PANIMALAR ENGINEERING COLLEGE
(An Autonomous Institution, Affiliated to Anna University, Chennai)
Bangalore Trunk Road, Varadharajapuram,
Poonamallee, Chennai – 600 123

Department of Mechanical Engineering
B.E- Mechanical Engineering

CURRICULUM AND SYLLABUS
REGULATION-2023 (2023- 2024 onwards)

OPEN ELECTIVES

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	23GE1001	Disaster Management	OE	3	3	0	0	3
2.	23GE1006	Intellectual Property Rights	OE	3	3	0	0	3
3.	23ME1001	Energy Auditing	OE	3	3	0	0	3
4.	23ME1002	Lean Six Sigma	OE	3	3	0	0	3
5.	23ME1003	Sensors for Automation	OE	3	3	0	0	3
6.	23ME1004	Industrial Pollution and Prevention	OE	3	3	0	0	3
7.	23ME1005	Hospital Management	OE	3	3	0	0	3
8.	23ME1006	Systems Engineering	OE	3	3	0	0	3
9.	23ME1007	Marketing Management	OE	3	3	0	0	3
10.	23CS1003	Cloud computing	OE	3	3	0	0	3
11.	23EE1004	Micro Electro Mechanical Systems	OE	3	3	0	0	3

23GE1001	DISASTER MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional processes in the country and
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

UNIT I INTRODUCTION TODISASTERS 9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks — Disasters: Types of disasters —Earthquake, Landslide, Flood, Drought, Fire etc -Classification, Causes, Impacts including social,economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste,class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complexe mergencies, Climate change-Dos and Don'ts during various types of Disasters.

UNIT II APPROACHES TO DISASTER RISK REDUCTION (DRR) 9

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders Institutional Processess and Frame work at State and Central Level State Disaster Management Authority (SDMA)–Early Warning System–Advisories from Appropriate Agencies.

UNIT - III INTER-RELATIONSHIP BETWEEN DISASTER S AND DEVELOPMENT 9

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation-IPCC Scenario and Scenariosin the context of India-Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT IV DISASTER RISK MANAGEMENT IN INDIA 9

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food,Sanitation,Shelter,Health,WasteManagement,Institutionalarrangements(Mitigation,ResponseandPreparedness, Disaster Management Act and Policy -Other related policies, plans, programmes and legislation— Role of GI Sand Information Technology Components in Preparedness, RiskAssessment, Response and Recovery Phases of Disaster–Disaster Damage Assessment

UNIT V DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS 9

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies;

Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1: Differentiate the types of disasters, causes and their impact on environment and society

CO2: Understand disaster management phases, risk reduction strategies, stakeholder roles, and early warning systems for effective preparedness and response.

CO3: Understand factors influencing vulnerability, the impacts of development projects, climate change adaptation, and the role of indigenous knowledge and local resources in disaster resilience.

CO4: Understand India's hazard and vulnerability profile, disaster relief components, legal frameworks, and the role of GIS and IT in disaster preparedness, response, and recovery.

CO5: Gain practical insights into disaster assessment and management through case studies, space-based technology applications, and fieldwork experiences.

TEXTBOOKS:

1. Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427ISBN-13: 978-9380386423
2. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India EducationPvt. Ltd., 2012. ISBN-10: 1259007367, ISBN-13**:** 978-1259007361]
3. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management,NIDM, New Delhi, 2011
4. KapurAnu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers,New Delhi, 2010.

REFERENCES:

1. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005
2. Government of India, National Disaster Management Policy,2009.

CO-PO MAPPING

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

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 %**

23GE1006	INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basic concepts, significance, and types of Intellectual Property Rights (IPRs).
- To Learn about the legal frameworks, international treaties, and conventions related to IPR.
- To explore the protection of inventions, biotechnology, traditional knowledge, and digital content under IPR.
- To study the rights, licensing agreements, and enforcement of Intellectual Property through case studies.
- To examine the role of patents in product development, commercialization, and industry cooperation.

