PANIMALAR ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)

Bangalore Trunk Road, Varadharajapuram,
Poonamallee, Chennai – 600123

Minor Degree

ROBOTICS AND AUTOMATION

Curriculum & Syllabus

DEPARTMENT OF
MECHANICAL ENGINEERING

REGULATION 2023

B.E.- MECHANICAL ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

CURRICULUM AND SYLLABI OF MINOR PROGRAMME

ROBOTICS AND AUTOMATION (REGULATION 2023)

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
1.	23ME4001	Fundamentals of Materials Science & Smart Materials	PE	3/0/0	3	3	60/40
2.	23ME4002	Sensors and Actuators for Robotics	PE	3/0/0	3	3	60/40
3.	23ME4003	Modelling and Design of Robots	PE	3/0/0	3	3	60/40
4.	23ME4004	Hydraulic and Pneumatic Drives for Robots	PE	3/0/0	3	3	60/40
5.	23ME4005	Automation System Design	PE	3/0/0	3	3	60/40
6.	23ME4006	Control and Optimization of Automation and Robotic Systems	PE	3/0/0	3	3	60/40
7.	23ME4007	Artificial Intelligence for Robotics	PE	3/0/0	3	3	60/40
8.	23ME4008	CNC Machine and Metrology	PE	3/0/0	3	3	60/40

23ME4001	FUNDAMENTALS OF MATERIALS SCIENCE AND SMART MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To Understand the structure and behavior of crystalline materials.
- To understanding of phase diagrams, phase transformations, and solid solution behavior in metals and alloys.
- To gain comprehensive knowledge of smart materials and their classifications
- To Understand the properties, functions, and applications of advanced functional materials.
- To Explore the mechanical behavior, structural analysis, and energy efficiency of smart materials,

UNIT I Introduction to engineering materials & their properties 9

Crystalline versus non crystalline solids, Unit cell, Crystal systems, Bravais lattice, Fundamental reasons behind classification of lattice, Miller indices for directions & planes, Close-packed planes & directions, packing efficiency, Interstitial voids, Role of X-ray diffraction in determining crystal structures. Deformation of metals, understanding of some material-properties independent of interatomic bonding forces/energies, Stiffness versus modulus, Theoretical/ideal strength versus actual strength of metals, Crystal defects, Role of dislocations in deformation, Strengthening Mechanisms, Role of Cottrell atmosphere.

UNIT II Phase Diagrams 9

Objectives & classification, System, Phases & structural constituent of phase diagram. Temperature– Pressure phase diagram of iron & Clausius –Clapeyron equation for boundary between phase regions of temperature-versus-pressure phase diagrams, Gibbs phase rule, Lever rule, Solid solutions, HumeRothery rules, Isomorphous, Eutectic, Peritectic & Eutectoid system, Equilibrium diagrams for nonferrous alloys.

UNIT - III Concept of Smart Materials 9

Retrospective review, main notion, energy aspects of external influence, systematization and methods of smart materials description: methods of materials taxonomy, smart material model, classification of smart materials and engineering systems, Materials for electrical engineering and electronics: conductors, semiconductors, dielectrics, magnetic materials, optically active materials, materials for thermoelectric devices, smart battery materials, radio wave absorbing materials, sealing materials, heat-insulating and sound absorbing materials.

UNIT IV Structural material 9

self-healing materials, heat and cold resistant materials, radiation resistant materials, corrosionresistant materials and anti-corrosive coatings, lubricants, frictional materials, materials for operation at abnormal temperatures. Materials for biological and iomedical systems materials for implants, targeted drug delivery and tissue growth, antimicrobial materials, filters for water cleaning, biodegradable packages, active and bio-selective packages.

UNIT V Mechanics of smart materials 9

Object and subject of smart materials mechanics, structural and functional analysis smart materials in terms of mechanics, the materials with negative characteristics as source of

smart effects in structures: Auxetics, statements and solutions of some smart materials based mechanics problems – e.g. self-healing of cracks, self-reinforcing of multimodular materials, porous materials-auxetic materials reversible transformations, self- assembling porous materials etc. Smart materials and energy problem: Global energy problem, energy consumption for production of materials, technical and economical efficiency of smart materials and technical systems

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1: Analyze the properties of smart materials and structures in the broader external conditions for the utilization in selected technologies.

CO2: Understand the basic properties that characterize the behavior of materials and classify the materials with their types of loadings/environment that materials should withstand.

