

**PROGRAMME: B.E.
MECHATRONICS ENGINEERING
CURRICULUM**

SEMESTER 1										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMTA1101	Engineering Mathematics - I	3	*	0	3	50	50	3
2	Theory	SPHA1101	Physics for Engineers	3	0	1	4	50	50	4
3	Theory	SCSA1103	Programming in C	3	0	0	3	50	50	6
4	Theory	SBTA1101	Environmental Science and Engineering	2	0	0	0	-	-	7
5	Theory	SMEA1101	Engineering Graphics	1	0	4	3	50	50	8
6	Theory	SMEA1203	Fundamentals of Mechanical Engineering	3	0	0	3	50	50	15
7	Practical	SPHA2101	Physics Lab	0	0	2	1	25	25	9
8	Practical	SCSA2104	Programming in C Lab	0	0	4	2	50	50	10
9	Practical	SMEA2101	Computer Aided Design Lab	0	0	4	2	50	50	11
Total Credits for Semester 1 – 21										
Total Marks for Semester 1 - 750										

SEMESTER 2										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SHSA1101	Technical English	3	0	0	3	50	50	1
2	Theory	SMTA1201	Engineering Mathematics - II	3	*	0	3	50	50	12
3	Theory	SCYA1101	Engineering Chemistry	3	1	0	4	50	50	13
4	Theory	SMEA1202	Engineering Mechanics	3	*	0	3	50	50	14
5	Theory	SEEA1101	Basic Electrical and Electronics Engineering	3	0	0	3	50	50	16
6	Theory	SMRA1201	Fundamentals of Automation & Control	3	0	0	3	50	50	17
7	Practical	SCYA2101	Engineering Chemistry Lab	0	0	2	1	25	25	18
8	Practical	SMEA2201	Workshop Practice	0	0	4	2	50	50	19
Total Credits for Semester 2 - 22										
Total Marks for Semester 2 - 750										

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

CAE – CONTINUOUS ASSESSMENT EXAMINATION,

ESE – END SEMESTER EXAMINATION

SEMESTER 3										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMTA1301	Engineering Mathematics - III	3	*	0	3	50	50	20
2	Theory	SMEA1305	Mechanics of Solids	3	*	0	3	50	50	21
3	Theory	SMEA1302	Engineering Thermodynamics	3	*	0	3	50	50	22
4	Theory	SECA1306	Electronics Devices and Circuits	3	0	0	3	50	50	23
5	Theory	SMEA1303	Fluid Mechanics and Machinery	3	*	0	3	50	50	24
6	Theory	SMEA1301	Engineering Metrology	3	0	0	3	50	50	26
7	Practical	SMEA2301	Fluid Mechanics and Machinery Lab	0	0	4	2	50	50	28
8	Practical	SECA2305	Electronic Devices and Circuits Lab	0	0	4	2	50	50	29
Total Credits for Semester 3 - 22										
Total Marks for Semester 3 - 800										

SEMESTER 4										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMTA1401	Engineering Mathematics - IV	3	*	0	3	50	50	30
2	Theory	SMEA1401	Manufacturing Technology - I	3	0	0	3	50	50	31
3	Theory	SAIC4001	Industry 4.0	2	0	0	2	50	50	32
4	Theory	SMRA1401	Automation and Programmable Logic Controller	3	0	0	3	50	50	33
5	Theory	SMEA1402	Mechanics of Machines	3	*	0	3	50	50	34
6	Theory	SMRA1402	Signals and Control Systems	3	0	0	3	50	50	35
7	Practical	SMEA2402	Manufacturing Process Lab	0	0	4	2	50	50	36
8	Practical	SECA2601	Microprocessor and Microcontroller Lab	0	0	4	2	50	50	37
Total Credits for Semester 4 - 21										
Total Marks for Semester 4 - 800										

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

CAE – CONTINUOUS ASSESSMENT EXAMINATION,

ESE – END SEMESTER EXAMINATION

SEMESTER 5										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMEA1503	Finite Element Analysis	3	*	0	3	50	50	38
2	Theory	SMEA1505	Manufacturing Technology - II	3	0	0	3	50	50	39
3	Theory	SEEA1401	Power Electronics	3	0	0	3	50	50	40
4	Theory	SMEA1502	Design of Machine Elements	3	*	0	3	50	50	41
5	Theory	SMEA1702	Industrial Mechatronics	3	0	0	3	50	50	42
6	Theory		Open Elective – I	3	0	0	3	50	50	-
7	Practical	S19APT1	Professional Training	0	0	4	2	50	50	-
8	Practical	SEEA2401	Power Electronics Lab	0	0	4	2	50	50	43
9	Practical	SMRA2501	Mechatronics and Simulation lab	0	0	4	2	50	50	44
Total Credits for Semester 5 - 24										
Total Marks for Semester 5 - 900										

SEMESTER 6										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMRA1601	Sensors and Instrumentation	3	0	0	3	50	50	45
2	Theory	SMRA1602	Micro Electro Mechanical Systems	3	0	0	3	50	50	46
3	Theory		Elective - I	3	0	0	3	50	50	-
4	Theory		Elective - II	3	0	0	3	50	50	-
5	Theory		Open Elective - II	3	0	0	3	50	50	-
6	Practical	SMRA2601	Sensors and Instrumentation Lab	0	0	4	2	50	50	47
7	Practical	SAUA2601	Automotive Electrical and Electronics Lab	0	0	4	2	50	50	48
8	Project	S19APT2	Inter Disciplinary Project	0	0	6	3	50	50	-
Total Credits for Semester 6 - 22										
Total Marks for Semester 6 - 800										

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

CAE – CONTINUOUS ASSESSMENT EXAMINATION,

ESE – END SEMESTER EXAMINATION

SEMESTER 7										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMEA3005	Non Destructive Testing and Techniques	3	0	0	3	50	50	49
2	Theory	SMRA1701	Robotics and Machine Vision System	3	0	0	3	50	50	50
3	Theory		Elective - III	3	0	0	3	50	50	-
4	Theory		Elective - IV	3	0	0	3	50	50	-
5	Theory		Open Elective - III	3	0	0	3	50	50	-
6	Practical	SMRA2701	Robotics and CAM Lab	0	0	4	2	50	50	51
7	Project	S19APROJ1	Project Phase - I	0	0	6	3	50	50	-
Total Credits for Semester 7 – 20										
Total Marks for Semester 7 – 700										

SEMESTER 8										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory		Elective - V	3	0	0	3	50	50	-
2	Theory		Elective - VI	3	0	0	3	50	50	-
3	Project	S19APROJ2	Project Phase - II	0	0	14	7	50	50	-
Total Credits for Semester 8 - 13										
Total Marks for Semester 8 - 300										

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

CAE – CONTINUOUS ASSESSMENT EXAMINATION,

ESE – END SEMESTER EXAMINATION

LIST OF ELECTIVES

PROFESSIONAL ELECTIVES COURSES									
Sl. No.	Course code	Course title	L	T	P	C	Marks		Page No.
							CAE	ESE	
1	SMRA3001	Instrumentation in Industries	3	0	0	3	50	50	52
2	SMEA3001	Additive Manufacturing	3	0	0	3	50	50	53
3	SMRA3002	Virtual Instrumentation	3	0	0	3	50	50	54
4	SMRA3003	Artificial Intelligence and Expert systems	3	0	0	3	50	50	55
5	SMRA3004	Medical Mechatronics	3	0	0	3	50	50	56
6	SMEA1701	Automobile Engineering	3	0	0	3	50	50	57
7	SMEA3003	Computational Fluid Dynamics	3	0	0	3	50	50	58
8	SMEA3012	Industrial Robotics and Expert Systems	3	0	0	3	50	50	59
9	SEIA3012	Adaptive Control Systems	3	0	0	3	50	50	60
10	SMEA3010	Automation in Manufacturing	3	0	0	3	50	50	61
11	SMEA3004	Fluid Power systems	3	0	0	3	50	50	62
12	SMEA3007	Computer Integrated Manufacturing Systems	3	0	0	3	50	50	64
13	SMRA3005	Experimental stress analysis	3	0	0	3	50	50	65
14	SMEA3015	Material handling and Storage systems	3	0	0	3	50	50	66
15	SEIA3013	Automotive Electronics	3	0	0	3	50	50	67
16	SEIA3010	Ultrasonic Instrumentation	3	0	0	3	50	50	68
17	SMEA3017	Industrial Safety Engineering	3	0	0	3	50	50	69
18	SMRA4001	Flexible Manufacturing systems	3	0	0	3	50	50	70
19	SMEA3019	Vibration and Noise Control	3	0	0	3	50	50	71
20	SMEA3016	Modern Manufacturing Systems	3	0	0	3	50	50	72
21	SEEA3009	Power Plant Instrumentation	3	0	0	3	50	50	74
22	SCSA1601	Machine Learning	3	0	0	3	50	50	75

OPEN ELECTIVE COURSES									
Sl. No.	Course Code	Course Title	L	T	P	C	Marks		Page No.
							CAE	ESE	
1	SALA4001	Intellectual Property Law	3	0	0	3	50	50	A1
2	SAEA4001	Fundamentals of Aerospace Technology	3	0	0	3	50	50	A2
3	SBAA4001	Fundamentals of Management	3	0	0	3	50	50	A3
4	SBAA4002	Principles of Management and Professional Ethics	3	0	0	3	50	50	A4
5	SBTA4001	Biology for Engineers	3	0	0	3	50	50	A5
6	SBMA4001	Neurology	3	0	0	3	50	50	A6
7	SBMA4002	Modelling of Physiological Systems	3	0	0	3	50	50	A7
8	SBMA4003	Drug Delivery System	3	0	0	3	50	50	A8
9	SBMA4004	Fundamentals of Mechatronics	3	0	0	3	50	50	A9
10	SBMA4005	Virtuality and Augmented Reality	3	0	0	3	50	50	A10
11	SBMA4006	Medical Optics and Laser Applications	3	0	0	3	50	50	A11
12	SBMA4007	Forensic Science	3	0	0	3	50	50	A12
13	SBMA4008	Artificial Intelligence and Expert Systems	3	0	0	3	50	50	A13
14	SBMA4009	Human Factors in Engineering and Design	3	0	0	3	50	50	A14
15	SCHA4001	Corrosion Engineering	3	0	0	3	50	50	A15
16	SCHA4002	Energy Engineering	3	0	0	3	50	50	A16
17	SCHA4003	Environmental Impact Assessment	3	0	0	3	50	50	A17
18	SCHA4004	Environmental Pollution and Control	3	0	0	3	50	50	A18
19	SCIA4001	Disaster Management	3	0	0	3	50	50	A19
20	SCSA4001	R Programming	3	0	0	3	50	50	A20
21	SCSA4002	5 G Networks	3	0	0	3	50	50	A21
22	SECA4001	Software Tools for Engineering Applications	3	0	0	3	50	50	A22
23	SMEA4001	Resource Management Techniques	3	0	0	3	50	50	A23
24	SMEA4002	Wind and Solar Energy	3	0	0	3	50	50	A24

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

CAE – CONTINUOUS ASSESSMENT EXAMINATION,

ESE – END SEMESTER EXAMINATION

SMEA3005	NON DESTRUCTIVE TESTING AND TECHNIQUES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To enable the student to understand the modern NDT techniques.
- To present the underlying principles and alternatives for destructive testing procedures.
- To provide the student with the opportunity for hands-on experience for diverse domains of application.