UNIT - I INTRODUCTION 9

Introduction to IPRs, Basic concepts and need for Intellectual Property – Meaning and practical aspects of Patents, Copyrights, Geographical Indications, IPR in India and Abroad. Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

UNIT - II INTELLECTUAL PROPERTY RIGHTS 9

The IPR tool kit, Patents, the patenting process, Patent cooperation treaties: International Treaties and conventions on IPRs: Trade Related Aspects of Intellectual Property Rights Agreement, Patent Cooperation Treaty, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

UNIT - III INTELLECTUAL PROPERTY PROTECTIONS 9

IPR of Living Species, protecting inventions in biotechnology, protections of traditional knowledge, biopiracy and documenting traditional knowledge, Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection. Case studies: The basmati rice issue, revocations of turmeric patent, revocation of neem patent.

UNIT - IV EXERCISING AND ENFORCING OF INTELLECTUAL PROPERTY RIGHTS 9

Rights of an IPR owner, licensing agreements, criteria for patent infringement. Case studies of patent infringement, IPR – contract, unfair competitions and control, provisions in TRIPS,

UNIT - V ROLE OF PATENTS IN PRODUCT DEVELOPMENT & COMMERCIALIZATION 9

Recent changes in IPR laws impacting patents and copy rights, intellectual cooperation in the science and allied industry. Patentable and non-patentable research. Case studies

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Remembering the basic concepts, types, and significance of Intellectual Property

Rights (IPRs), including patents, copyrights, and trademarks.

CO2: Understand the legal processes, international agreements, and conventions surrounding the protection of intellectual property.

CO3: Apply IPR principles to protect biotechnology innovations, traditional knowledge, and digital content in real-world scenarios.

CO4: Analyze case studies to assess patent infringement, licensing agreements, and the enforcement of intellectual property rights.

CO5: Apply the concepts of patents in product development, commercialization, and collaborative innovation in technology and industry.

TEXT BOOKS

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2. V. ScopleVinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012.
3. KompalBansal and Dr. ParikshitBansal, “Fundamentals of Intellectual Property for Engineers" BS Publications, 2020.

REFERENCE BOOKS

1. Ahuja, V K. Law relating to Intellectual Property Rights. India, IN: Lexis Nexis, 2017.
2. PrabuddhaGanguli,”Intellectual Property Rights: Unleashing the Knowledge Economy”, McGraw Hill Education, 2017.
3. Neeraj, P., &Khusdeep, D. Intellectual Property Rights. India, IN: PHI learning Private Limited, 2018.
4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.

WEB REFERENCES

1. Intellectual Property Rights and Development Policy: Report of the Commission on Intellectual Property Rights, London September 2002.
2. WIPO Intellectual Property Handbook. Policy, Law and Us.
3. Subramanian, N., &Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf
4. Cell for IPR Promotion and Management (http://cipam.gov.in/) .
5. Office of the Controller General of Patents, Designs & Trademarks (http://www.ipindia.nic.in/).

ONLINE COURSES / RESOURCES:

1. NPTEL Resource: Intellectual Property Rights (https://nptel.ac.in/courses/109106137)
2. Coursera Resource: Introduction to Intellectual Property (https://www.coursera.org/learn/introduction-intellectual-property)
3. Coursera Resource: Intellectual Property Law (https://www.coursera.org/specializations/introduction-intellectual-property)
4. Udemy Resource: Everything About Industrial Property Rights (https://www.udemy.com/course/everything-about-ipr-intellectual-property-rights/)

CO-PO MAPPING

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

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 %**

23ME1001	ENERGY AUDITING	L	T	P	C
		3	0	0	3

Course Objectives: The course should enable the students to:

- Understand energy scenario and general aspects of energy audit.
- Learn about methods and concept of energy audit
- Understand the energy utilization pattern including wastage and its management
- Understand Material and Energy balance of the systems.

UNIT - I ENERGY SCENARIO 9

Introduction to IPRs, Basic concepts and need for Intellectual Property – Meaning and practical aspects of Patents, Copyrights, Geographical Indications, IPR in India and Abroad. Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

UNIT - II ENERGY PERFORMANCE ASSESSMENT 12

Types & Forms of Energy - Primary / Secondary Energy Sources –EC Act 2003 - Energy Auditing: Types, classifications, deliverables, barriers – Benchmarking - Roles & Responsibility of Energy Energy Conservation and its importance.

