analyze	40	50
Evaluate		
Create		

COURSE CODE	FLEXIBLE MANUFACTURING SYSTEMS	L	T	P	C
1152ME136		3	0	0	3

1. **Preamble**

This course provide concept of various production system, group technology, Flexible manufacturing system and FMS software.

2. Pre-requisite

Nil

3. Links to other Courses

Factory automation

4. Course Educational Objectives

Students undergoing this course are expected to gain knowledge in

- Understand the concept of various production systems and group technology
- Understand the concept of Flexible manufacturing and FMS software.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Discuss the various types of production systems	K2
CO2	Discuss about the concept of Group technology	K2
CO3	Discuss about the concept of flexible manufacturing systems	K2
CO4	Discuss about the concept of flexible manufacturing cells	K2
CO5	Discuss about the overview of FMS software	K2

(K2-Understand)

6. Correlation of Course Outcomes with Programme Outcomes:

COs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			L	M								M	L	
CO2			L	M								M	L	
CO3			L	M								M	L	
CO4			L	M								M	L	
CO5			L	M								M	L	

H- High; M-Medium; L-Low

7. Course Content

UNIT I PRODUCTION SYSTEMS **L-9**

Types of production-Job Shop, Batch and Mass production - Functions in manufacturing - Organization and information processing in manufacturing - Plant layout - Batch production – Work in progress inventory - Scheduling, problems.

UNIT II GROUP TECHNOLOGY **L-9**

Formation of part families - Part classification - Coding system optiz, Multi Class - Production flow analysis – Machine cells design - Clustering methods - Modern algorithms - Benefits of GT - System planning - Objective, guide line, system definition and sizing - Human resources - Objective, staffing, supervisor role.

UNIT III FLEXIBLE MANUFACTURING SYSTEMS **L-9**

Introduction – Evolution – Definition - Need for FMS - Need for Flexibility - Economic Justification of FMS-Application Criteria - Machine tool Selection and Layout - Computer control system - Data files – Reports - Planning the FMS - Analysis Methods for FMS - Benefits and limitations.

UNIT IV FLEXIBLE MANUFACTURING CELLS **L-9**

Introduction - Cell description and classifications - Unattended machining – Component handling and storage system - Cellular versus FMS – System - Simulation, Hardware configuration – Controllers - Communication networks - Lean production and agile manufacturing.

UNIT V FMS SOFTWARE **L-9**

Introduction - General Structure and requirements - Functional descriptions - Operational overview - Computer simulation - FMS installation – Objective - Acceptance testing - Performance goals – Expectations - Continued support.

TOTAL : 45 PERIODS

8. Text Books

1. William W.Luggen., *Flexible Manufacturing Cells and Systems*, Prentice Hall, NJ, 1991.
2. Mikell P.Groover., *Automation Production Systems* &*Computer Integrated manufacturing*, PHI, 1989.

9. References

1. David J.Parrish., *Flexible Manufacturing*, Butterworth-Heinemann, 1990.
2. Buffa, E.S., *Modern Production and Operation Management,* 1985.
3. Jha N.K .,Handbook of Flexible manufacturing system, Academic press Inc,1991.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I %	Unit Test-II %	Mid Term Test II %	
Remember	20	20	20	20	20
Understand	20	20	20	20	20
Apply	60	60	60	60	60
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand	20	10
Apply	40	40
Analyze	40	50
Evaluate		
Create		

COURSE CODE	INTELLIGENT MANUFACTURING TECHNOLOGY	L	T	P	C
1152ME137		3	0	0	3

1. **Preamble**

This course provide the concept of various sensors in manufacturing, principles of monitoring systems, and automatic identification techniques in intelligent manufacturing technology.

2. Pre-requisite

Industrial Robotics

3. Links to other Courses

Factory automation

4. Course Educational Objectives

Students undergoing this course are expected to gain knowledge in

- Understand the concept of manufacturing automation and principles of various sensors.
- Understand the concept of automatic monitoring and identification techniques

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Discuss the role of sensors used in manufacturing automation.	K2
CO2	Discuss the various sensor principles used in automated manufacturing	K2
CO3	Discuss the process monitoring systems	K2
CO4	Discuss the condition monitoring systems	K2
CO5	Discuss the automatic identification techniques in manufacturing automation process	K2

(K2-Understand)

6. Correlation of Course Outcomes with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			L	M								M	L	
CO2			L	M								M	L	
CO3			L	M								M	L	
CO4			L	M								M	L	
CO5			L	M								M	L	

H- High; M-Medium; L-Low

7. Course Content

UNIT I INTRODUCTION **L-9**

Introduction – Role of sensors in manufacturing automation- operation principles of different sensors –electrical, optical, acoustic, pneumatic, magnetic, electro-optical, photo – electric, vision, proximity, tactile, range sensors.

UNIT II SENSORS IN MANUFACTURING **L-9**

Sensors in manufacturing – Temperature sensors in process control-Pressure sensors – Fiber optic sensors and their principles and applications – Displacement sensor for robotic application- Sensors for CNC machine tools – Linear and angular position sensors, velocity sensors. Sensors in Robotics – encoder, resolver, potentiometers, range, proximity, touch sensors.

UNIT III PROCESS MONITORING **L-9**

Principle, Sensors for Process Monitoring - online and off line quality control, Quality parameter design Direct monitoring of fault based on process signals.

UNIT IV CONDITION MONITORING **L-9**

Condition monitoring of manufacturing systems -principles –sensors for monitoring force, vibration and noise. Selection of sensors and monitoring techniques. Acoustics emission sensors-principles and applications-online tool wear monitoring.

UNIT V AUTOMATIC IDENTIFICATION TECHNIQUES **L-9**

MRP -MRPII-Shop floor control –Factory data collection systems – Automatic identification methods – Bar code technology, automated data collection system – Agile manufacturing-flexible manufacturing-Enterprise integration and factory information system.

TOTAL : 45 PERIODS

8. Text Books

1. Sabrie salomon, *Sensors and Control Systems in Manufacturing*, McGraw Hill int. edition, 1994.
2. Patranabis .D, *Sensors and Transducers, Wheeler publishers*, 1994.
3. S.R.Deb, Robotics technology and flexible automation, Tata McGraw Hill publishing Co. Ltd., 1994.

9. References

1. Mikell P. Groover, *Automation Production System and Computer Integrated Manufacturing,* Prentice Hall of India Ltd., 2001.
2. Richard D.Klafter, *Robotic Engineering*, Prentice Hall of India Pvt., Ltd., 2001.
3. Julian W.Gardner, *Micro Sensor MEMS and Smart Devices*, John Wiley & Sons, 2001.
4. Randy Frank, *Understanding Smart Sensors*, Artech house, USA, 1996.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I %	Unit Test-II %	Mid Term Test II %	
Remember	20	20	20	20	20
Understand	20	20	20	20	20
Apply	60	60	60	60	60
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand	20	10
Apply	40	40
Analyze	40	50
Evaluate		
Create		