UNIT 1 INTRODUCTION AND VISUAL INSPECTION METHODS**9 Hrs.**

Scope and advantages of NDT. Comparison of NDT with DT. Some common NDT methods used since ages, Terminology. Flaws and Defects, Visual inspection-Unaided, Equipment used for visual inspection. Ringing test chalk test (oil whitening test). Attractive uses of above tests in detecting surface cracks, bond strength & surface defects.

UNIT 2 LIQUID PENETRANT TESTING AND MAGNETIC PARTICLE TESTING**9 Hrs.**

Die penetrate test (liquid penetrate inspection), Principle, scope. Equipment & techniques, Tests stations, Advantages, types of penetrant and developers. Illustrative examples – Heavy castings of large size, frame of jet engine, porosity testing of nickel alloys, leak testing. Magnetic particle Inspection – Scope, principle, Ferro Magnetic and Non-ferro magnetic materials, equipment & testing. Advantages, limitations Interpretation of results. DC & AC magnetization, Skin Effect, use of dye & wet powders for magna glow testing, different methods to generate magnetic fields, Applications and demonstration.

UNIT 3 RADIOGRAPHIC METHODS**9 Hrs.**

X-ray radiography principle, equipment & methodology. Applicability, types of radiations limitations. Interpretation of Radiographs, limitations of gamma-ray radiography –principle, equipment. Attenuation of electromagnetic radiations, source of radioactive materials & technique. Photo electric effect, Rayleigh's scattering (coherent scattering), Compton's scattering (Incoherent scattering). Pair production, Beam geometry, scattering factor. Precautions against radiation hazards. Xero-Radiography, Digital Radiography, Gamma ray Radiography, Safety in X- ray and Gamma ray radiography. Advantages of gammaray radiography over X-ray radiography.

UNIT 4 ULTRASONIC TESTING AND ACOUSTIC EMISSION TESTING**9 Hrs.**

Introduction, Principle of operation, Piezoelectricity. Ultrasonic probes, CRO techniques, advantages, Limitation & typical applications. Applications in inspection of castings, forgings, Extruded steel parts, bars, pipes, rails and dimensions measurements. Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages& Limitations, Applications and demonstration.

UNIT 5 EDDY CURRENT TESTING AND THERMOGRAPHY**9 Hrs.**

Eddy current Testing – Principle, properties of eddy currents, Eddy current sensing elements, probes, Instrumentation, Types of arrangement, Advantages & Limitations& applications. Thermography – Introduction, Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Applications and demonstration.

Max. 45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - Describe the basic concepts of NDT.
- CO2 - Interpret the quality of the components.
- CO3 - Design the precautions against the radiation hazards.
- CO4 - Knowledge on Interpretation of results.
- CO5 - Analyze products as production team member.
- CO6 - Knowledge on Electromagnetic spectrum.

TEXT / REFERENCE BOOKS

1. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. Research Techniques in NDT Vol.3, R.S. Shah, Academic 2002.
3. Paul E Mix, "Introduction to nondestructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005.
4. Ravi Prakash, "Non-Destructive Testing Techniques", New Age International Publishers, 1st Revised Edition, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 10 Questions of 2 marks each – No choice**20 Marks****PART B:** 2 Questions from each unit of internal choice, each carrying 16 marks**80 Marks**

SMRA1701	ROBOTICS AND MACHINE VISION SYSTEM	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To introduce the robotic concepts, parts and various types of robots.
- To make the students familiar with sensors, drive systems for robot and their applications in robots, programming of robots.
- To understand the various applications of robots, justification, implementation and safety of robot.

UNIT 1 BASICS OF ROBOTICS**9 Hrs.**

Introduction-Anatomy of Robot-Laws of robotics- Configurations of robot-work volume- -Spatial resolution-accuracy-resolution –repeatability of robot-Drive Systems of Robot-Control system of Robot-: Robot motions Rotary to rotary motion, Rotary to linear motion, Harmonics drives-**Robotic sensors and actuators-control systems-Robot actuation and feedback components- Power transmission system.**

UNIT 2 ROBOT END EFFECTORS**9 Hrs.**

Robot End effectors: Types of End effectors- Mechanical gripper- types of gripper mechanism- gripper force analysis- other types of gripper- special purpose **grippers-Tools-Selection and design of Grippers.**

UNIT 3 ROBOT MECHANICS**9 Hrs.**

Robot kinematics: Introduction-Position representation- rigid motion & homogeneous transformation forward & inverse kinematics- trajectory planning-Wrist Orientation-Manipulator path control. Robot Dynamics: Robot Arm dynamics – Lagrange - Euler formulation- Newton - Euler formulation.

UNIT 4 MACHINE VISION SYSTEM**9 Hrs.**

Machine vision:- Sensing and Digitizing-Imaging Devices-Lighting Techniques-AD Converter-Image Processing-Data reduction-segmentation- Thresholding-Region Growing-Edge Detection-Feature extraction-Object recognition-Applications-Inspection-identification-visual servicing and navigation-Training the vision.

UNIT 5 ROBOT PROGRAMMING**9 Hrs.**

Robot programming: Types-Methods of Defining Position-Motion Interpolation-Commands-Branching-Robot Languages-Classification of robot language-Computer control and robot software-Val system and Languages- application of robots.

Max. 45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able

- CO1 - Understand the basic concepts of Robotics.
- CO2 - Educate the various types of End **effectors used in robots for various applications.**
- CO3 - Introduce the position representation on work space.
- CO4 - Understand **machine vision system and its applications.**
- CO5 - Impart knowledge on **robot programming language** and to educate how to program a robot.
- CO6 - Upon completion of this course, the students can able to **apply the basic engineering knowledge for the design of robotics.**

TEXT / REFERENCE BOOKS

1. M.P.Groover, M.Weiss ,R.N. Nagal, N.G.Odrey, "Industrial Robotics - Technology, programming and Applications" Tata, McGraw-Hill Education Pvt Limited, 2010.
2. Sathya Ranjan Deb, "Robotics Technology & flexible Automation" 6th Edition, Tata McGraw- Hill Publication, 2013.
3. K.S.Fu, R.C.Gonzalez, C.S.G.Lee, "Robotics: Sensing, Vision & Intelligence", Tata McGraw- Hill Publication, 2009.
4. John.J.Craig, "Introduction to Robotics: Mechanics & Control", 2nd Edition, 2012.
5. Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer, Indian Reprint, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 10 Questions of 2 marks each – No choice**20 Marks****PART B:** 2 Questions from each unit with internal choice, each carrying 16 marks**80 Marks**

SMRA2701	ROBOTICS AND CAM LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVES

- To introduce different types of robotics and demonstrate them to identify different parts and Components.
- To write programming for simple operations like pick and place, rotoxim etc.
- Use of Adam's software and MAT Lab software to model the different types of robots and calculate work volume for different robots.
- To study the features of CNC Machine Tool.
- To expose students to modern control systems (Fanuc).
- To know the application of various CNC machines like CNC lathe, CNC Milling etc.

SUGGESTED LIST OF EXPERIMENTS – ROBOTICS LAB

1. Study of Robot anatomy and programming methods.
2. Study of sensor operations using LEGO kits.
3. Study of Actuators using LEGO kits.
4. Programming of basic motion commands using Teach pendant.
5. Programming for pick and place and palletizing operation in Robot.
6. Programming the robot for a drilling and Milling application.
7. Programming on operation for cutting and welding application.
8. Programming a parallel kinematic robot for a pick and place application.
9. Introduction to Matlab for Image processing.
10. Reduction and Noise and Grey levels using Mat lab.

SUGGESTED LIST OF EXPERIMENTS - CAM LAB**CNC LATHE****i) Part Programming for;**

- Facing
- Turning
- Step Turning
- Taper Turning
- Chamfering
- Threading
- Grooving
- Boring
- Drilling

CNC MILLING**i) Part Programming for;**

- Point to Point Motions
- Linear Motions
- Contour Motions
- Peck Drilling
- Rectangular Pocketing
- Circular Pocketing
- Mirroring

COURSE OUTCOMES

On completion of the course, student will be able

- CO1 - Provide sufficient knowledge of industrial robot.
- CO2 - Understand basic knowledge of robot programming.
- CO3 - Understand the concepts of work volume, configuration of industrial robot.
- CO4 - Understand the latest development in CNC system.
- CO5 - Understand the basic concepts of CNC programming and machining.
- CO6 - Prepare CNC Part Programming and perform manufacturing.

SMRA1601	SENSORS AND INSTRUMENTATION	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the characteristics of instruments and the sources and types of errors.
- To be familiar with different types of sensors.
- To know the techniques and methods for measurement of displacement, force, velocity.
- To know the techniques and methods for measurement of Pressure, Temperature, Flow, Level.

UNIT 1 MEASUREMENTS**9 Hrs.**

General Configuration and functional description of measuring instruments-Characteristics of instruments- Static characteristics -Dynamic characteristics - Types of errors -sources of errors- methods of elimination-Analysis of data - Limiting errors-Relative limiting error-Combination of Quantities with limiting errors – Statistical treatment of data: Histogram, Mean, Measure of dispersion from the mean, Range, Deviation, Average deviation, Standard Deviation, variance.