UNIT - III METERING FOR ENERGY MANAGEMENT & POWER QUALITY ANALYSES 8

Instruments Used in Energy systems: Load and power factor measuring equipment, Wattmeter, flue gas analysis, Temperature and thermal loss measurements, air quality analysis etc. Relationships between parameters-Units of measure-Typical cost factors-Utility meters – Timing of meter disc for kilowatt measurement - Demand meters - Paralleling of current transformers - Instrument transformer burdens-Multitasking solid-state meters - Metering location vs. requirements – Net metering - Metering techniques and practical examples.

UNIT - IV ELECTRICAL ENERGY MANAGEMENT 8

Concept of lighting systems - The task and the working space - Light sources - Ballasts - Luminaries - Lighting controls - Optimizing lighting energy - energy saving opportunities in fans - Energy conservation opportunities in pumping system -Power factor and effect of harmonics on power quality - Cost analysis techniques. Detailed performance analysis of boilers and pumps.

UNIT - V ENERGY ECONOMICS 8

Energy Economics – Depreciation - Financial Analysis Techniques – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing – ESCO concept - CUSUM Technique – ESCO Concept – ESCO Contracts.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Understand the basic concepts of energy audit and energy management.
CO2: Understand the different types of energy audit, and efficiency.
CO3: Apply energy management systems and Energy audit instruments
CO4: Analyze Energy audit Procedures and Techniques.

CO5: Apply the knowledge of the technology in energy conservation and energy auditing.

TEXT BOOKS

1. Callaghn, P.W. “Design and Management for Energy Conservation”, Pergamon Press, Oxford, 1981.
2. W.R. Murphy and G. McKay “Energy Management” Butterworth, London 1987
3. Energy management and conservation –k v Sharma and p venkataseshaiah-I K International Publishing House pvt. Ltd, 2011.

REFERENCES:

1. Turner, W. C., Doty, S. and Turner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
2. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
3. Energy Management Handbook – W.C. Turner (John Wiley and Sons, A Wiley (Interscience publication).
4. Industrial Energy Management and Utilization -L.C. Witte, P.S. Schmidt, D.R. Brown (Hemisphere Publication, Washington, 1988).
5. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982.
6. Energy Conservation guide book Patrick/Patrick/Fardo (Prentice hall1993).

WEB REFERENCES

1. https://sites.google.com/a/venusict.org/energy-conservation-and-management/material
2. https://insightiitb.org/energy-audit/
3. https://fdocuments.in/document/energy-audit-of-iit-campus-558458070c81e.html

ONLINE COURSES / RESOURCES:

1. https://www.irtc.org.in/online-courses-in-energy-auditing/
2. https://www.youtube.com/watch?v=8Aqc44PG4Ws
3. https://nptel.ac.in/courses/112/106/112106286/
4. https://nptel.ac.in/courses/122/104/122104015/
5. https://www.udemy.com/course/energy-audit/
6. https://www.youtube.com/watch?v=WwBquDjDGOA&list=PLImNQubhYtnAmyPNwO-nPU-VQIlXH0xqM
7. https://www.youtube.com/watch?v=2zWt-pBCU2I

CO-PO MAPPING

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

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 %

23ME1002	LEAN SIX SIGMA	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand Lean and Six sigma and their importance in the globalized competitive world.
- To understand the importance of integrating Lean and Six sigma and also the process of their integration.
- To apply the Resources required undertaking the LSS projects and also acquiring how to select the suitable projects and the teams.
- To apply DMAIC methodology to execute LSS projects and in this regard they will be acquainted with various LSS tools.
- To evaluate the process of institutionalizing the LSS effort and also understand the Design for LSS.

UNIT I INTRODUCTION TO LEAN AND SIX SIGMA 9

Introduction to Lean- Definition, Purpose, Features of Lean ; Top seven wastes, Need for Lean management, The philosophy of lean management, Creating a lean enterprise, Elements of Lean, Lean principles, the lean metric, Hidden time traps. Introduction to quality, Definition of six sigma, origin of six sigma, Six sigma concept and Critical success factors for six sigma.