CO3: Acquire the knowledge of various smart materials, their fabrication and their multidisciplinary applications.

CO4: Know the concept of “Smart” materials and systems

CO5: Analysis the mechanics of smart materials.

TEXTBOOKS:

1. Raghvan, Materials Science and Engineering, Prentice Hall of India Publishing 5th Edition, 2006.
2. W.D. Callister, Materials Science and Engineering 8th Edition, 2006

REFERENCES:

1. Smart Materials: Integrated Design, Engineering Approaches and Potential Applications,Edited by Anca Filimon, Apple Academic Press and CRC Press, 1st Edition, 2019.
2. Smart Materials Taxonomy by Victor Goldade, Serge Shil’ko, Alexander Neverov, CRC Press, 1st Edition, 2016.
3. Askland & Phule, Material Science & Engineering of materials 4th Edition, 2002
4. Design, Fabrication Properties and Applications of Smart and Advanced Materials, Edited by Xu Hou, CRC Press, 1st Edition, 2016.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	2	-	-	-	-	-	-	3
CO2	3	2	2	1	-	-	-	-	-	-	3
CO3	3	2	2	-	-	-	-	-	-	-	3
CO4	3	2	2	-	-	-	-	-	-	-	3
CO5	3	3	2	2	-	-	-	-	-	-	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23ME4002	SENSORS AND ACTUATORS FOR ROBOTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the fundamental components of robotic systems
- To gain knowledge of various sensors used in robotics and automation
- To understand the principles and advancements in smart and MEMS
- To develop an understanding of various actuators used in robotic systems
- To Understand the design, selection, and application of hydraulic, pneumatic, and advanced actuators in robotic systems.

UNIT - I Anatomy of Robotic system 9

links and joints in robots, types of joints, end effectors, concept of degrees of Freedom and its calculations.

UNIT - II Sensors 9

Pressure/contact. Resistive position. Infrared. Light. Position Sensors, optical encoders, proximity sensors, Range sensors, Ultrasonic sensors, Touch and Slip sensors. sensors for motion and position, Force, torque and tactile sensors, Flow sensors, Temperature sensing devices.

UNIT - III Advanced Sensor Technology 9

Smart sensors, MEMS based sensors, Innovations in sensor technology Actuators and its selection while designing a robot system. Types of transmission systems.

UNIT - IV Electric Actuators 9

Direct current motor, Permanent magnet stepper motor, Servo Control DC motors, Linear and latching linear actuators, Rotary actuators, Piezoelectric actuators, Actuator parameters and characteristics, Stepper motors, Specifications and characteristics of Stepper Motors Servo Motors.

UNIT - V Pneumatic & Hydraulic actuators 9

Hydraulic Actuators, selection of linear actuating cylinders, Hydraulic Motors, Pneumatic actuators, design considerations and selection, pneumatic cylinders, pneumatic drive system, Linear & rotary actuators. Advanced actuators – Piezoelectric actuators, elastomer actuators, soft actuators, shape memory alloy based actuators, under actuated robotic hand.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze sensory systems in robotics.
CO2: Select the sensor for robotic application and design the systems.
CO3: understand the principles and advancements in smart and MEMS.
CO4: Develop an understanding of various actuators used in robotic systems
CO5: Understand the design, selection, and application of hydraulic, pneumatic, and advanced actuators in robotic systems

TEXT BOOKS

1. D. Patranabis, Sensors and Transducers, PHI, 2nd Edition 2013.
2. Jon S. Wilson, Sensor Technology Handbook, Elsevier, 2005.

REFERENCE BOOKS

1. Braünl, T. Embedded robotics: mobile robot design and applications with embedded
2. systems. 3rd edition Berlin; Heidelberg: Springer, 2008. ISBN 9783540705338.
3. Martin, F.G. Robotic explorations: a hands-on introduction to engineering. Upper Saddle River, N.J.: Prentice-Hall, 2001. ISBN 0130895687
4. Gerard C., M. Meijer, Smart Sensors System, Wiley, 2008.
5. Andrzej M. Pawlak, Sensors and Actuators in mechatronics, Taylor & Francis Group, 2007.
6. S. R. Ruocco, Robot Sensors & Transducers, Springer, 2013.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	-	-	-	-	-	-	-	3
CO2	3	2	2	-	-	-	-	-	-	-	3
CO3	3	2	2	-	-	-	-	-	-	-	3
CO4	3	2	2	-	-	-	-	-	-	-	3
CO5	3	2	2	-	-	-	-	-	-	-	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23ME4003	MODELLING AND DESIGN OF ROBOTS	L	T	P	C
		3	0	0	3