UNIT 2 SENSORS**9 Hrs.**

Sensors for Motion and Position Measurement, GPS, INS, Doppler, SONAR, Thermal Sensors – Gas Thermometric Sensors, Acoustic Temperature Sensor, Thermo-EMF Sensors, NQR Thermometry, Heat Flux Sensor, Chemical Sensor, Hall Effect Sensor, Tactile sensor, Ultrasonic sensor, High speed Image sensor.

UNIT 3 MEASUREMENT OF DISPLACEMENT, FORCE, VELOCITY**9 Hrs.**

Transducers for displacement-potentiometer, LVDT, Capacitance types, Optical Encoder, Transducers for Strain-Strain gauge, gauge factor, temperature compensation, Wheatstone bridge, . Force Measurement – Load cell, different types of load cells – elastic load cell-strain gauge load cell. Torque measurement-Using strain gauge and magneto elastic principle. Transducers for velocity– Revolution counter-capacitive tachometer, D.C and A.C tachometer generators – stroboscopic methods. Measurement of Acceleration - Elementary accelerometer, Seismic accelerometer, Practical accelerometers.

UNIT 4 MEASUREMENT OF TEMPERATURE AND PRESSURE**9 Hrs.**

Measurement of Temperature- Thermometer, Thermocouple, Thermistor, Pyrometer. Measurement of Pressure: Manometers – different types of manometers, Elastic pressure transducers, Dead weight Tester, Electrical types, Vacuum gauges - McLeod gauge, Knudsen gauge, thermocouple gauge, ionization gauge, Differential pressure Transmitter - electrical & pneumatic types.

UNIT 5 MEASUREMENT OF FLOW, LEVEL**9 Hrs.**

Orifice, Venturi, Pitot tube, flow nozzle rotameter, Dahl tube, Positive displacement meter, turbine flow meter, electromagnetic flow meter, ultrasonic flow meter, open channel flow measurement, solid flow measurement. Level: Sight glass, float gauge, displacer, torque tube, bubbler tube, diaphragm box, Differential Pressure methods, electrical methods-resistance type, capacitance type, ultrasonic level gauging.

Max. 45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - Understand the characteristics of instruments and determine the errors associated with it.
- CO2 - List the various sensors and its applications.
- CO3 - Understand the techniques of measurement of Displacement, Force, Velocity, Industrial parameters..
- CO4 - Apply the knowledge of measurement in industries.
- CO5 - Select a device for particular measurement.
- CO6 - Develop an appropriate method for measurement.

TEXT / REFERENCE BOOKS

1. Sawhney A.K., "Electrical & Electronic Measurements and Instrumentation", Dhanpat Rai Publications, 2001.
2. Patranabis.D, 'Sensors and Transducers', Prentice Hall of India, 1999.
3. Doebelin E.O. "Measurement System Applications and Design", TMH, 5th Edition, 2004.
4. Rangan C.S. Mani V.S.V: and Sharma G.R., "Instrumentation Devices and Systems" Tata McGraw Hill.
5. Renganathan.S, "Transducer Engineering" -Allied Publishers Limited.
6. D.V.S Murthy –"Transducer and Instrumentation", PHI, 1st Edition.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 10 Questions of 2 marks each - No choice**20 Marks****PART B:** 2 Questions from each unit with internal choice, each carrying 16 marks**80 Marks**

SMRA1602	MICRO ELECTRO MECHANICAL SYSTEMS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To have adequate knowledge in MEMS and Microsystems.
- To understand the fabrication procedures and have knowledge on MEMS sensors and actuators and their applications.
- To be made aware of the MEMS design procedures and RFMEMS.
- To investigate various applications of MEMS.

UNIT 1 INTRODUCTION**9 Hrs.**

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 2 MICRO SENSORS AND ACTUATORS**9 Hrs.**

Micro-sensing for MEMS: Piezo-resistive Pressure Sensor, Capacitive sensor, Piezoelectric sensing, Resonant sensing, Surface Acoustic Wave sensors Vibratory gyroscope, Electromechanical transducers: Piezoelectric transducers, Electrostrictive transducers, Magnetostrictive transducers, Electrostatic actuators, Electromagnetic transducers, Electrodynamic transducers, Case study-Piezo-resistive pressure sensor, Comb drive actuators.

UNIT 3 MICROMACHINING**9 Hrs.**

Silicon Anisotropic Etching – Anisotropic 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 Antistraction methods – LIGA Process – Assembly of 3D MEMS – Foundry process.

UNIT 4 POLYMER AND OPTICAL MEMS**9 Hrs.**

Polymers in MEMS– Polyimide – 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.

UNIT 5 MEMS PACKAGING AND APPLICATIONS**9 Hrs.**

MEMS packaging: Role of MEMS packaging, Types of MEMS packaging, selection of packaging materials, flip-chip and multichip Unit packaging, RF MEMS packaging issues. Micro-machined transmission line and components, micro-machined RF Filters, Micromachined Phase shifters, and Micro-machined antenna, Gyros and Bio-MEMS. Recent.

Max. 45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - Understand the basics of MEMS technology and microsystems.
- CO2 - Acquire knowledge in the types and procedures involved in MEMS fabrication.
- CO3 - Apply the acquired knowledge in understanding MEMS sensors and actuators.
- CO4 - Analyse various MEMS design and familiarise with optical RF MEMS.
- CO5 - Ability to understand the operation of micro devices, micro systems and their applications.
- CO6 - Ability to design the micro devices, micro systems using the MEMS fabrication process.

TEXT / REFERENCE BOOKS

1. Vijay K. Varadan, K. J. Vinoy and K. A. Jose , "RF MEMS & Their Applications", John Wiley & Sons, 2003.
2. Tai - Rai Hsu, "MEMS and Microsystems Design and Manufacturing", Tata MC Graw Hill, New Delhi, Edition 2002.
3. Gabriel M Rebeiz, "RF MEMS - Theory Design and Technology", John Wiley and Sons, 2003.
4. Nadim Maluf, "An introduction to Micro electro mechanical system design", Artech House ,2000.
5. Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2012.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 10 Questions of 2 marks each - No choice**20 Marks****PART B:** 2 Questions from each unit with internal choice, each carrying 16 marks**80 Marks**

SMRA2601	SENSORS AND INSTRUMENTATION LAB	L	T	P	Credits	Total Marks
		0	0	3	2	100

COURSE OBJECTIVES

1. To understand the working of sensors and transducers.
2. To understand the characteristics of sensors.
3. To calibrate voltmeter and ammeter.

SUGGESTED LIST OF EXPERIMENTS

1. Characteristics of Thermocouple.
2. Characteristics of Potentiometer.
3. Characteristics of Strain Gauge.
4. Characteristics of LVDT.
5. Calibration of Voltmeter using Potentiometer.
6. Calibration of Ammeter using Potentiometer.
7. Characteristics of Load Cell.
8. Characteristics of Resistance Thermometer.
9. Characteristics of Thermistor.
10. Characteristics of Synchros.
11. Characteristics of Piezoelectric Sensor.
12. Characteristics of Hall Effect Sensor.

COURSE OUTCOMES

On completion of the course, students are able to

- CO1 - Understand the functioning of few sensors and transducers.
 CO2 - Understand the characteristics of few sensors and transducers.
 CO3 - Understand the process and need for calibration.
 CO4 - Calibrate voltmeters and ammeters.
 CO5 - Choose the sensor for measurement of few parameters.
 CO6 - Use the appropriate sensor and calibrate.

SMRA2501	MECHATRONICS AND SIMULATION LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVES

- To teach basics about the mechatronics systems and its interfacing.
- To teach basic concepts of lab view software and its applications.
- To teach fundamentals about image processing techniques.

SUGGESTED LIST OF EXPERIMENTS

- a. Basic cylinder sequencing operations using pneumatic trainer kit.
- b. Simulation of basic hydraulic and pneumatic circuits using software.
- c. Experiment on cylinder sequencing for A+ B+ A- B- using pneumatic trainer kit.
- d. Proportional Integral Derivative (PID) controller interfacing.
- e. Basic operations and interfacing of sensors in lab view.
- f. Study of Boolean operations in lab view.
- g. Speed control of stepper and servo motor using microprocessor kit.
- h. A/D and D/A Conversion.
- i. Assembly language programming of 8085 – Addition – Subtraction – Multiplication – Division – Sorting – code conversion.
- j. Design and testing of fluid power circuits to control (i) Velocity (ii) direction and (iii) force of single and double acting actuators.
- k. Study of Image Processing Technique.

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1 - Understand basics about pneumatic and hydraulic circuits.
- CO2 - Understand basics about valves and controls.
- CO3 - Understand the concepts of using PID controllers.
- CO4 - Understand the knowledge of servo and stepper drives.
- CO5 - Understand the concept of using Lab views.
- CO6 - Understand the basics of analogue to digital convertors.

SMRA1401	AUTOMATION AND PROGRAMMABLE LOGIC CONTROLLER	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To familiarise with the actuators, control valves and different types of controllers.
- To learn about the architecture of PLC and its working.
- To write programs using ladder logic.
- To design a PLC based control system.

UNIT 1 ACTUATORS AND CONTROL VALVES**8 Hrs.**

Control valve:, Control valve Characteristics (Inherent & Installed) Control valve terminology: Range ability, Turndown, valve capacity, viscosity index, AO, AC (Fail Safe Action) etc. Classification of control valve based on: valve body, Construction, type of actuation and application . Construction & applications of Globe: Single, double, 3way, angle, Gate, Needle, Diaphragm, Rotary valves, Ball, Butterfly. Types of actuators: Construction, Advantages, Disadvantages & applications: Spring Diaphragm & Smart actuators. Positioners, Volume boosters, Pressure boosters, Reversing relay, Solenoid valves, Air lock, Position indicating switches, Electro pneumatic converter, Hand wheel, Motors.

UNIT 2 CONTROLLERS**9 Hrs.**

Controllers: Discontinuous: ON/OFF, Multi-position Control, Floating Control, Continuous Controller: P, I, D controllers, Composite controllers, Anti-reset windup, Rate before Reset, Concept of Bump less transfers in PID controller, Effect of process characteristics on PID combination, **Selection & application of controller actions.**

UNIT 3 BASICS OF PROGRAMMABLE LOGIC CONTROLLER (PLC)**9 Hrs.**

PLC Architecture and specifications – PLC hardware components Analog & digital Input/ Output modules - Power supplies – I/O slots, CPU & memory module – Programming devices –General PLC programming procedures - **programming on-off outputs, Auxiliary commands and functions** - creating ladder diagrams from process control descriptions – PLC programming Simple instructions – Manually operated switches – Mechanically operated a Proximity switches - Latching relays.