UNIT II INTEGRATION OF LEAN AND SIX SIGMA 9

Evolution of lean six sigma, the synergy of Lean and six sigma, Definition of lean six sigma, the principles of lean six sigma, Scope for lean six sigma, Features of lean six sigma. The laws of lean six sigma, Key elements of LSS, the LSS model and the benefits of lean six sigma. Initiation - Top management commitment – Infrastructure and deployment planning, Process focus, organizational structures, Measures – Rewards and recognition, Infrastructure tools, structure of transforming event and Launch preparation.

UNIT III PROJECT SELECTION AND TEAM BUILDING 9

Resource and project selection, Selection of Black belts, Training of Black belts and Champions, Identification of potential projects, top down (Balanced score card) and Bottom up approach – Methods of selecting projects – Benefit/Effort graph, Process mapping, value stream mapping, Predicting and improving team performance, Nine team roles and Team leadership.

UNIT IV THE DMAIC PROCESS AND TOOLS 9

The DMAIC process – Toll gate reviews; The DMAIC tools; Define tools – Project definition form, SIPOC diagram; Measure tools – Process mapping, Lead time/cycle time, Cause and Effect matrix, Idea – generating and organizing tools – Brainstorming, Nominal group technique and Multi-voting; Data collection and accuracy tools- Check sheet, Gauge R&R; Understanding and eliminating variation- run charts; Analyze tools - Scatter plots, ANOVA, Regression analysis, Time trap analysis; Improve tools – Mistake proofing, Set up time reduction (SMED) and the pull system; Control tools – statistical process control

UNIT V INSTITUTIONALIZING AND DESIGN FOR LSS 9

Institutionalizing lean six sigma – improving design velocity, creating cycle time base line, valuing projects, gating the projects, reducing product line complexity, Design for lean six sigma, QFD, Theory of Inventive Problem solving (TRIZ), Robust design; Case study presentations.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Understand the Lean and Six sigma and their importance in the globalized competitive world.

CO2: Understand the importance of integrating Lean and Six sigma and also the process of their integration.

CO3: Apply the Resources required undertaking the LSS projects and also acquiring how to select the suitable projects and the teams.

CO4: Apply DMAIC methodology to execute LSS projects and in this regard they will be acquainted with various LSS tools.

CO5: Evaluate the process of institutionalizing the LSS effort and also understand the Design for LSS.

TEXT BOOKS

1. Thomas Pyzdek, Paul Keller "The Six Sigma Handbook", 3rd Edition, McGraw-Hill., 2018.
2. Michael L. George, Lean Six Sigma, McGraw-Hill, 2003.

REFERENCE BOOKS

1. James P. Womack, Daniel T. Jones, Lean Thinking, Free press business, 2011.
2. Ronald G.Askin and Jeffrey B.Goldberg, Design and Analysis of Lean Production Systems, John Wiley &Sons., 2003.
3. Salman Taghizadegan, Essentials of Lean Six Sigma, Elsevier., 2010.

WEB REFERENCES

1. https://www.mtcbh.net/mt-content/uploads/2017/01/6-sigma-handnbook.pdf
2. https://aalssc.org/wp-content/uploads/2017/10/AALSSCstudyguide-Green2018.pdf
3. https://www.researchgate.net/publication/331648936_Six_Sigma_Approach_in_Material_Management
4. https://www.sciencedirect.com/science/article/abs/pii/S0009912022002661

CO-PO MAPPING

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

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 %

23ME1003	SENSORS FOR AUTOMATION	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

Definition, Measurement Techniques, Classification of errors, Error analysis, Static and dynamic characteristics of transducers, Performance measures of sensors, Classification of sensors, calibration techniques.

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS –Semiconductor devices – Stress and strain analysis – Flexural beam bending-Torsional deflection.

UNIT - II RESISTANCE, INDUCTANCE AND CAPACITANCE TRANSDUCERS 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 AND CASE STUDIES 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: Explain about fabrication processes for producing micro-sensors and actuators.
CO2: Design Micro sensors and actuators actuated by Electrical and Thermal Actuation
CO3: Design Micro sensors and actuators actuated by Piezo-Electric and magnetic Actuation.
CO4: Analyse the behaviour of MEMS system.
CO5: Understand the operation and manufacturing of Microsystem with application of MEMS devices.

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.