Course Objectives: The course should enable the students to:

- To Gain comprehensive knowledge of robotic manipulators
- To Understand the kinematics and dynamics of robotic systems
- To Learn the principles and techniques of trajectory planning for robotic systems
- To Understand and apply various control strategies for robotic systems
- To Develop foundational knowledge of robot perception

UNIT - I Manipulators and End Effectors 9

Types of Manipulators, Manipulator Drive Systems, Manipulator Control Systems, Types of end effectors, Grippers, Gripper joints, Gripper force,Applications of robots

UNIT - II Kinematics and Dynamics 12

Kinematics and Dynamics: Basics of theory of machines, Rotation Matrix, Homogenous Transformation Matrix, Direct and Inverse Kinematics for industrial robots, Manipulator dynamics, Manipulator Jacobean.

Mobile Robot: Introduction, wheeled mobile robots and their kinematics, humanoid robots.

UNIT - III Trajectory Planning 8

Terminology, Joint Space Techniques, Cartesian Space Techniques,Comparison

UNIT - IV Control Architecture 8

position, path velocity and force control systems, computed torque control, adaptive control, and Servo system for robot control

UNIT - V Robot Perception, Vision and Navigation 8

Introduction to robot perception, Feature extraction, Image acquisition, representation and processing. Introduction to localization, obstacle avoidance and navigation

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Understand the basics of manipulator, mobile robots, end-effectors
CO2: Model forward and inverse kinematics of robots
CO3: Decide robot perception and navigation algorithms
CO4: Build and program robots using sensors.
CO5: Acquire, process, and analyze sensory data for robotic perception

TEXT BOOKS

1. John Craig, Introduction to Robotics: Mechanics and Control, Pearson/Prentice Hall Education, 3rd Edition, 2005
2. R. Siegwart, et.al Introduction to Autonomous Mobile Robots, Prentice Hall of India, 3rd Edition,2005.
3. Mittal, R. K., and I. J. Nagrath. Robotics and control. Tata McGraw-Hill, 2003.

REFERENCES:

1. Richard D. Klafter, Robotics Engineering, An Integrated approach, Prentice Hall of India, 3rd Edition, 2003.
2. Fu K S, Gomalez R C and Lee C S G, Robotics: Control, Sensing, Vision and Intelligence, McGraw Hill Book Company, 1st Edition, 1987.
3. Groover, Mikell P., et al. Industrial robotics: technology, programming, and applications. McGrawHill, 2012.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	3	-	-	-	-	-	-	3
CO2	3	3	3	3	-	-	-	-	-	-	3
CO3	3	3	3	3	-	-	-	-	-	-	3
CO4	3	3	3	3	2	-	-	-	-	-	3
CO5	3	3	3	3	2	-	-	-	-	-	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23ME4004	HYDRAULIC AND PNEUMATIC DRIVES FOR ROBOTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand and apply principles for fluid system design and analysis.
- To understand and analyze valve operations in hydraulic and pneumatic systems.
- To familiarize students with the components of hydraulic and pneumatic power systems
- To impart knowledge on the construction and operation of linear and rotary actuators
- To enable students to understand and apply control methods for hydraulic and pneumatic actuators.

UNIT - I Fluid Power Systems **9**

Introduction of Fluid Power Systems, Properties of Fluids and Selection, Pascal's Law and Pressure Measurement, Fluid Flow and Measurement, Gas Laws.

UNIT - II Control Valves **9**

Fluid power control elements and standard graphical symbols, Directional, Pressure and Flow Control Valves – Construction and Working, Rotary Valves, Pilot-Operated Valves Servo-valves.

UNIT - III Hydraulic and Pneumatic Power Supplies **9**

Hydraulic Power Packs, Hydraulic Loading Valve and Filters, Air Compressors & Receivers, Air Treatment and FRL Units, Pressure Regulation in Fluid Power Circuits

UNIT - IV Fluid Power Actuators **9**

Linear actuators and their Construction, Rotary actuators and their Construction, Mounting Arrangements, Cylinder Dynamics, Speed Control.

UNIT - V Fluid Power Circuits & Control **9**

Control of Single and Double Acting Hydraulic Cylinders, Control of Single and Double Acting Pneumatic Cylinders, Electrical Controls for Fluid Power Circuits, Electro-hydraulic and Electro Pneumatic Circuits, Examples of Fluid Power Circuits in Robotics.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Select a fluid power actuation system for a given robotic application.
CO2: Select components for designing a fluid power circuit.
CO3: Assemble and operate a fluid power actuation system.
CO4: Design fluid power actuation system for robotic application..
CO5: Apply control methods for hydraulic and pneumatic actuators.

TEXT BOOKS

1. Saeed B. Niku, "Introduction to Robotics – Analysis, Control, Applications", Wiley India Pvt. Ltd., 2010.
2. R. Mittal, Nagrath, "Robotics and Control", McGraw Hill Education, 2017.

REFERENCE BOOKS

1. Hydraulics and Pneumatics, Jagadeesha T; I. K. International Publishing House Pvt. Ltd.,2015.

2. Hydraulics and Pneumatics, Andrew Parr; Jaico Books, 1993

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	3	-	-	-	-	-	-	3
CO2	3	3	3	3	-	-	-	-	-	-	3
CO3	3	3	3	3	-	-	-	-	-	-	3
CO4	3	3	3	3	-	-	-	-	-	-	3
CO5	3	3	3	3	-	-	-	-	-	-	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23ME4005	AUTOMATION SYSTEM DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know about the basic concepts in industrial automation
- To design automated systems.
- To know about transfer lines and automated assembly
- Be exposed to pneumatic, electric, hydraulic and electronic systems in automation of
- mechanical operations.
- To know about the advancement in hydraulics and pneumatics

UNIT I FUNDAMENTAL CONCEPTS OF INDUSTRIAL AUTOMATION 9

Fundamental concepts in manufacturing and automation, definition of automation, reasons for automating. Types of production and types of automation, automation strategies, levels of automation.

UNIT II TRANSFER LINES AND AUTOMATED ASSEMBLY 9

General terminology and analysis, analysis of transfer lines without storage, partial automation. Automated flow lines with storage buffers. Automated assembly-design for automated assembly, types of automated assembly systems, part feeding devices, analysis of multi-station assembly machines. AS/RS, RFID system, AGVs, modular fixturing. Flow line balancing.

UNIT III DESIGN OF MECHATRONIC SYSTEMS 9

Stages in design, traditional and mechatronic design, possible design solutions. Case studies-pick and place robot, engine management system.

UNIT IV PROGRAMMABLE AUTOMATION 9

Special design features of CNC systems and features for lathes and machining centers. Drive systemfor CNC machine tools. Introduction to CIM; condition monitoring of manufacturing systems.

UNIT V DESIGN FOR HIGH SPEED AUTOMATIC ASSEMBLY 9

Introduction, Design of parts for high speed feeding and orienting, high speed automatic insertion. Analysis of an assembly. General rules for product design for automation.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Knowledge of industrial automation by transfer lines and automated assembly lines.
CO2: Ability to design an automated system
CO3: Understanding of automated controls using pneumatic and hydraulic systems
CO4: understand the electronic control systems in metal machining and other manufacturing processes.
CO5: Understand advancement in hydraulics and pneumatics systems

TEXT BOOKS

1. Mikell P Groover, “Automation Production Systems and Computer- Integrated Manufacturing” Pearson Education, New Delhi, 2001.
2. Bolton W, “Mechatronics“, Pearson Education, 1999

REFERENCE BOOKS

1. Mikell P Groover, "Industrial Robots – Technology Programmes and Applications" , McGraw Hill , New York, USA. 2000.
2. Steve F Krar, "Computer Numerical Control Simplified", Industrial Press, 2001.
3. Joffrey Boothroyd, Peter Dewhurst and Winston A. Knight, "Product Design for manufacture and Assembly", CRC Press, 2011

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	-	-	-	-	-	-	-	3
CO2	3	3	3	3	-	-	-	-	-	-	3
CO3	3	2	1	2	-	-	-	-	-	-	3
CO4	3	2	1	-	2	-	-	-	-	-	3
CO5	3	2	1	3	-	-	-	-	-	-	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23ME4006	CONTROL AND OPTIMIZATION OF AUTOMATION AND ROBOTIC SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the various types of sensors, transducers and signal conditioning circuits essential for industrial automation.
- To understand the working principles and applications of resistance, inductance and capacitance transducers.
- To understand the various types of piezoelectric and magnetic sensors.
- To impart knowledge on chemical and radiation sensors.
- To understand the real time usage of various modern sensor.
- To understand the real time application of sensors in the field of Automobile Engineering, Aeronautics, Machine tools and Manufacturing processes with case studies

UNIT - I INTRODUCTION 9

Introduction to control systems, Brief History, Examples of control systems. Automated vehicles, human-in-the-loop control, humanoid robots, unmanned aerial vehicles, industrial control systems, Control system design, Future evolution of control systems, Different types of controls: Model-based control, position control, speed control, perturbation control

UNIT - II MICROCONTROLLERS 9

Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors - Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications – Magnetic Actuators – Micro-magnetic components– Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys.

UNIT - III PIEZOELECTRIC & MAGNETIC SENSORS 9

Piezo-resistive sensors – Piezo-resistive sensor materials - Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials– Applications to Inertia, Acoustic, Tactile and Flow sensors.

UNIT - IV RADIATION AND ELECTRO CHEMICAL SENSORS 9

Silicon Anisotropic Etching – Anisotrophic Wet Etching – Dry Etching of Silicon – Plasma Etching – Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies - Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antistriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process.

UNIT - V MODERN SENSORS 9

Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS – Lenses and Mirrors – Actuators for Active Optical MEMS.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Compare and Experiment with microcontrollers
CO2: Apply various control designs using MATLAB and LabVIEW
CO3: Build and Analyze automatic systems for real applications.
CO4: Design and Evaluate a control system
CO5: Understand the properties and applications of polymers in MEMS fabrication and design

TEXT BOOKS

1. Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2012.
2. Stephen D Senturia, 'Microsystem Design', Springer Publication, 2000.
3. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2002.

REFERENCE BOOKS

1. NadimMaluf," An Introduction to Micro Electro Mechanical System Design",Artech House, 2000
2. Mohamed Gad-el-Hak, editor, " The MEMS Handbook", CRC press Baco Raton,2001.
3. Julian w. Gardner, Vijay K. Varadan, Osama O.Awadelkarim, Micro Sensors MEMS and Smart Devices, John Wiley & Son LTD, 2002.
4. James J.Allen, Micro Electro Mechanical System Design, CRC Press Publisher, 2005.
5. Thomas M.Adams and Richard A.Layton, "Introduction MEMS, Fabrication and Application," Springer, 2010.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	3	2	-	-	-	-	-	3
CO2	3	3	3	3	2	-	-	-	-	-	3
CO3	3	3	3	3	2	-	-	-	-	-	3
CO4	3	3	3	3	2	-	-	-	-	-	3
CO5	3	3	3	3	2	-	-	-	-	-	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23ME4007	ARTIFICIAL INTELLIGENCE FOR ROBOTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Study the concepts of Artificial Intelligence.
- Learn the methods of solving problems using Artificial Intelligence.
- Introduce the concepts of Expert Systems and machine learning.
- Learn about planning and reasoning artificial intelligence.
- Solve the risk in artificial intelligence

UNIT - I INTRODUCTION 9

History, state of the art, Need for AI in Robotics. Thinking and acting humanly, intelligent agents, structure of agents. PROBLEM SOLVING: Solving problems by searching – Informed search and exploration–Constraint satisfaction problems–Adversarial search, knowledge and reasoning– knowledge representation – first order logic.

UNIT - II PLANNING 9

Planning withforward and backward State space search – Partial order planning – Planning graphs– Planning with propositional logic – Planning and acting in real world.

UNIT - III REASONING 9

Uncertainity – Probabilistic reasoning–Filtering and prediction–Hidden Markov models– Kalman filters– Dynamic Bayesian Networks, Speech recognition, making decisions.

UNIT - IV LEARNING 9

Forms of learning – Knowledge in learning – Statistical learning methods –reinforcement learning, communication, perceiving and acting, Probabilistic language processing, perception.

UNIT - V AI IN ROBOTICS 9

Robotic perception, localization, mapping- configuring space, planning uncertain movements, dynamics and control of movement, Ethics and risks of artificial intelligence in robotics.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Identify problems that are amenable to solution by AI methods.
CO2: Identify appropriate AI methods to solve a given problem.
CO3: Formalise a given problem in the language/framework of different AI methods.
CO4: Implement basic AI algorithms.
CO5: Design and carry out an empirical evaluation of different algorithms on a problemformalisation, and state the conclusions that the evaluation supports.

TEXT BOOKS

1. Stuart Russell, Peter Norvig, “Artificial Intelligence: A modern approch”, Pearson Education, India2003.
2. Negnevitsky, M, “Artificial Intelligence: A guide to Intelligent Systems”,. Harlow: Addison-Wesley,2002.

REFERENCE BOOKS

1. David Jefferis, “Artificial Intelligence: Robotics and Machine Evolution”, Crabtree Publishing Company, 1992.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	2	1	-	-	-	-	-	3
CO2	3	2	2	2	1	-	-	-	-	-	3
CO3	3	2	2	2	1	-	-	-	-	-	3
CO4	3	2	2	2	1	-	-	-	-	-	3
CO5	3	2	2	2	1	-	-	-	-	-	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23ME4008	CNC MACHINE AND METROLOGY	3	3	0	0
		3	**0**	**0**	**3**

OBJECTIVES:

- Understand evolution and principle of CNC machine tools
- Write simple programs for CNC turning and machining centres
- Generate CNC programs for popular CNC controllers
- Describe about linear and angular measurements in metrology
- Study about the advancement in metrology

UNIT - I INTRODUCTION TO CNC MACHINE TOOLS 9

Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept,classification of CNC Machines – turning centre, machining centre, grinding machine, EDM, types of control systems, CNC controllers, characteristics, interpolators– Computer Aided Inspection, CNC Machine building,structural details, configuration and design, guide ways – Friction, Anti friction and other types of guide ways

UNIT - II DRIVES AND WORK HOLDING DEVICES 9

Spindle drives – DC shunt motor, 3 phase AC induction motor, feed drives –stepper motor, servo principle, DC and AC servomotors, Axis measuring system – synchro, synchro-resolver, gratings, moiré fringe gratings,encoders, inductosysn, laser interferometer, work holding devices for rotating and fixed work parts, economics of CNC, maintenance of CNC machines.

UNIT - III CNC PROGRAMMING 9

Coordinate system, structure of a part program, G & M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, mirror image, parametric programming, machining cycles, programming for machining centre and turning centre for well known controllers such as Fanuc, Heidenhain, Sinumerik etc., generation of CNC codes from CAM packages.

UNIT - IV LINEAR AND ANGULAR MEASUREMENTS 9

Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – gauge design – terminology – procedure – concepts of interchange ability and selective assembly – Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar – Angle alignment telescope – Autocollimator – Applications.

UNIT - V ADVANCES IN METROLOGY 9

Basic concept of lasers Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment. Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Element – Applications.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Understand about the basic in CNC machineries.
CO2: Understand Evolution and principle of CNC machine tools and different measurement technologies.
CO3: Write simple programs for CNC machinery
CO4: Impart knowledge about linear and angular measurements in metrology
CO5: Know about the advancement in metrology

TEXT BOOKS

1. M.D. Singh, J.G. Joshi, “Mechatronics”, HMT, Tata McGraw-Hill Publishing Company Limited,New Delhi, 2006.
2. Warren S.Seamers, “Computer Numeric Control”, Fourth Edition, Thomson Delmar, 2002.
3. Jain R.K. “Engineering Metrology”, Khanna Publishers, 2005

REFERENCE BOOKS

1. Gupta. I.C., “Engineering Metrology”, Dhanpatrai Publications, 2005.
2. Charles Reginald Shotbolt, “Metrology for Engineers”, 5th edition, Cengage Learning EMEA,1990.
3. Backwith, Marangoni, Lienhard, “Mechanical Measurements”, Pearson Education , 2006.
4. Peter Smid, “CNC Programming Hand book”, Industrial Press Inc., 2000
5. Berry Leathan – Jones, “Introduction to Computer Numerical Control”, Pitman, London, 1987.
6. Radhakrishnan P “Computer Numerical Control Machines”, New Central Book Agency, 2002.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	3	2	-	-	-	-	-	3
CO2	3	3	3	3	2	-	-	-	-	-	3
CO3	3	3	3	3	2	-	-	-	-	-	3
CO4	3	3	3	3	2	-	-	-	-	-	3
CO5	3	3	3	3	2	-	-	-	-	-	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**