UNIT 4 PLC INTERMEDIATE FUNCTIONS**11 Hrs.**

Arithmetic functions - number comparison functions - skip and MCR functions - data move systems. **PLC Advanced intermediate functions- utilizing digital bits** - sequencer functions - **PLC Advanced functions: alternate-programming languages - operation. PLC basic programming** – digital logic Gates – Boolean algebra. Basic PLC functions-register basics-timers-counters.

UNIT 5 APPLICATIONS OF PLC**8 Hrs.**

Simple materials handling applications, Automatic control of warehouse door, Automatic lubrication of supplier Conveyor belt, motor control, Automatic car washing machine, Bottle label detection and process control application - Case Study of Bottle Filling System, Field Bus and HART Protocol.

Max. 45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - Understand the working of actuators, control valves, controllers, PLC.
- CO2 - Explain the use of actuators, control valves, controllers.
- CO3 - Select an appropriate controller for a process.
- CO4 - Apply the knowledge of **PLC in control.**
- CO5 - Develop a program using ladder logic.
- CO6 - **Design a control system using PLC.**

TEXT/ REFERENCE BOOKS

1. Process control and Instrument technology, C.D.Johnson, TMH.
2. Instrumentation for Process measurement and control , N.A. Anderson, CRC Press.
3. Introduction to Programmable Logic Controller, Gary Dunning, DELMAR Cengage Learning.
4. Programmable Logic Controller, Webb, PHI Reference Books.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****PART A:** 10 Questions of 2 marks each – No Choice**PART B:** 2 Questions from each units of internal choice, each carrying 16 marks**Exam Duration: 3 Hrs.****20 Marks****80 Marks**

SMRA1402	SIGNAL AND CONTROL SYSTEM ENGINEERING	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To impart knowledge regarding the various types of system and different transfer function analyzing techniques associated with control systems.
- To analyze the response and error of various types of system in time domain.
- To understand the stability analysis of frequency domain systems.

UNIT 1 SYSTEM CONCEPTS**9 Hrs.**

Basic Elements of Control System – Open loop and Closed loop systems - Differential equation - Transfer function, Modeling of Electric systems, Translational and rotational mechanical systems - Block diagram reduction Techniques - Signal flow graph- Mason's Gain Formula.

UNIT 2 TIME RESPONSE ANALYSIS OF CONTROL SYSTEMS**9 Hrs.**

Standard test signals, Time response of first order and second order systems with unit step as input, Time domain specification, steady state errors and static error constants, Concept of stability- P, PI, PD and PID controllers.

UNIT 3 FREQUENCY RESPONSE AND STABILITY ANALYSIS OF CONTROL SYSTEM**9 Hrs.**

Frequency Response of the System - Correlation between Time and Frequency Response - Gain and Phase Margin - Bode Plot The concept of stability- Routh Hurwitz stability Criterion.- Root Locus Analysis.

UNIT 4 CLASSIFICATION OF SIGNALS**9 Hrs.**

Continuous time signals (CT signals) and Discrete time signals (DT signals) –Basic operations on signals-elementary signals- Step, Ramp, Pulse, Impulse, Exponential – Classification of CT and DT signals – Periodic, aperiodic signals- Deterministic and Random signals-even and odd signals – Real and Complex signals – Energy and power signals.

UNIT 5 FOURIER TRANSFORM AND LAPLACE TRANSFORM**9 Hrs.**

Continuous time Fourier Transform –Properties of CTFT-Inverse Fourier transform- unilateral and bilateral Laplace Transform analysis with examples – Basic properties – Parseval's relation -Inverse Laplace transform using partial fraction expansion method – Relation between Fourier transform and Laplace transform.

Max. 45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - Understand the types of control systems in different domains.
- CO2 - Analyse the response of any linear time invariant system.
- CO3 - Determine and analyse the stability of the system.
- CO4 - Perform the analysis of the control system by Routh Hurwitz and Root Locus.
- CO5 - Understand mathematical description and representation of continuous and discrete time signals.
- CO6 - Analyze the spectral characteristics of continuous-time periodic and a periodic signals using Fourier transform and laplace transform.

TEXT / REFERENCE BOOKS

1. I.J.Nagarath and M.Gopal, "Control System Engineering" New Age International (p) Limited Publishers, 2nd Edition, 2009.
2. Kausuhio Ogata, "Modern Control Engineering", Prentice Hall of India PVT. Ltd, 5th Edition, 2010.
3. Richard Dorf, "Modern Control Systems", Pearson Education Ltd, 11th Edition 2009.
4. M.N. Bandyopadhyay, "Control Engineering, Theory and Practice" PHI, 4th Print, 2006.
5. N.K.Sinha, "Control Systems", New Age International Private Limited Publishers, 3rd Edition, 200, reprint 2008.
6. A.Nagoorkani, "Control System", RBA Publications, 3rd Edition, reprint 2012.
7. U.A.Bakshi and S.C.Goyal, "Control System Engineering", Technical Publication, 2nd Revised reprint 2007.
8. Allan V. Oppenheim et al, 'Signals and Systems', 2nd Edition, Prentice Hall of India Pvt. Ltd., 1997.
9. P.Ramesh Babu *et al*, 'Signals and Systems', 4th Edition, Scitech publishers, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 10 Questions of 2 marks each - No choice**20 Marks****PART B:** 2 Questions from each unit of internal choice; each carrying 16 marks**80 Marks**

SMRA1201	FUNDAMENTALS OF AUTOMATION AND CONTROL	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- Be aware of the scope and usefulness of industrial automation and its consequences.
- To apply automation technologies.
- Learn the most common sensors and ways of wiring.
- Differentiate the different types of actuators.

UNIT 1 MODELING AND ANALYSIS OF DYNAMIC SYSTEMS**9 Hrs.**

Fundamental concepts in dynamic systems: systems, models, linearity, static behavior, dynamic behavior, modeling of continuous dynamic systems, Definition of transfer function. Block diagrams, Time response in linear systems.

UNIT 2 AUTOMATIC CONTROL**9 Hrs.**

Concepts of feedback. Robustness, stability, accuracy, ability to follow set-points, PID control. Empirical tuning and analytical tuning, Feedback loop instrumentation, Control structures.

UNIT 3 INDUSTRIAL AUTOMATION**9 Hrs.**

Concept of industrial automation, Continuous and discrete systems, Integrated production systems: CAD/CAM, CAE and CIM, General structure of an automated system, Examples of **automated production systems**.

UNIT 4 COMPONENTS OF AN AUTOMATED SYSTEMS**9 Hrs.**

Control devices – open loop, closed loop, feedback control, Sensors- Types of sensors, Selection of Sensors, **Application of sensors**, **Actuators**- Types of actuators, **Application of actuators**.

UNIT 5 COMPUTER BASED INDUSTRIAL CONTROL**9 Hrs.**

Introduction & **Automatic Process Control**, Building Blocks of Automation Systems: LAN, Analog & Digital I/O Modules, **SCADA Systems & RTU**. Distributed Control System: Functional Requirements, Configurations & some popular Distributed Control Systems. (SLE: Display Systems in Process Control Environment.)

Max: 45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - **Select & identify suitable automation hardware for the given application.**
- CO2 - Describe & explain potential areas of automation.
- CO3 - Differentiate various **control aspects of automation.**
- CO4 - Demonstrate the self-learning capability of Industrial Automation.
- CO5 - **SCADA architecture, communication in SCADA, develops any application based on SCADA along with GUI using SCADA software.**
- CO6 - Understand evolution and architecture of **DCS, hierarchical control in DCS, programming DCS through function Block Diagram (FBD) method.**

TEXT / REFERENCE BOOK

- Automation, Production Systems and Computer Integrated Manufacturing- M.P.Groover, Pearson Education.5th Edition, 2009.
- Computer Based Industrial Control- Krishna Kant, EEE-PHI, 2nd Edition, 2010.
- An Introduction to Automated Process Planning Systems- Tiess Chiu Chang & Richard A. Wysk.
- Performance Modeling of Automated Manufacturing Systems,-Viswanandham, PHI, 1st Edition, 2009.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 10 Questions of 2 marks each – No choice**20 Marks.****PART B:** 2 Questions from each unit of internal choice; each carrying 16 marks**80 Marks.**

PROGRAMME: B.E MECHATRONICS ENGINEERING
CURRICULUM
SEMESTER 1

Sl. No. THEORY	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
1.	SHS1101	English for Science and Technology	3	0	0	3	1
2.	SMT1101	Engineering Mathematics – I	3	1	0	4	3
3.	SPH1101	Physics of Engineering Materials	3	0	0	3	5
4.	SCY1101	Engineering Chemistry	3	0	0	3	7
5.	SME1101	Engineering Mechanics	3	1	0	4	9
6.	SIC1102	Science of Measurements & Instrumentation	3	1	0	4	11
PRACTICAL							
7.	SPH4051	Engineering Physics Lab	0	0	2	1	13
8.	SCY4051	Engineering Chemistry Lab	0	0	2	1	14
9.	SME4051	Engineering Graphics – I	1	0	2	2	15
TOTAL CREDITS 25							

SEMESTER 2							
Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
THEORY							
1.	SCH1101	Environmental Science and Engineering	3	0	0	3	17
2.	SMT1105	Engineering Mathematics – II	3	1	0	4	19
3.	SPH1103	Engineering Physics	3	0	0	3	21
4.	SCY1102	Chemistry of Electronic Materials	3	0	0	3	23
5.	SCS1102	Fundamentals of Programming	3	0	0	3	25
6.	SMR1101	Digital Electronics	3	0	0	3	27
PRACTICAL							
7.	SCS4101	Programming in C Lab	0	0	4	2	29
8.	SME4052	Engineering Graphics– II	1	0	2	2	30