WEB REFERENCES

1. https://www.lboro.ac.uk/microsites/mechman/research/ipm
2. ktn/pdf/Technology_review/an-introduction-to-mems.pdf

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/117105082
2. https://www.digimat.in/nptel/courses/video/112108092/L01.html

CO-PO MAPPING

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

23ME1004	INDUSTRIAL POLLUTION AND PREVENTION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn a variety of chemical, physical, biological treatment processes related to industrial pollution control.
- To make pollution profiles of the industries, categorization, control methodologies and technologies, system design, ethic concepts and solving of the engineering problems on industrial systems.

UNIT - I TYPES OF POLLUTION 9

Types of emissions from chemical industries and effects of environment, environment legislation, Type of pollution, sources of wastewater, Effluent guidelines and standards, characteristics of air pollutants and ambient air quality standards.

UNIT - II CHARACTERISTICS OF POLLUTANTS 9

Characterization of effluent streams, oxygen demands and their determination (BOD, COD, and TOC), Oxygen sag curve, BOD curve mathematical, controlling of BOD curve, self - purification of running streams, sources and characteristics of pollutants in fertilizer, paper and pulp industry.

UNIT - III CONTROL OF POLLUTION 9

General methods of control and removal of sulfur dioxide, oxides of nitrogen and organic vapors from gaseous effluent, treatment of liquid and gaseous effluent in fertilizer industry.

UNIT - IV POLLUTION MEASUREMENTS 9

Air pollution sampling and measurement: Types of pollutant and sampling and measurement, ambient air sampling: collection of gaseous air pollutants, collection of particulate air pollutants. Stack sampling: sampling system, particulate sampling, and gaseous sampling.Analysis of air pollutants: Sulphur dioxide, nitrogen oxides, carbon monoxide, oxidants andOzone, hydrocarbons, particulate matter.

UNIT - V EMISSION CONTROL TECHNIQUES 9

Air pollution control methods and equipments: Source collection methods: raw material changes, process changes, and equipment modification. Cleaning of gaseous equipments particulate emission control: collection efficiency, control equipment like gravitational settling chambers, Cyclone separators, fabric filters, scrubbers, packed beds and plate columns, venturi scrubbers, their design aspects. Control of gaseous emissions: absorption by liquids, absorption equipments, adsorption by solids.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Understanding of air/water pollution regulations and their scientific basis.
CO2: Apply knowledge for the protection and improvement of the environment
CO3: Understanding the sources and characteristics of the pollutants
CO4: Ability to monitor and design the air and water pollution control systems.
CO5: Ability to select and use suitable waste treatment technique..

TEXT BOOKS

1. Environmental pollution and control engineering, Rao C. S. - Wiley Eastern Limited, India,1993.
2. Pollution control in process industries by S.P. Mahajan TMH.,1985.

REFERENCE BOOKS

1. Waste water treatment by M.NarayanaRao and A.K.Datta,Oxford and IHB publ. New Delhi.
2. Air pollution control by P.Prathapmouli and N.Venkatasubbayya. DivyaJyothiPrakashan,Jodhpur.
3. "Industrial Pollution Control and Engineering." Swamy AVN, Galgotia publications, 2005.Hyderabad.
4. Air pollution control Engineering" Lawerence .K.Wang, Norman C Pereira, Yung-TseHung,Humana press Inc,2004.

WEB REFERENCES

1. https://www.oecd.org/env/ehs/risk-management/best-available-techniques.htm

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc22_ce22/preview

CO-PO MAPPING

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

23ME1005	HOSPITAL MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the difference between hospitals and industries and how hospitals are planned.
- To understand how human resources are managed in hospitals.
- To know how hospitals hire, train, and develop staff.
- To explore the important support services in hospitals like records, pharmacy, and food.
- To learn about communication methods and safety rules in hospitals.

UNIT I OVERVIEW OF HOSPITAL ADMINISTRATION **9**

Distinction between Hospital and Industry, Challenges in Hospital Administration – Hospital Planning- Equipment Planning – Functional Planning

UNIT II HUMAN RESOURCE MANAGEMENT IN HOSPITAL **9**

Principles of HRM – Functions of HRM – Profile of HRD Manager –Human Resource Inventory – Manpower Planning

UNIT III RECRUITMENT AND TRAINING **9**

Different Departments of Hospital, Recruitment, Selection, Training Guidelines – Methods of Training – Evaluation of Training – Leadership grooming and Training, Promotion – Transfer

UNIT IV SUPPORTIVE SERVICES **9**

Medical Records Department – Central Sterilization and Supply Department – Pharmacy – Food Services - Laundry Services.