TOTAL CREDITS 23

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

SEMESTER 3

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
THEORY							
1	SMT1201	Engineering Mathematics – III	3	1	0	4	32
2	SME1203	Kinematics of Machines	3	1	0	4	34
3	SME1211	Strength of Materials	3	1	0	4	36
4	SMR1201	Mechanics of Fluids	3	1	0	4	38
5	SPR1202	Engineering Metrology	3	0	0	3	40
6	SEC1204	Electronic Devices and Circuits	3	0	0	3	42
PRACTICAL							
7.	SME4054	Fluid Mechanics and Machinery Lab	0	0	4	2	44
8.	SEC4077	Devices and Electric Circuit Laboratory	0	0	4	2	45
TOTAL CREDITS 26							

SEMESTER 4

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
THEORY							
1	SMT1204	Engineering Mathematics – IV	3	1	0	4	46
2	SME1208	Applied Thermal Engineering	3	1	0	4	48
3	SME1206	Dynamics of Machinery	3	1	0	4	50
4	SPR1206	Manufacturing Processes	3	0	0	3	52
5	SIC1201	Industrial Instrumentation	3	1	0	4	54
6	SEC1201	Microprocessors And Microcontrollers	3	1	0	4	56
PRACTICAL							
7	SPR4051	Manufacturing Process Lab – I	0	0	4	2	58
8	SEC4084	Microprocessor and Microcontroller Lab	0	0	4	2	59
9	S05PT1	Professional Training – 1	0	0	10	5	

– TOTAL CREDITS 32

SEMESTER 5

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
THEORY							
1	SME1301	Design of Machine Elements	3	1	0	4	60
2	SEC1208	Signals and Systems	3	0	0	3	62
3	SEE1203	Control Systems	3	0	0	3	64
4	SEE1305	Power Electronics	3	0	0	3	66
5	SME1302	Fluid Power Systems	3	0	0	3	68
6	SPR1304	Industrial Mechatronics	3	0	0	3	70
PRACTICAL							
7	SEE4057	Power Electronics Lab	0	0	4	2	72
8	SME4058	Mechatronics Lab	0	0	4	2	73
			TOTAL CREDITS 23				

SEMESTER 6

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
THEORY							
1	SPR1307	Resource Management Techniques	2	1	0	3	74
2	SMR1301	Micro Electro Mechanical Systems	3	0	0	3	76
3	SMR1302	Sensors and Instrumentation	3	0	0	3	78
4	SMR1303	PLC And Automation	3	0	0	3	80
5	SAU1302	Automotive Electrical And Electronics	3	0	0	3	82
6		Elective – 1	3	0	0	3	
PRACTICAL							
7	SMR4051	Sensors and Instrumentation Laboratory	0	0	4	2	84
8	SAU4052	Automotive Electrical And Electronics Laboratory	0	0	4	2	85
9	S05PT 2	Professional Training - 2	0	0	10	5	
TOTAL CREDITS 27							

SEMESTER 7							
Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
THEORY							
1	SMR1401	Robotics And Machine Vision System	3	0	0	3	86
2	SMR1402	Computer Aided Design	3	0	0	3	88
3		Elective – 2	3	0	0	3	
4		Elective – 3	3	0	0	3	
PRACTICAL							
5	SPR4054	CAD / CAM Lab	0	0	4	2	90
6	SMR4052	Robotics Lab	0	0	4	2	91
7	S05PROJ	Project Work (Phase – 1)					
TOTAL CREDITS 16							

SEMESTER 8							
Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
THEORY							
1	SBA1101	Principles of Management and Professional Ethics	3	0	0	3	92
2	SPR1403	Modern Manufacturing Processes	3	0	0	3	94
3		Elective – 4	3	0	0	3	
4	S05PROJ	Project Work (Phase - 1 & 2)	0	0	30	15	

TOTAL CREDITS 24

TOTAL CREDITS FOR THE PROGRAMME 196

Sl. No.	COURSE CODE	ELECTIVE COURSES (GROUP A) COURSE TITLE	L	T	P	C	PAGE No.
1	SME1308	Finite element analysis	3	0	0	3	96
2	SME1607	Computational fluid dynamics	3	0	0	3	98
3	SME1614	Experimental Stress Analysis	3	0	0	3	100
4	SPR1604	Design for Manufacture and Assembly	3	0	0	3	102
5	SPR1616	Rapid Prototyping	3	0	0	3	104
6	SIC1612	Adaptive Control Systems	3	0	0	3	106
7	SIC1610	Ultrasonic Instrumentation	3	0	0	3	108
8	SIC1614	Soft Computing Techniques	3	0	0	3	110

ELECTIVE COURSES (GROUP B)

1	SEC1314	Digital Signal Processing	3	0	0	3	112
2	SIC1404	Instrumentation in Industries	3	0	0	3	114
3	SPR1602	Artificial intelligence and expert systems	3	0	0	3	116
4	SPR1607	Industrial Safety Engineering	3	0	0	3	118
5	SPR1605	Flexible Manufacturing Systems	3	0	0	3	120
6	SEC1609	Fundamentals of Fuzzy Logic and Artificial Neural Networks	3	0	0	3	122
7	SMR1601	Virtual Instrumentation	3	0	0	3	124
8	SEC1615	Nano electronics	3	0	0	3	126
9	SEE1608	Computer Aided Design	3	0	0	3	128
10	SIC1310	Theory of Robotics	3	0	0	3	130
11	SIC1608	Power Plant Instrumentation	3	0	0	3	132

SMR1401	ROBOTICS AND MACHINE VISION SYSTEM	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- Upon completion of this course, the students can able to apply the basic engineering knowledge for the design of robotics

UNIT 1 BASICS OF ROBOTICS

9 Hrs.

Introduction- Basic components of robot-Laws of robotics- classification of robot-work space accuracy- resolution – repeatability of robot. **Power transmission system:** Rotary to rotary motion, Rotary to linear motion, Harmonics drives

UNIT 2 ROBOT END EFFECTORS

9 Hrs.

Robot End effectors: Introduction- types of End effectors- **Mechanical gripper-** types of gripper mechanism- gripper force analysis- other types of gripper- special purpose grippers.

UNIT 3 ROBOT MECHANICS

9 Hrs.

Robot kinematics: Introduction- Matrix representation- rigid motion & homogeneous transformation forward & inverse kinematics- trajectory planning. Robot Dynamics: Introduction – Manipulator dynamics – Lagrange - Euler formulation- Newton - Euler formulation

UNIT 4 MACHINE VISION FUNDAMENTALS

9 Hrs.

Machine vision: image acquisition, digital images-sampling and quantization-levels of computation Feature extraction- windowing technique- segmentation- Thresholding- edge detection- binary morphology - grey morphology

UNIT 5 ROBOT PROGRAMMING

9 Hrs.

Robot programming: Robot Languages- Classification of robot language-**Computer control and robot software-**Val system and Languages- **application of robots.**

Max. 45 Hours

COURSE OUTCOMES

On completion of the course, student will be able

- CO1 - To understand the basic concepts of Robotics.
- CO2 - To educate the various types of **End effectors used in robots for various applications.**
- CO3 - To introduce the position representation on work space.
- CO4 - To understand machine vision system and its applications.
- CO5 - To impart knowledge on **robot programming language** and to educate how to program a robot.
- CO6 - Upon completion of this course, the students can able to apply the basic engineering knowledge for the **design of robotics.**

TEXT / REFERENCE BOOKS:

- M.P.Groover, M.Weiss ,R.N. Nagal, N.G.Odrey, "Industrial Robotics - Technology, programming and Applications" Tata , McGraw-Hill Education Pvt Limited, 2008
- Sathya Ranjan Deb, "Robotics Technology & flexible Automation" Sixth edition, Tata McGraw- Hill Publication, 2003.

3. K.S.Fu, R.C.Gonzalez, C.S.G.Lee, "Robotics: Sensing, Vision & Intelligence", Tata McGraw- Hill Publication, 1987.
4. John.J.Craig, "Introduction to Robotics: Mechanics & control", Second edition, 2002.
5. Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer, Indian Reprint, 2010

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100

Exam Duration : 3 Hrs.

PART A : 2 Questions from each unit, each carrying 2 marks

20 Marks

PART B : 2 Questions from each unit with internal choice, each carrying 16 marks

80 Marks

SMR1402	COMPUTER AIDED DESIGN	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To provide an overview of how computers are being used in mechanical component design
- Enable students to use computer and CAD software's for modeling of mechanical components

UNIT 1 FUNDAMENTALS OF COMPUTER GRAPHICS

9 Hrs.

Product cycle- Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics – co-ordinate systems- 2D and 3D transformations homogeneous coordinates - Line drawing -Clipping- viewing transformation

UNIT 2 GEOMETRIC MODELING

9 Hrs.

Representation of curves- Hermite curve- Bezier curve- B-spline curves-rational curves-Techniques for surface modeling– surface patch- Coons and bicubic patches- Bezier and B-spline surfaces. Solid modeling techniques- CSG and B-rep

UNIT 3 VISUAL REALISM

9 Hrs.

Hidden – Line-Surface-Solid removal algorithms – shading – colouring – computer animation.

UNIT 4 ASSEMBLY OF PARTS

9 Hrs.

Assembly modelling – interferences of positions and orientation – tolerance analysis-mass property calculations – mechanism simulation and interference checking.

UNIT 5 CAD STANDARDS

9 Hrs.

Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images- Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALSetc. - communication standards.

Max. 45 Hours

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1 - Understand the basics of computer graphics, different graphics systems and applications of computer graphics
- CO2 - Discuss various algorithms for scan conversion and filling of basic objects and their comparative analysis.
- CO3 - Use of geometric transformations on graphics objects and their application in composite form.
- CO4 - Extract scene with different clipping methods and its transformation to graphics display device.
- CO5 - Explore projections and visible surface detection techniques for display of 3D scene on 2D screen.
- CO6 - Render projected objects to naturalize the scene in 2D view and use of illumination models for this.

TEXT / REFERENCE BOOKS:

1. Ibrahim Zeid "Mastering CAD CAM" Tata McGraw-Hill Publishing Co.2007
2. Chris McMahon and Jimmie Browne "CAD/CAM Principles", "Practice and Manufacturing management " Second Edition, Pearson Education, 1999.
3. William M Neumann and Robert F.Sproul "Principles of Computer Graphics", McGraw Hill Book Co. Singapore, 1989.
4. Donald Hearn and M. Pauline Baker "Computer Graphics". Prentice Hall, Inc, 1992.
5. Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles & practice" Pearson Education - 2003.

END SEMESTER EXAM QUESTION PAPER PATTERN**Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 2 Questions from each unit, each carrying 2 marks****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks**

SPR4054	CAD /CAM LAB (For Mech, Mech&Prod & Auto)	L	T	P	Credits	Total Marks
		0	0	4	2	100

SUGGESTED LIST OF EXPERIMENTS

A.CAD LAB

CAD ANALYSIS USING ANALYSIS SOFTWARE

Exercises will be given on Analyzing of mechanical components using Suitable Software

1. Cantilever beam with Point load at the end
2. Simply supported beam with inclined load
3. Overhanging beam with Uniformly distributed load (UDL)
4. Determination of deflection for a Truss system
5. Determination of deflection in a Pressure vessel
6. Determination of deflection in a Bent tube
7. Determination of temperature distribution in a stepped bar
8. Analysis of a bicycle frame
9. Thermal - mixed boundary example

B.CAM LAB

1. CNC Milling

- (i). Part Programming for: Point to point motions, Contour motions, Circular milling, Linear motions, Pocket milling, Mirroring Commands, Circular interpolations (both CW & CCW), Rectangular milling.
- (ii). Part Programming involving fixed or canned cycles: Drilling, Peck drilling, Boring and Tapping. (iii). Part programming using: Do loops, Sub Routines.

2. CNC Lathe

- (i). Part programming for: Turning, Facing, Chamfering, Grooving, Step Turning, Taper Turning, Circular Interpolation.
- (ii). Part programming using standard fixed cycles: Turning, Facing, Taper Turning, Thread Cuttings.

COURSE OUTCOME

- CO1 - Execute steps required for modeling 3D objects by using protrusion, cut, sweep, extrude commands
- CO2 - Convert 3D solid models into 2D drawing-different views, sections
- CO3 - Use isometric views and dimensioning of part models
- CO4 - Machine simple components on CNC machines
- CO5 - Use CAM software to generate NC code
- CO6 - Implement CNC programs for milling and turning machining operations

SMR4052	ROBOTICS LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

SUGGESTED LIST OF EXPERIMENTS

1. Study of Robot anatomy and programming methods
2. Study of sensor operations using LEGO kits
3. Study of Actuators using LEGO kits
4. Programming of basic motion commands using Teach pendant
5. Programming for pick and place operation in ROBOT
6. Programming the robot for a drilling application
7. Programming on palletizing operation
8. Programming a parallel kinematic robot for a pick and place application
9. Introduction to Matlab for Image processing
10. Reduction and Noise and Grey levels using Matlab

Course Outcome

After the successful completion of the course the students will be able to:

- CO1 - Explain the fundamentals of robotics and its components
- CO2 - Illustrate the Kinematics and Dynamics of robotics
- CO3 - Elucidate the need and implementation of related Instrumentation & control in robotics
- CO4 - Illustrate the movement of robotic joints with computers/microcontrollers.
- CO5 - Explain sensors and instrumentation in robotics
- CO6 - To learn about application of robot

SPR1403	MODERN MANUFACTURING PROCESSES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the basic concepts of different machining process.
- To understand the basic concepts of non traditional machining

UNIT 1 MECHANICAL PROCESSES**9 Hrs.**

Ultrasonic Machining- Elements of process, cutting tool system design, effect of parameters, economic considerations, applications, limitations of the process, advantages and disadvantages. Abrasive Jet Machining- **Variables in AJM**, metal removal rate in AJM. Water Jet Machining- Jet cutting equipments, process details, advantages and applications

UNIT 2 ELECTROCHEMICAL AND CHEMICAL METAL REMOVAL PROCESSES**9 Hrs.**

Electrochemical Machining- Elements of ECM process, tool work gap, chemistry of the process, metal removal rate, accuracy, surface finish and other work material characteristics, economics, advantages, applications, limitations. Electrochemical Grinding – Material removal, surface finish, accuracy, advantages, applications.

UNIT 3 THERMAL METAL REMOVAL PROCESSES**9 Hrs.**

Electric Discharge Machining (EDM) or **spark erosion machining** processes, mechanism of metal removal, spark erosion generators, electrode feed control, dielectric fluids, flushing. Electrodes for spark erosion, selection of electrode material, tool electrode design, surface finish, machining accuracy, machine tool selection and applications. **Wire cut EDM**. **Laser beam machining (LBM)** - Apparatus, material removal, cutting speed and accuracy of cut, metallurgical effects, advantages and limitations

UNIT 4 PLASMA ARC MACHINING (PAM)**9 Hrs.**

Plasma, **non thermal generation of plasma**, mechanism of metal removal, PAM parameters, equipments for D.C. plasma torch unit, safety precautions, economics, other applications of plasma jets - **Electron Beam Machining (EBM)**– Generation and control of electron beam, theory of electron beam machining, process capabilities and limitations..

UNIT 5 ULTRASONIC MACHINING AND HYBRID PROCESSES**9 Hrs.**

Ultrasonic machining system, mechanics of cutting, process parameters, analysis, capability, grain growing model, grain hammering model, limitations and applications Introduction, working principle, equipment, process parameters, process capabilities and applications of electro chemical grinding (ECG), electrical discharge grinding (EDG), electro chemical discharge grinding (ECDG).

Max.45 Hours**COURSE OUTCOMES:**

On completion of the course, student will be able to

- CO1: Analyse the fundamentals of the non-traditional machining processes.
- CO2: Explain the working principle of chemical metal removal processes.
- CO3: Choose a suitable nontraditional machining process for electrochemical metal removal processes.
- CO4: Compare the construction and working of electrical metal removal processes.
- CO5: Categorize the **EBM, LBM, PAM and USM processes**.
- CO6: **Apply a suitable nontraditional machining process for hybrid metal removal processes.**

TEXT / REFERENCE BOOKS

1. Pandey P.C., Shan H.S., Modern Machining Processes – Tata McGraw Hill, 1980.
2. Ghosh and Malik, Machining Science Affiliated East-West Press, 2002.
3. Jain V.K., Unconventional Machining, 2004.
4. Benedict G.F. & Marcel Dekker Non Traditional Manufacturing Processes, 1995.
5. McGeough Chapman J.A. and Hall - Advanced Methods of Machining, Kulwer Academic Publishers Group, 1988
6. Gunsekaran A., Agile Manufacturing, Elsevier, 2001.
7. Hartely J.R., Cambridge M.A., Concurrent Engineering by Productivity by Press, 1992.

END SEMESTER EXAM QUESTION PAPER PATTERN**Max. Marks : 100****Exam Duration : 3 Hrs.****PART A** : 2 Questions from each unit, each carrying 2 marks**20 Marks****PART B** : 2 Questions from each unit with internal choice, each carrying 16 marks**80 Marks**

SIC1612	ADAPTIVE CONTROL SYSTEMS (For EIE and E&C)	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To make the student familiarize with adaptive control schemes and MRAS
- To identify the techniques of linear and nonlinear systems with unknown parameters
- To introduce stability robustness concepts with protection systems.

UNIT 1 INTRODUCTION TO ADAPTIVE CONTROL SYSTEM

9 Hrs.

Definition of adaptive control system - functions of adaptive control - Different approaches to Adaptive Control - gain scheduling - Relay feedback

UNIT 2 IDENTIFICATION OF ADAPTIVE CONTROL

9 Hrs.

Conventional methods of Identifications - step response, impulse response, Bode plot - Identification of linear time- invariant systems - Adaptive observers - Sufficient richness condition for parameter convergence - Equation error and output error methods

UNIT 3 MODEL REFERENCE ADAPTIVE SYSTEMS (MRAS)

9 Hrs.

The need for MRAS - An over view of adaptive control systems - Mathematical description of MRAS - Design hypothesis

- Equivalent representation of MRAS.

UNIT 4 CLASSIFICATION OF ADAPTIVE CONTROL

9 Hrs.

Definitions - Auto tuning - Types of adaptive control - Recent trends in self-tuning - Robustness studies - Multivariable systems - Model updating - General-purpose adaptive regulator

UNIT 5 ADAPTIVE PROTECTION

9 Hrs.

Need of Adaptive Protection in the system - Techniques for adaptive strategies in distance protection - Synchro-phasor based adaptive protection schemes - protection schemes - SCADA based protection systems - FTA - Testing of Relays.

Max. 45 Hours

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1 - Remember the functions of adaptive control system and its various approaches.
- CO2 - Understand the applications of adaptive control system for protection.
- CO3 - Apply the tuning techniques for the robust multivariable systems
- CO4 - Analyze linear time-invariant system for parameter convergence and errors.
- CO5 - Estimate the parameters of the dynamic systems
- CO6 - Design Model Reference Adaptive Control System for a given system.

TEXT / REFERENCE BOOKS

1. Astrom K.J, Wittenmark B, Adaptive Control, Addison-Wesley, 2nd edition, 1995
2. Shankar Sastry, Marc Bodson, "Adaptive Control", Prentice Hall of India (P) Ltd., 1993.
3. Chalam V.V "Adaptive Control Systems - Techniques & Applications" - Marcel Dekker Inc
4. Chang C. Hong, Tong H. Lee and Weng K. Ho, Adaptive Control, ISA press, Research Triangle Park, 1993.

END SEMESTER EXAM QUESTION PAPER PATTERN**Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 2 Questions from each unit, each carrying 2 marks****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks**

SPR1606	INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OUTCOMES:

On completion of the course, student will be able to

- CO1: To understand the basics of Industrial Robot and its anatomy
 CO2: To understand robot drive system and servo control system
 CO3: To understand robot sensors and image processing techniques
 CO4: To understand robot work cell design and various configurations and its application.
 CO5: To understand robot types of programming techniques
 CO6: To understand fundamentals of AI search techniques and expert systems

UNIT 1 INTRODUCTION AND ROBOTIC KINEMATICS**9 Hrs.**

Definition need and scope of industrial robots- Coordinate Systems Classification of Robot- Robot anatomy - work volume - Precision movement – End effectors - sensors. Robot kinematics - Direct and inverse kinematics - Robot trajectories-Control of robot manipulators - Robot dynamics - Methods for orientation and location of objects. Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load

UNIT 2 ROBOT DRIVES AND CONTROL**9 Hrs.**

Controlling the robot motion - Position and velocity sensing devices - Design of drive systems - Hydraulic and Pneumatic drives - D.C. Servo Motors, Stepper Motors, A.C. Servo Motors Linear and rotary actuators and control valves –Electro hydraulic servo valves, electric drives - Motors - designing of end effectors - Vacuum, magnetic and air operated grippers

UNIT 3 ROBOT SENSORS**9 Hrs.**

Transducers and sensors - Sensors in robot - Tactile sensor - Proximity and range sensors - Sensing joint forces- Robotic vision system - Image Gripping - Image processing and analysis - Image segmentation – Pattern recognition - Training of vision system

UNIT 4 ROBOT CELL DESIGN AND APPLICATION**9 Hrs.**

Robot work cell design and control - Safety in Robotics - Robot cell layouts - Multiple robots and machine interference - Robot cycle time analysis - Industrial applications of robots- Application of robot in welding, machine tools, material handling, mobile vehicles and assembly operations parts sorting and parts inspection.