UNIT V COMMUNICATION AND SAFETY ASPECTS IN HOSPITAL **9**

Purposes – Planning of Communication, Modes of Communication – Telephone, ISDN, Public Address and Piped Music – CCTV. Security – Loss Prevention – Fire Safety – Alarm System – Safety Rules

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Remembering the key differences between hospitals and industries, and the basic principles of hospital planning.

CO2: Understanding the human resource management functions and their application in a hospital setting.

CO3: Applying the process of recruitment, training, and staff development within a hospital.

CO4: Analyzing the effectiveness of supportive services in hospitals, including medical records, pharmacy, and food services.

CO5: Design and implement communication and safety protocols that ensure a secure and efficient hospital environment.

TEXT BOOKS

1. R.C.Goyal, “Hospital Administration and Human Resource Management”, PHI – Fourth Edition, 2017.
2. G.D.Kunders, “Hospitals – Facilities Planning and Management – TMH, New Delhi – Fifth Reprint 2016.

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1. Cesar A.Caceres and Albert Zara, “The Practice of Clinical Engineering, Academic Press, New York, 2012.
2. Norman Metzger, “Handbook of Health Care Human Resources Management”, 2nd edition, Aspen Publication Inc. Rockville, Maryland, USA, 1990.
3. Peter Berman “Health Sector Reform in Developing Countries” - Harvard University Press, 1995.
4. William A. Reinke “Health Planning For Effective Management” - Oxford University Press.1988.
5. Blane, David, Brunner, “Health and SOCIAL Organization: Towards a Health Policy for the 21st Century”, Eric Calrendon Press 2002.
6. Arnold D. Kalcizony& Stephen M. Shortell, “Health Care Management”, 6th Edition Cengage Learning, 2019.

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1. https://www.karexpert.com/blogs/what-is-hospital-management-system/
2. https://mocdoc.in/blog/a-detailed-view-of-hospital-management-system-hms
3. https://www.leadsquared.com/hospital-management-system-hms/
4. https://gloriumtech.com/hospital-management-software-development-key-features-and-benefits/

CO-PO MAPPING

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

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 %**

23ME1006	SYSTEMS ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Illustrate the life cycle phases and framework for systems engineering.
- Describe about systems engineering process.
- Apply ergonomic and system dynamic models for evaluation of alternatives.
- Create knowledge on Reliability, Markov and Time series models for analysis of alternatives.
- Describe about decision assessment methods in systems engineering.

UNIT I INTRODUCTION 9

Definitions of Systems Engineering, Systems Engineering Knowledge, Life cycles, Life-cycle phases, logical steps of systems engineering, Frame works for systems engineering.

UNIT II SYSTEMS ENGINEERING PROCESSES 9

Formulation of issues with a case study, Value system design, Functional analysis, Business Process Reengineering, Quality function deployment, System synthesis, Approaches for generation of alternatives.

UNIT III ANALYSIS OF ALTERNATIVES - I 9

Cross-impact analysis, Structural modeling tools, System Dynamics models with case studies, Economic models: present value analysis – NPV, Benefits and costs over time, ROI, IRR; Work and Cost breakdown structure.

UNIT IV ANALYSIS OF ALTERNATIVES – II 9

Reliability, Availability, Maintainability, and Supportability models; Stochastic networks and Markov models, Queuing network optimization, Time series and Regression models, Evaluation of large scale models

UNIT V DECISION ASSESSMENT 9

Decision assessment types, Five types of decision assessment efforts, Utility theory, Group decision making and Voting approaches, Social welfare function; Systems Engineering methods for Systems Engineering Management

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Remembering the basic concepts, definitions, and life-cycle phases of systems engineering.

CO2: Understanding the processes involved in systems engineering, such as value system design and business process reengineering.

CO3: Applying economic and system dynamics models to analyze alternatives in engineering projects.

CO4: Analyzing various reliability, availability, and optimization models for system analysis.

CO5: Creating decision-making frameworks and apply systems engineering methods for effective management

TEXT BOOKS

1. Andrew P. Sage, James E. Armstrong Jr. “Introduction to Systems Engineering”, John Wiley and Sons, Inc, 2000.
2. Alexander Kossiakoff, Steven M. Biemer, Samuel J. Seymour, David A. Flanigan "Systems Engineering Principles and Practice", 3rd Edition, John Wiley & Sons, Inc., 2020.

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1. Andrew P.Sage, “Systems Engineering”, John Wiley & Sons, 1992.
2. Andrew P.Sage, William B.Rouse, “Hand book of Systems Engineering and Management”, John Wiley & Sons, 2011.

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1. https://user.eng.umd.edu/~austin/enes489p/lecture-slides/2012-MA-Introduction-to-SE.pdf
2. https://www.sebokwiki.org/w/images/SEBoK%20v.%201.9.1.pdf
3. https://www.researchgate.net/publication/273457341_Systems_engineering_evolution_and_challenges
4. https://freecomputerbooks.com/Systems-Engineering-Practice-and-Theory.html

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/107/106/107106009/
2. https://nptel.ac.in/courses/110104074
3. https://freevideolectures.com/course/4724/nptel-systems-engineering

CO-PO MAPPING

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

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 %**

23ME1007	MARKETING MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the marketing process, concepts, and strategies.
- To analyze consumer behavior and factors influencing buying decisions.
- To develop pricing strategies and marketing research skills.
- To create and implement effective marketing plans and strategies.
- To evaluate marketing communications, sales promotions, and distribution channels.

UNIT I **MARKETING PROCESS** **9**

Definition, Marketing process, dynamics, needs, wants and demands, marketing concepts, environment, mix, types. Philosophies, selling versus marketing, organizations, industrial versus consumer marketing, consumer goods, industrial goods, product hierarchy

UNIT II **BUYING BEHAVIOUR AND MARKET SEGMENTATION** **9**

Cultural, demographic factors, motives, types, buying decisions, segmentation factors - demographic -Psycho graphic and geographic segmentation, process, patterns.

UNIT III **PRODUCT PRICING AND MARKETING RESEARCH** **9**

Objectives, pricing, decisions and pricing methods, pricing management. Introduction, uses, process of marketing research.

UNIT IV **MARKETING PLANNING AND STRATEGY FORMULATION** **9**

Components of marketing plan-strategy formulations and the marketing process, implementations, portfolio analysis, BCG, GEC grids.

UNIT V **ADVERTISING, SALES PROMOTION AND DISTRIBUTION** **9**

Characteristics, impact, goals, types, and sales promotions - point of purchase - unique selling proposition. Characteristics, wholesaling, retailing, channel design, logistics, and modern trends in retailing, Modern Trends, e-Marketing.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Remembering key marketing terms, concepts, and the marketing mix.
CO2: Understanding how consumer behaviour and segmentation affect marketing decisions.
CO3: Applying pricing strategies and marketing research in real-life situations.
CO4: Analyzing marketing strategies and use tools like BCG and GEC grids.
CO5: Evaluating the effectiveness of advertising, promotions, and distribution strategies.

TEXT BOOKS

1. Philip Kolter& Keller, “Marketing Management”, Prentice Hall of India, 14th edition, 2012.
2. Chandrasekar. K.S., “Marketing Management Text and Cases”, 1st Edition, Tata McGraw Hill –Vijaynicole, 2010.

REFERENCE BOOKS

1. Czinkota&Kotabe, “Marketing management”, Thomson learning, Indian edition 2007.

2. Adrain palmer, “ Introduction to marketing theory and practice”, Oxford university press IE 2004.
3. Donald S. Tull and Hawkins, “Marketing Research”, Prentice Hall of Inida, Digitized, 2008..
4. Philip Kotler and Gary Armstrong “Principles of Marketing” Prentice Hall of India, 2018.
5. Steven J.Skinner, “Marketing”, All India Publishers and Distributes Ltd. 2018.
6. Graeme Drummond and John Ensor, "Introduction to marketing concepts", Elsevier, Indian Reprint, 2007.

WEB REFERENCES

1. https://commecsinstitute.edu.pk/wp-content/uploads/2024/08/Kotler-and-Armstrong-Principles-of-Marketing.pdf
2. https://www.tandfonline.com/loi/rjmm20

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/110104068
2. https://nptel.ac.in/courses/110104070
3. https://onlinecourses.nptel.ac.in/noc20_mg04/preview

CO-PO MAPPING

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

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 %**

23CS1003	CLOUD COMPUTING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn about the concept of cloud and utility computing.
- To have knowledge on the various issues in cloud computing.
- To be familiar with the lead players in cloud.
- To appreciate the emergence of cloud as the next generation computing paradigm.

UNIT - I INTRODUCTION TO CLOUD COMPUTING 9

Introduction to Cloud Computing – Roots of Cloud Computing – Desired Features of Cloud Computing – Challenges and Risks – Benefits and Disadvantages of Cloud Computing.

UNIT - II VIRTUALIZATION 9

Introduction to Virtualization Technology – Load Balancing and Virtualization – Understanding Hypervisor – Types of Virtualization – Server, Desktop, Application Virtualization.

UNIT - III CLOUD ARCHITECTURE, SERVICES AND STORAGE 9

NIST Cloud Computing Reference Architecture – Public, Private and Hybrid Clouds - laaS – PaaS – SaaS – Architectural Design Challenges.

UNIT - IV RESOURCE MANAGEMENT AND SECURITY IN CLOUD 9

Inter Cloud Resource Management – Resource Provisioning Methods – Security Overview – Cloud Security Challenges – Data Security –Application Security – Virtual Machine Security.

UNIT - V CASE STUDIES 9

Google App Engine(GAE) – GAE Architecture – Functional Modules of GAE – Amazon Web Services(AWS) – GAE-Open Stack .

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Articulate the main concepts, key technologies, strengths and limitations of cloud computing.
CO2: Learn the key and enabling technologies that help in the development of cloud.
CO3: Develop the ability to understand and use the architecture of compute and storage cloud, service and delivery models.
CO4: Explain the core issues of cloud computing such as resource management and security.
CO5: Be able to install and use current cloud technologies.
CO6: Choose the appropriate technologies, algorithms and approaches for implementation and use of cloud.

TEXT BOOKS

1. Buyya R., Broberg J., Goscinski A., Cloud Computing: Principles and Paradigm, First Edition, John Wiley and Sons, 2011.
2. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
3. Rittinghouse, John W., and James F. Ransome, Cloud Computing: Implementation, Management, And Security, CRC Press, 2017.

REFERENCE BOOKS

1. RajkumarBuyya, Christian Vecchiola, S. ThamaraiSelvi, Mastering Cloud Computing, Tata Mcgraw Hill, 2013.
2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing – A Practical Approach, Tata Mcgraw Hill, 2009.
3. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice), OReilly, 2009.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2				2			1			3
CO2	2				2			1			3
CO3	2				2			1			3
CO4	2				2			1			3
CO5	2				2			1			3
CO6	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 %

23EE1004	MICRO ELECTRO MECHANICAL SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices
- To educate on the rudiments of Micro fabrication techniques.
- To introduce various sensors and actuators
- To introduce different materials used for MEMS
- To educate on the applications of MEMS to disciplines beyond Electrical and Mechanical engineering.

UNIT - I INTRODUCTION 9

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis – Flexural beam bending- Torsional deflection.

UNIT - II SENSORS AND ACTUATORS-I 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 SENSORS AND ACTUATORS-II 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 MICROMACHINING 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 POLYMER AND OPTICAL MEMS 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: Explain about fabrication processes for producing micro-sensors and actuators.

CO2: Design Micro sensors and actuators actuated by Electrical and Thermal Actuation

CO3: Design Micro sensors and actuators actuated by Piezo-Electric and magnetic Actuation

CO4: Analyse the behavior of MEMS system

CO5: Understand the operation and manufacturing of Microsystems and application of MEMS devices.

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.

REFERENCES:

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.

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1. https://www.lboro.ac.uk/microsites/mechman/research/ipm
2. ktn/pdf/Technology_review/an-introduction-to-mems.pdf

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/117105082
2. https://www.digimat.in/nptel/courses/video/112108092/L01.html

CO-PO MAPPING

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