UNIT 5 ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS**9 Hrs.**

Methods of robot programming - characteristics of task level languages lead through programming methods- Motion interpolation. Artificial intelligence - Basics - Goals of artificial intelligence - AI techniques – problems representation in AI- Problem reduction and solution techniques - Application of AI. Elements of Knowledge Representation -Logic, Production Systems, Semantic Networks, Expert Systems Knowledge Building Environment Systems (KBES)

Max. 45 Hrs.**TEXT / REFERENCE BOOKS:**

1. K.S.Fu, R.CGonzalez and C.S.G. Lee, Robotics control, Sensing, Vision and intelligence", McGraw Hill,1994
2. Kozyrey, Yu, "Industrial Robotics", MIR Publishers Moscow, 1998.
3. Richard.D.,Klafter, Thomas.A, Chmielewski, Machine Negin "Robotics Engineering-An Integrated Approach", Prentice Hall of India Pvt.,Ltd., 1984
4. Deb, S.R. "Robotics Technology and Flexible Automation", Tata McGraw Hill,1994
5. Mikell,P.Groover, Mitchell Weis, Roger N.Nagel, Nicholas Odrey "Industrial Robotics Technology, Programming and Applications", McGraw Hill,Int.,1986
6. Timothy Jordonidesetal,"Expert Systems and Robotics", Springer-Verlag, New York, May 1991.
7. Ashitave Ghosal "Robotics – Fundamental concepts and Analysis" Oxford University Press, 2006
8. Koren Y., "Robotics for Engineers", McGraw Hill Book Co., 1992.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 2 Questions each from CO1-CO4, 1 question each from CO5 and CO6 – No choice**20 Marks****PART B:** 4 Questions each with internal choice from CO1-CO4, 1 question from CO5 and CO6 with internal choice, each carrying 16 marks**80 Marks**

SMR1201	MECHANICS OF FLUID	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVES

- To understand fluid properties, flow characteristics and basic governing equations-mass, momentum, energy.
- To understand types of flow and boundary layer concept.

UNIT 1 FLUID PROPERTIES AND FLUID STATICS**9 Hrs.**

Fluid - definition, distinction between solid and fluid - Units and dimensions – Properties of fluids - density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapor pressure, capillary and surface tension. Fluid statics: Pascal law - Hydrostatic law - Relative equilibrium - Pressure measurements using Manometers and pressure gauges - Forces on immersed plane and curved surfaces – Buoyancy –Meta-centre - Stability of floating and submerged bodies

UNIT 2 FLUID KINEMATICS AND FLUID DYNAMICS**9 Hrs.**

Fluid Kinematics – Lagrangian and Eulerian descriptions - Flow visualization - Lines of flow -Types of flow - Flow characteristics – concept of control volume - velocity field and acceleration -continuity equation – energy equation – momentum equation – Impact of - Euler's equation along streamline - Bernoulli's equation– Applications - Venturi meter, Orifice meter, Pitot tube.

UNIT 3 FLUID FLOW AND DIMENSIONAL ANALYSIS**9 Hrs.**

Laminar flow between parallel plates - Laminar flow through circular tubes (Hagen Poiseuille equation) - Turbulent Flow in a pipe – Boundary layer concepts – types of boundary layer thickness - Hydraulic and energy gradient - Darcy Weisbach equation - Pipe roughness – Friction factor - Moody's diagram minor losses - Flow through pipes in series and in parallel. Dimension and units - Buckingham π theorem - Discussions on dimensionless parameters – applications - Laws of models and similitude.

UNIT 4 HYDRAULIC TURBINES**9 Hrs.**

Fluid machines: definition and classification - exchange of energy - Euler's equation for turbomachines - Construction of velocity vector diagram's - head and specific work - components of energy transfer - degree of reaction. Hydro turbines: definition and classifications - Pelton turbine - Francis turbine – propeller turbine - Kaplan turbine - working principles - velocity triangles - work done – specific speed -efficiencies -performance curve for turbines

UNIT 5 HYDRAULIC PUMPS**9 Hrs.**

Pumps: definition and classifications - Centrifugal pump: classifications, working principles, velocity triangles, specific speed, efficiency and performance curves - Reciprocating pump: classification, working principles, indicator diagram, and work saved by air vessels and performance curves - Cavitations in pumps.

Max. 45 Hours**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - Evaluate the hydrostatic stability of floating and submersible bodies.
- CO2 - Apply the Bernoulli's equation of fluid motion to flow measuring devices.
- CO3 - Evaluate the hydraulic coefficients and the energy losses in pipes.
- CO4 - Analyze the performance characteristics of centrifugal and reciprocating pumps.

- CO5 - Interpret the performance characteristics of hydraulic turbines.
- CO6 - Predict the performance of prototype with dimensional analysis.

TEXT / REFERENCE BOOKS

1. White, F.M., "Fluid Mechanics", Tata McGraw-Hill, 7th Edition, New Delhi, 2011.
2. Douglas J.F., Gasoriek J.M., (et.al), "Fluid Mechanics", Pearson India, 5th Edition, 2008.
3. Cengel Y.A., Cimbala J.M., " Fluid Mechanics – Fundamentals and applications", McGraw Hill higher education, 2nd Edition, 2010.
4. Modi P.N., Seth S.M., "Hydraulics and fluid mechanics including hydraulic machines", Standard publishers, 20th edition, 2015
5. Bansal, R.K., "Fluid Mechanics and Hydraulics Machines", (9th edition), Laxmipublications (P) Ltd., New Delhi, 2011.
6. Som, S.K., and Biswas, G., "Introduction to fluid mechanics and fluid machines", Tata McGraw-Hill, 2nd edition, 2007.
7. Kumar, K.L., "Engineering Fluid Mechanics", Eurasia Publishing House (P) Ltd, New Delhi (7th edition), 2008.
8. Ramamirtham, S., "Fluid Mechanics and Hydraulics and Fluid Machines", Dhanpat Rai and Sons, Delhi, 2006.

END SEMESTER EXAM QUESTION PAPER PATTERN**Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 2 Questions from each unit, each carrying 2 marks****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks**

SMR1302	SENSORS AND INSTRUMENTATION	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- The principle and applications of various measurement systems.
- Learn about sensors and its uses.

UNIT 1 MEASUREMENT SYSTEMS**9 Hrs**

Generalized Measurement System – Performance Characteristics: Static and Dynamic Characteristics – Errors in Measurements – Calibration and Standards – Generalized Performance of Zero Order, First Order and Second Order Systems – Classifications of Transducers- General working principles of Resistive, capacitive and inductive type transducers with governing equations.

UNIT 2 MEASUREMENT OF NON ELECTRICAL PARAMETERS - 1**9 Hrs**

Linear and angular displacement: Resistive, capacitive, inductive types and Optics (encoders), proximity sensors Velocity measurement: tachometers, tachogenerators and resolvers Temperature measurement: Contact type: Bimetallic, RTD, Thermocouple and Thermistor Non- Contact type: Radiation Pyrometer – Optical Pyrometer Humidity: Capacitive and resistive and hot and wet bulbs. Other sensors: Fire, smoke and metal detectors.

UNIT 3 MEASUREMENT OF NON ELECTRICAL PARAMETERS - 2**9 Hrs**

Force measurement: Resistive type strain gauges: Bridge configurations, Temperature compensation, Load cells, Fiber optic strain gauge- Semiconductor strain gauges- Piezo electric transducers. Vacuum Measurement: McLeod Gauge, Thermal Conductivity Gauge – Ionization Gauge. Airflow: Anemometers Light: UV, IR, Light emitter and detector Introduction to Acoustics and acoustic sensors: Ultrasonic sensor- Types and working of Microphones and Hydrophones

– Sound level meters- Nuclear radiation sensors.

UNIT 4 MEASUREMENT OF ELECTRICAL PARAMETERS**9 Hrs**

3 phase & 1 phase 1 watt meter and power factor - Resistive, capacitive and inductive measurements- Instrument Transformers: CT and PT; their errors, Applications of CT and PT in the extension of instrument range.

UNIT 5 SIGNAL CONDITIONING AND DATA ACQUISITION**9 Hrs**

Amplification, Filtering – Level conversion – Linearization - Buffering – Sample and Hold circuit – Quantization – Multiplexer / De multiplexer – Analog to Digital converter – Digital to Analog converter- I/P and P/I converter - Instrumentation Amplifier-V/F and F/V converter Data Acquisition -Data Logging – Data conversion – Introduction to Digital Transmission system.

Max. 45 Hours**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - Understand the characteristics of instruments and determine the errors associated with it.
- CO2 - List the various sensors and its applications.
- CO3 - Understand the techniques of measurement of Displacement, Force, Velocity, Industrial parameters..
- CO4 - Apply the knowledge of measurement in industries
- CO5 - Select a device for particular measurement
- CO6 - Develop an appropriate method for measurement

TEXT/ REFERENCE BOOKS:

1. Ernest O. Doebelin, "Measurement Systems – Applications and Design", Tata McGrawHill, 2009.
2. D. Patranabis, "Sensors and Transducers", PHI, New Delhi, 2nd Edition, 2010.
3. John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications, 1999
4. A.K. Sawney and Puneet Sawney, "A Course in Mechanical Measurements and Instrumentation and Control", 12th edition, Dhanpat Rai & Co, New Delhi, 2013.

END SEMESTER EXAM QUESTION PAPER PATTERN**Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 2 Questions from each unit, each carrying 2 marks****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks**

SMR1301	MICRO ELECTRO MECHANICAL SYSTEMS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

On completion of this course the student will recognize

- Acquire knowledge about the **Micromachining**
- Acquire knowledge about **MEMS Devices**

UNIT 1 INTRODUCTION

9 Hrs.

Introduction to MEMS: Introduction to Microsystems and microelectronics - 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 2 FABRICATION OF MEMS

9 Hrs.

Clean room technology - Substrates and wafer - single crystal silicon wafer formation – ideal substrates - mechanical properties - Processes for bulk micro machining - Wet Vs dry etching - Chemical etching of Silicon - etchant systems and etching process - Reactive ion etching and DRIE - mask layout design. Processes for Surface micro machining - 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 micro molding processes such as HeXIL

UNIT 3 DESIGN CONSIDERATIONS BASED ON MICROMECHANICS

9 Hrs.

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 – thermos mechanics - thermal stresses - fracture mechanics - stress intensity factors - fracture toughness – and interfacial fracture mechanics

UNIT 4 MEMS DEVICES

9 Hrs.

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 – Micro accelerometer – Micro pressure sensors, MEMS switches/resonators, MEMS reliability.

UNIT 5 MICROSYSTEM PACKAGING AND DESIGN

9 Hrs.

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

Max. 45 Hours

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1 - Understand the basics of MEMS technology and microsystems.
- CO2 - Acquire knowledge in the types and procedures involved in MEMS fabrication.
- CO3 - Apply the acquired knowledge in understanding **MEMS sensors and actuators**.

- CO4 - Analyse various MEMS design and familiarise with optical RF MEMS.
- CO5 - Ability to understand the operation of micro devices, micro systems and their applications.
- CO6 - Ability to design the micro devices, micro systems using the MEMS fabrication process.

TEXT / REFERENCE BOOKS

1. William I. Fletcher, 'An Engineering Approach to Digital Design', PHI.
2. B. Holdsworth and R. C. Woods, 'Digital Logic Design', Newnes, 4th Edition
3. Morris Mano, Digital Design, Pearson Education, Asia 2002.
4. John F.Wakerley, Digital Design Principles And Practices,Third Edition Updated,Pearson Education,Singapore, 2002
5. Anil K. Maini, Digital Electronics, Principles, Devices and Applications, Wiley
6. Stephen Brown and Zvonko Vranesic, Fundamentals of digital logic design with VHDL, McGraw Hill, 2nd Edition

END SEMESTER EXAM QUESTION PAPER PATTERN**Max. Marks : 100****Exam Duration : 3 Hrs.****PART A** : 2 Questions from each unit, each carrying 2 marks**20 Marks****PART B** : 2 Questions from each unit with internal choice, each carrying 16 marks**80 Marks**

SMR4051	SENSORS AND INSTRUMENTATION LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

SUGGESTED LIST OF EXPERIMENTS

1. Study Of Sensors And Measuring Instruments
2. Measurement Of Strain Using Strain Gauge
3. Study Of Distance Measurement Using Ultrasonic Transducer
4. To Determine Output Characteristics Of LVDT And Measure Displacement Using LVDT
5. Flow Measurement and Level Detection.
6. Measurement of Inductance, Resistance and Capacitance.
7. Voltage and Current detection
8. Temperature Measurement using Thermocouple
9. Resistance Measurement using Potentiometer
10. SONAR

COURSE OUTCOMES

On completion of the course, students are able to

- CO1 - Understand the functioning of few sensors and transducers
- CO2 - Understand the characteristics of few sensors and transducers
- CO3 - Understand the process and need for calibration.
- CO4 - Calibrate voltmeters and ammeters.
- CO5 - Choose the sensor for measurement of few parameters.
- CO6 - Use the appropriate sensor and calibrate

SMR1303	PLC AND AUTOMATION	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

On completion of this course the student will recognize

- Acquire knowledge about the PLC and automation systems
- Acquire knowledge about applications of PLC
- Acquire knowledge about Automation in various fields.

UNIT 1 PROGRAMMABLE LOGIC CONTROLLERS

9 Hrs

Introduction - Parts of PLC - Principles of operation - PLC sizes - PLC hardware components - I/O section - Analog I/O modules - digital I/O modules CPU processor memory module – PLC programming Simple instructions - Output control devices - Latching relays PLC ladder diagram, Converting simple relay ladder diagram in to PLC relay ladder diagram.

UNIT 2 INSTRUCTIONS

9 Hrs

Timer instructions ON Delay, OFF Delay and Retentive Timers-UP Counter, DOWN Counter and UP down Counters, program control instructions - Data manipulating instructions-math instructions

UNIT 3 APPLICATION OF PLC

9 Hrs

Traffic light control, 24 hour clock design, Automatic stacking process, temperature control, Automatic control of warehouse door, Automatic lubrication of supplier Conveyor belt, motor control.

UNIT 4 NETWORKING OF PLC AND SCADA

9 Hrs

Networking of PLCs-Data communication-Fieldbus, PROFI bus, and Mod bus-OSI Model types-OPC function. Supervisory Control and Data Acquisition-Architecture-Remote terminal unit-Master terminal unit-Data Storage

UNIT 5 DISTRIBUTED CONTROL SYSTEM

9 Hrs

Evolution - Architectures - Comparison - Local control unit - Process interfacing issues - Communication facilities. Operator interfaces - Low level and high level operator interfaces -Operator displays - Engineering interfaces - Low level and high level engineering interfaces Applications of DCS in - Pulp and paper environment -Power plant - Petroleum – Refining environment Introduction to Soft PLC.

Max. 45 Hours

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1 - Understand the working of actuators, control valves, controllers, PLC.
- CO2 - Explain the use of actuators, control valves, controllers.
- CO3 - Select an appropriate controller for a process..
- CO4 - Apply the knowledge of PLC in control
- CO5 - Develop a program using ladder logic
- CO6 - Design a control system using PLC.

TEXT / REFERENCE BOOKS

1. Petruzella Frank D, Programmable Logic Controllers, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2010.
2. Lucas, M.P., Distributed Control System, Van Nostrand Reinhold Co. NY, 1986.
3. Webb, John W. Programmable Logic Controllers: Principles and Application, Fifth edition, Prentice Hall of India, New Delhi, 2004.
4. Stuart A. Boyer, SCADA: Supervisory Control and Data Acquisition, (4e), ISA Publication, 2009.
5. Bolton, "Programmable Logic Controllers 5th Edition Newnes, 2009

END SEMESTER EXAM QUESTION PAPER PATTERN**Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 2 Questions from each unit, each carrying 2 marks****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks**

SMR1101	DIGITAL ELECTRONICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

On completion of this course the student will recognize

- Acquire knowledge about the Digital Design
- Acquire knowledge about Classifications and Characteristics of Memory
- Acquire knowledge about Simulation

UNIT 1 FUNDAMENTALS OF DIGITAL DESIGN**9Hrs.**

Logic Gates: Basic gates, Universal gates, Sum of products and products of sum, minimization with Karnaugh Map (upto four variables) and realization. Logic Families: Types of logic families (TTL and CMOS), characteristic parameters (propagation delays, power dissipation, Noise Margin, Fan-out and Fan-in), transfer characteristics of TTL NAND, Interfacing CMOS to TTL and TTL to CMOS Combinational Circuits using basic gates as well as MSI devices: Half adder, Full adder, Half Subtractor, Full Subtractor, multiplexer, demultiplexer, decoder, Comparator (Multiplexer and demultiplexer gate level upto 4:1). MSI devices IC7483, IC74151, IC74138, IC7485.

UNIT 2 ELEMENTS OF SEQUENTIAL LOGIC DESIGN**9 Hrs.**

2.1 Sequential Logic: Latches and Flip-Flops, Conversion of flip flops (timing considerations and metastability are not expected) 2.2 Counters: Asynchronous, Synchronous Counters, Up Down Counters, Mod Counters, Ring Counters Shift Registers, Universal Shift Register

UNIT 3 SEQUENTIAL LOGIC DESIGN**9 Hrs.**

Mealy and Moore Machines, Clocked synchronous state machine analysis, State reduction techniques and state assignment, Clocked synchronous state machine design. (Complex word problems like traffic light controller etc. are not expected) MSI counters (7490, 74163, 74169) and applications, MSI Shift registers (74194) and their applications.

UNIT 4 MEMORIES AND PROGRAMMABLE LOGIC DEVICES**9 Hrs.**

Classification and characteristics of memory: SRAM, DRAM, ROM, PROM, EPROM and FLASH memories 4.2 Concepts of PAL and PLA. Architecture of CPLD and FPGA, Xilinx XC 9500 CPLD Series and Xilinx XC 4000 FPGA Series.

UNIT 5 SIMULATION**9 Hrs.**

Functional Simulation, Timing simulation, Logic Synthesis, RTL, VHDL: Data types, Structural Modeling using VHDL, Implementation of basic combinational and sequential Circuits

Max. 45 Hours**COURSE OUTCOME**

On completion of the course, student will be able to

- CO1 - Examine the structure of number systems and perform the conversion among different number systems
- CO2 - Illustrate reduction of logical expressions using boolean algebra, k-map and tabulation method and implement the functions using logic gates
- CO3 - Realize combinational circuits for given application
- CO4 - Understand the working mechanism and design guidelines of different combinational, sequential circuits and their role in the digital system design.

- CO5 - Understand the concepts of simulation model, structural modelling using VHDL
- CO6 - Assess the nomenclature and technology in the area of memory devices and apply the memory devices in different types of digital circuits for real world application.

TEXT / REFERENCE BOOKS

1. William I. Fletcher, 'An Engineering Approach to Digital Design', PHI.
2. B. Holdsworth and R. C. Woods, 'Digital Logic Design', Newnes, 4th Edition
3. Morris Mano, Digital Design, Pearson Education, Asia 2002.
4. John F. Wakerley, Digital Design Principles And Practices, third Edition Updated, Pearson Education, Singapore, 2002
5. Anil K. Maini, Digital Electronics, Principles, Devices and Applications, Wiley
6. Stephen Brown and Zvonko Vranesic, Fundamentals of digital logic design with VHDL, McGraw Hill, 2nd Edition

END SEMESTER EXAM QUESTION PAPER PATTERN**Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 2 Questions from each unit, each carrying 2 marks****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks**