



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with 'A' grade by NAAC
Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai - 600 119.



School of Mechanical Engineering **Department of Mechatronics Engineering**

1.1.3 Courses having focus on Employability / Entrepreneurship / Skill Development

S.NO	COURSE CODE	COURSE NAME	PAGE NO
------	-------------	-------------	---------

EMPLOYABILITY

1	SMRB1301	SENSORS AND ELECTRONIC INSTRUMENTATION	2
2	SMRBLH31	PROGRAMMABLE LOGIC CONTROLLER AND SCADA	4
3	SMRB2301	SENSORS AND ELECTRONIC INSTRUMENTATION LAB	7
4	SMRBLH41	MACHINING AND MANUFACTURING PROCESSES	8
5	SMRB2402	METALLURGY AND METROLOGY LAB	12
6	SMRB1501	DESIGN OF MECHATRONICS SYSTEMS	14
7	SMRB1503	ACTUATION SYSTEMS FOR MECHATRONICS	17
8	SMRB2501	MECHATRONICS AND SIMULATION LAB	20
9	SMRB1602	EMBEDDED SYSTEM DESIGN	22
10	SMRB1603	MICRO AND NANO ELECTRO MECHANICAL SYSTEMS	24
11	SMRB1702	ROBOTICS AND MACHINE VISION SYSTEMS	27

SKILL DEVELOPMENT

12	SMEB2101	COMPUTER AIDED DESIGN LAB	29
13	SMRB2601	MODELING AND ANALYSIS LAB	30
14	SMRB2701	ROBOTICS AND CAM LAB	32
15	SMEB3026	COMPUTATIONAL FLUID DYNAMICS	34

ENTREPRENEURSHIP

16	SMRB3004	VIRTUAL AND AUGMENT REALITY IN INDUSTRY 4.0	36
17	SMRB3024	INDUSTRY 4.0 AND 5.0 TECHNOLOGIES AND APPLICATIONS	38

SMRB1301	SENSORS AND INSTRUMENTATION	L	T	P	EL	Credits	Total Marks
		3	0	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, flow

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 & VIRTUAL INSTRUMENTATION

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. Graphical programming techniques, Data types, Advantage of Virtual Instrumentation techniques, Concept of WHILE & FOR loops, Arrays, Clusters & graphs.

UNIT 3 MEASUREMENT OF FORCE & VELOCITY

9

Hrs.

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 type

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** - Prefer suitable sensors based on the applications.
- CO3** - Understand the measurement techniques 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. Measurement, Instrumentation, and Sensors Handbook: Electromagnetic, Optical, Radiation, Chemical, and Biomedical Measurement, CRC Press; 2nd edition (14 August 2017)
2. John G. Webster, Halit Eren., Measurement, Instrumentation, and Sensors Handbook, CRC Press, 2nd edition (12 December 2018)
3. Dr.O.N.Pandey, Sensors and Instrumentation, 2021 Reprint S.K.Kataria and Sons
4. Subhas Chandra Mukhopadhyay. Smart Sensors, Measurement and Instrumentation Springer 2022.
5. Rangan C.S. Mani V.S.V: and Sharma G.R., —Instrumentation Devices and Systemsll Tata McGraw Hill.
6. Renganathan.S, —Transducer Engineeringll -Allied Publishers Limited.
7. D.V.S Murthy ——Transducer and Instrumentationll, 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

2 Questions from each unit with internal choice, each carrying

80 Marks

PART B :

16 marks

SMRBLH31	PROGRAMMABLE LOGIC CONTROLLER AND SCADA	L	T	P	EL	Credits	Total Marks
		3	0	2	1	4	100

COURSE OBJECTIVES

- To understand the need of automation in various industrial sectors
- To learn about the various technology developments such as PLC, SCADA and DCS in industrial automation
- To understand the basics of communication with its protocol.

UNIT 1 BASICS OF AUTOMATION

12 Hrs.

Automation in Production System-Principles and Strategies of Automation-Basic Elements of an Automated System-Advanced Automation Functions-Levels of Automation-Flow lines, Transfer Mechanisms-Fundamentals and Analysis of Transfer Lines, Fundamentals of IoT

UNIT 2 PROGRAMMABLE LOGIC CONTROLLER

12

Hrs.

PLC Architecture - Processor Memory Organization: Program Files, Data Files- Programming

Languages- Wiring Diagrams and Ladder Logic Programs- Instructions: Simple Instructions, Timer, Counter, Program Control, Data Manipulation, Math Instructions - Selection of PLC

UNIT 3 SUPERVISORY CONTROL AND DATA ACQUISITION

12 Hrs.

Elements of SCADA-Functionalities of SCADA-Architecture: Hardware, Software: Development, Runtime mode Functions-Tools: Tag Database-Recipe database- Alarm Logging-Trends: Real Time, Historical Trends-Security and User Access Management-Management Information System-Report Function.

UNIT 4 DISTRIBUTED CONTROL SYSTEM

12 Hrs.

Evolution of DCS - Types of Architecture - Local Control Unit - Communication Facilities - Operator and Engineering Interfaces - Operator Displays - Process Interfacing issues.

UNIT 5 COMMUNICATION PROTOCOLS

12 Hrs.

Introduction - Communication Hierarchy, Communication System Requirements - Network Topologies - Communication Modes HART Networks and OSI models- Communication buses - Fieldbus, Modbus, Profibus - Device net - CAN network - System Operation and Troubleshooting.

LIST OF EXPERIMENTS

EXPERIMENT 1 Implementation of logic gates using RS Logix software

EXPERIMENT 2 Two way and four way traffic light control system using PLC

EXPERIMENT 3 Bottle filling process using PLC

EXPERIMENT 4 Automate the cylinder sequencing process using PLC

EXPERIMENT 5 Select the suitable I/O module for control of elevator using PLC 6 3 Hours

EXPERIMENT 6 Design a SCADA screen to display the plant information such as temperature, pressure and humidity using historical trends 7 3 Hours

EXPERIMENT 7 Design a SCADA screen for automatic level monitoring system 8 3 Hours
 EXPERIMENT 8 Design a SCADA screen for recipe database
 EXPERIMENT 9 Design a SCADA screen for alarm logging
 EXPERIMENT 10 Design a SCADA screen for security access management

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1** - Outline the need of automation in industries
- CO2** - Illustrate different instructions available in PLC for various applications
- CO3** - Implement supervisory control and data acquisition systems for particular applications
- CO4** - Integrate the distributed control system and to differentiate the DCS over other automation systems.
- CO5** - Select the proper communication buses and its protocol for industrial applications
- CO6** - Develop the PLC program for various applications like traffic light control, bottle filling, cylinder actuation and elevator control

TEXT / REFERENCE BOOKS

1. M. P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Fourth Edition, Pearson Education, UK, 2016
2. Webb J.W, Programmable Controller Principles and applications, Fifth Edition, Morrill Publishing Co, USA, 2002
3. Petruzella, FD, Programmable Logic Controllers, Fifth Edition, McGraw-Hill, New York, 2016.
4. Stuart A. Boyer, SCADA: Supervisory Control and Data Acquisition, Fourth Edition, ISA Publication, Europe, 2009

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks:100

Exam

Duration:3 Hrs.

CAE	Continuous Assessment exams	50 Marks
ESE	University Practical exam	50 Marks

SMRB2301	SENSORS AND ELECTRONIC INSTRUMENTATION LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To understand the working of sensors and transducers.
- To understand the characteristics of sensors.
- To calibrate voltmeter and ammeter.

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.
13. Proximity Sensors (Inductive)
14. Measurement of Resistance, Inductance and Capacitance Using Bridge

Max. 30 Hrs.

COURSE OUTCOMES

On completion of the course, student will be 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.

SMRBLH41	MACHINING AND MANUFACTURING PROCESSES	L	T	P	EL	Credits	Total Marks
		3	0	2	1	4	100

COURSE OBJECTIVES

- To illustrate theory of machining processes and operations of machine tools.
- To Study various metal casting and joining processes
- To Develop Different laws and equations for solving metal forming problems

UNIT 1 CASTING AND FORMING PROCESSES

12 Hrs.

Introduction to casting processes, Patterns: Pattern materials, types of pattern, allowances pattern design, molding sand, Properties of molding sands, Core making, Defects and remedies, Principle and equipment of Permanent mold casting, Investment casting, Centrifugal casting, Continuous casting. Plastic deformation. Stress-strain diagram for different types of material, Hot and Cold working, Factors affecting plastic deformation, Yield criteria, Concept of flow stress, Rolling, Open and closed die forging, Forging operations Extrusion: Types, Process parameter Wire and Tube Drawing: Wire and tube drawing process, Die profile Friction and lubrication in metal forming, Forming defects, causes and remedies for all forming processes.

UNIT 2 SHEET METAL FORMING AND WELDING PROCESSES

12 Hrs. Types of sheet metal operations, Press working equipment and terminology, Types of dies, Clearance analysis, Estimation of cutting forces, Centre of pressure and blank size determination, Design of strip lay-out, blanking die design, Introduction to Drawing, bending dies, Methods of reducing forces, Formability and forming limit diagrams. Classification of joining processes, welding terminology and types of joints Arc Welding. Weld inspection, Defects in various joints and their remedies. Theories of Metal Cutting Introduction: material removal processes, types of machine tools – theory of metal cutting: chip formation, orthogonal cutting, cutting tool materials, tool wear, tool life, surface finish, cutting fluids.

UNIT 3 CENTRE LATHE AND SPECIAL PURPOSE LATHES

12 Hrs.

Centre lathe, constructional features, cutting tool geometry, various operations, taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes – automats – single spindle, Swiss type, automatic screw type, multi spindle - Turret Indexing mechanism, Bar feed mechanism.

UNIT 4 SHAPER, MILLING, DRILLING, BORING, PLANER AND BROACHING

12 Hrs.

Reciprocating machine tools: shaper, planer, slotter - Milling: types, milling cutters, operations - Hole making: drilling - Quill mechanism, Reaming, Boring, Tapping - Sawing machine: hack saw, band saw, circular saw; broaching machines: broach construction – push, pull, surface and continuous broaching machines.

UNIT 5 ABRASIVE PROCESSES, GEAR CUTTING, CNC MACHINE TOOLS AND PART PROGRAMMING

12 Hrs.

Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centerless grinding – honing, lapping, super finishing, polishing and buffing, abrasive jet machining - Gear cutting, forming, generation, shaping, hobbing. Numerical control (NC) machine tools – CNC: types, constructional details, special features. Part programming fundamentals – manual programming – computer assisted part programming.

LIST OF EXPERIMENTS

1. Lathe Operations: Turning, Taper Turning, Knurling, Thread cutting – Internal and External.
2. Shaping Machines: Machine of plane and inclined surfaces, grooving – V grooving.
2. Study of Planning.
3. Grinding: Exercise involving cylindrical grinding – Surface grinding – single point tool grinding in tool and cutter
4. Milling: Cutting of spur gear.
5. Boring: Simple exercise in boring machine.
6. Hobbing: Making of spur and helical gear.
7. Slotting: Key way cutting (external).
8. Measurement of cutting forces in turning (tool dynamometer). 9. Practices in Capstan and Turret lathes (at least one exercise).

Max.60 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Appreciate the conditions required for casting and welding process.

CO2 - Understand and perform hot and cold working process

CO3 - Explain sheet metal forming process

CO4 - Describe the constructional and operational features of center lathe and other Special purpose lathes.

CO5 - Describe the constructional and operational features of shaper, planner, milling, Drilling, sawing and broaching machines, grinding and other super finishing processes **CO6**

- Summarize numerical control of machine

TEXT / REFERENCE BOOKS

1. Hajra Choudhary. S.K. and Hajra Choudhary A.K, —Elements of Manufacturing Technology, Vol. 1 st Edition, Media Publishers 2013.
2. P. N. Rao, —Manufacturing Technology Vol. I & III, Tata McGraw Hill Publishers, 2nd Edition 2002
3. P. C. Sharma, —Production EngineeringII, Khanna Publishers, 1999
4. R. K. Jain, —Production TechnologyII, Khanna Publishers, 2001
5. K. C. Chawala, —Composite MaterialsII, Springer, ISBN 978- 0387743646, ISBN 978-0387743653
- 3
6. Brent Strong, —Fundamentals of Composites Manufacturing: Materials, MethodsII, SME Book series, 2008
7. Pabla B.S. and Adithan M., —CNC MachinesII, 1 st Edition, New Age International, 2012.

SMRB2402	METALLURGY AND METROLOGY LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- Generate knowledge and skill in use of precision instruments.
- Learn a basic understanding of various instruments used in linear and angular.
 - To know the micro structure of different materials

LIST OF EXPERIMENTS IN METROLOGY

1. Angle measurement using Sine bar
2. Angle measurement using Bevel Protractor.
3. Bore Measurement by two ball and four ball method
4. Testing Squareness of a Tri-square using Slip Gauges.
5. Measurement of dimensions with Tool Maker's Microscope
6. Measurement of gear tooth thickness
7. Gear profile checking using Profile projector
8. Composite error in gears using Parkinson Gear Tester
9. Measurement of surface finish.
10. Electronic Comparator

LIST OF EXPERIMENTS IN METALLURGY LAB

1. To study the metallurgical microscope.
2. Studying the preparation of a specimen for metallographic examination
3. To study the microstructure of plain carbon steel (Low carbon steel, medium carbon steel and high speed steel).
4. To study the effect of heat treatment on plain carbon steel (Annealing, Normalizing and Hardening)
5. To study the microstructure of alloy steels (Stainless steels, Tool steels)
6. To study the microstructure of cast iron (Grey cast iron, white cast iron, malleable cast iron and spheroidal graphite cast iron)
7. To study the microstructure of light alloys (Aluminium alloy and Magnesium alloy)
8. To study the microstructure of heavy alloys (Copper alloy, Nickel alloy)
9. To determine the Hardenability of steel by Jominy end quench testing.
10. To study the hardness of ferrous and non-ferrous alloys

Max.30 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1** - Perform the angular measurement using Sine Bar and Bevel Protractor.
- CO2** - Compare the dimension of the given geometry using various measurement method.
- CO3** - Calculate the surface finish and quality of the given component.
- CO4** - Categorize the material from its microstructure
- CO5** - Ability to relate properties to microstructure.

CO6 - Understand various crystal structures and relationship to properties and Ability to select metals and alloys for industrial applications

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks:100

Exam

Duration:3 Hrs.

CAE	Evaluation of Regular Lab class	50 Marks
	Model practical exam	
ESE	University Practical exam	50 Marks

SMRB1501	DESIGN OF MECHATRONIC SYSTEMS	L	T	P	EL	Credits	Total Marks
		2	0	2	1	3	100

COURSE OBJECTIVES

- To familiarize students with basic of systems and its design.
- To provide students an understanding of control and drives.
- To teach students various interfacing techniques.

UNIT 1 SYSTEMS AND DESIGN

9 Hrs.

Mechatronic systems Introduction: Applications of mechatronics system. Systems like CDROM, scanner Elements of mechatronics system: Sensor, actuator, plant, and controller. Integrated mechanical-electronics design philosophy. Examples of real life systems – Integrated design issue in mechatronic – mechatronic key element, mechatronics approach – control program control – adaptive control and distributed system – Design process – Type of design – Integrated product design – Mechanism, load condition design and flexibility – structures – man machine interface, industrial design and ergonomics, information transfer, safety.

UNIT 2 CONTROL AND DRIVES

9

Hrs.

Control devices – Electro hydraulic control devices, electro pneumatic proportional controls – Rotational drives – Pneumatic motors: continuous and limited rotation – Hydraulic motor: continuous and limited rotation – Motion convertors, fixed ratio, invariant motion profile, variators. Smart sensor concept and utility of compliant mechanisms in mechatronics Microcontrollers for mechatronics: Interfacing. Microcontroller programming philosophy.

UNIT 3 REAL TIME INTERFACING

9 Hrs.

Real time interface – Introduction, Elements of a data acquisition and Control system, overview of I/O process, installation of I/O card and software – Installation of the application software – over framing. Modeling DC motor, importance of and modeling friction in mechatronic systems. Lagrange formulation for system dynamics, example of 2R manipulator; Selection of sensor and actuators, use of modeling for the same. Representation of systems and control design in linear domain

UNIT 4 CASE STUDIES -I

9 Hrs.

Case studies on data acquisition – Testing of transportation bridge surface materials – Transducer calibration system for Automotive application – strain gauge weighing system – solenoid force – Displacement calibration system – Rotary optical encoder – controlling temperature of a hot/cold reservoir – sensors for condition monitoring – mechatronic control in automated manufacturing.

UNIT 5 CASE STUDIES – II

9 Hrs.

Case studies on data acquisition and Control – thermal cycle fatigue of a ceramic plate – pH control system. De-icing temperature control system – skip control of a CD player – Auto focus Camera. Case studies on design of mechatronic product – pick and place robot – car park barriers – car engine management – Barcode reader.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1** - Explain the difference between traditional and Mechatronic design approach.
- CO2** - Analyze types of hydraulic /pneumatic drives and controls.
- CO3** - Demonstrate the installation procedure of a real time data acquisition system.
- CO4** - Develop a data acquisition for a Mechatronic system.
- CO5** - Develop a data acquisition and control system
- CO6** - Design and Develop a Mechatronics product

TEXT / REFERENCE BOOKS

1. Bolton (2015), —Mechatronics – Electronic Control Systems in Mechanical and Electrical EngineeringII, Pearson Education Limited, ISBN - 9781292076683.
2. Devdas Shetty, Richard A. Kolkm (2010), —Mechatronics System DesignII, Cengage Learning, ISBN - 9781439061992.
3. Clarence W. de Silva, Farbod Khoshnoud, Li Maoqing, Saman K. Halgamuge (2015) 4. —Mechatronics: Fundamentals and ApplicationsII, Taylor & Francis, ISBN:9781482239317.
5. Maksat Kalimoldayev, Sergii Pavlov, Waldemar Wojcik, —Mechatronic Systems - Applications in
6. Transport, Logistics, Diagnostics, and ControlII(2021), CRC Press, ISBN:9781000487299.
7. Victor Giurgiutiu, Sergey Edward Lyshevski, —Micromechatronic, Modeling, Analysis, and
8. Design with MATLAB, Second EditionII, (2016), CRC Press, ISBN:9781439883105
9. Brian Morriss (1994), —Automated Manufacturing Systems – Actuators Controls, Sensors and RoboticsII, McGraw-Hill Inc., ISBN - 9780028023311.
10. Bradley, D. Dawson, N.C. Burd and A.J. Loader (1993), —Mechatronics: Electronics in products and ProcessesII, CRC Press, ISBN – 9780748757428.

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

2 Questions from each unit with internal choice, each carrying

80 Marks

PART B

:

16 marks

SMRB1503	ACTUATION SYSTEMS FOR MECHATRONICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To provide student with knowledge on the application of fluid power in process, construction and manufacturing Industries.
- To provide students with an understanding of the fluids and components utilized in modern industrial fluid power system.
- To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.

UNIT 1 HYDRAULIC PUMPS

9 Hrs.

Introduction to Hydraulic Power: Definition of hydraulic system, advantages, limitations, applications, Pascal's law, structure of hydraulic control system, problems on Pascal's law. The source of Hydraulic Power: Pumps Classification of pumps, pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump Selection factors, problems on pumps. L1, L2, L3.

UNIT 2 HYRAULIC MOTORS, ACTUATORS AND VALVES

9

Hrs.

Hydraulic Actuators and Motors: Classification cylinder and hydraulic motors, Linear Hydraulic Actuators [cylinders], single and double acting cylinder, Mechanics of Hydraulic Cylinder Loading, mounting arrangements, cushioning, special types of cylinders, problems on cylinders, construction and working of rotary actuators such as gear, vane, piston motors, Hydraulic Motor Theoretical Torque, Power and Flow Rate, Hydraulic Motor Performance, problems, symbolic representation of hydraulic actuators (cylinders and motors). Control Components in Hydraulic Systems: Classification of control valves, Directional Control Valves- Symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, check valves, Pressure control valves – types, direct operated types and pilot operated types. Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation. L1, L2, L3, L4

UNIT 3 HYDRAULIC CIRCUITS

9 Hrs.

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double- Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

UNIT 4 PNEUMATIC CONTROL

9 Hrs.

Introduction to Pneumatic Control: Definition of pneumatic system, advantages, limitations, applications, Choice of working medium. Characteristic of compressed air. Structure of Pneumatic control System, fluid conditioners and FRL unit. Pneumatic Actuators: Linear cylinder – Types, Conventional type of cylinder- working, End position cushioning, seals, mounting arrangements- Applications. Rod – Less cylinders types, working, advantages,

Rotary cylinders- types construction and application, symbols. Pneumatic Control Valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols. Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders – supply air throttling and Exhaust air throttling and Exhaust air throttling. L1, L2, L3, L4.

UNIT 5 SIGNAL PROCESSING ELEMENTS

9 Hrs.

Signal Processing Elements: Use of Logic gates – OR and AND gates in pneumatic applications. Practical Examples involving the use of logic gates, Pressure dependent controls- types – construction

– practical applications, Time dependent controls principle, Construction, practical applications. L1, L2, L3, L4 Multi- Cylinder Application: Coordinated and sequential motion control, Motion and control diagrams. Signal elimination methods, Cascading method-principle, Practical application examples (up to two cylinders) using cascading method (using reversing valves). Electro- Pneumatic Control: Principles – signal input and output, pilot assisted solenoid control of directional control valves, Use of relay and contactors. Control circuitry for simple signal cylinder application.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Explain the Fluid power and operation of different types of pumps.

CO2 - Summarize the features and functions of Hydraulic motors, actuators and Flow control valves

CO3 - Explain the different types of Hydraulic circuits and systems

CO4 - Explain the working of different pneumatic circuits and systems

CO5 - Summarize the various trouble shooting methods and applications of hydraulic and pneumatic systems.

CO6 - Design pneumatic and hydraulic circuits and predict the responses.

TEXT / REFERENCE BOOKS

1. Robert H. Bishop, " Mechatronic Systems, Sensors, and Actuators Fundamentals and Modeling ", CRC Press, 2017.
2. Abdullah M. Asiri, Inamuddin, Rajender Boddula, —Actuators and Their Applications Fundamentals, Principles, Materials, and Emerging Technologies II, Wiley, 2020
3. Robert H. Bishop, —Mechatronics an Introduction II, Taylor & Francis , 2017
4. Jorn Malzahn, Monica Daley, Navvab Kashiri, Nikos Tsagarakis, " Advances in Mechatronics and Biomechanics towards Efficient Robot ActuationII, Frontiers Media SA, 2019

SMRB2501	MECHATRONICS SIMULATION LAB	AND	L	T	P	EL	Credits	Total Marks
			0	0	4	0	2	100

COURSE OBJECTIVES

- To give a basic introduction to Mechatronics Elements.
- To provide students knowledge on hydraulic and pneumatic systems.
- To design the feedback circuits, the importance of electro-pneumatic circuit and PLC

LIST OF EXPERIMENTS

1. Introduction to Mechatronics
2. Assembly language programming of 8085 – Addition – Subtraction – Multiplication – Division – Sorting – Code Conversion
3. Stepper motor interface
4. Traffic light interface.
5. Speed control of DC motor.
6. Study of various types of transducers.
7. Study of hydraulic, pneumatic and electro-pneumatic circuits.
8. Modelling and analysis basic hydraulic, pneumatic and electrical circuits using software.
9. Study of PLC and its applications.
10. Study of image processing

Max. 30 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Measuring of physical quantity such as displacement, force and temperature and also the operation of signal conditioning circuits.

CO2 - Applying a suitable sensor and image processing technique for Mechatronics systems.

CO3 - Design appropriate circuits to automate and control the hydraulic, pneumatic and electric actuators.

CO4 - Apply PLC, PID and 8085 micro controller as a control unit in Mechatronics system.

CO5 - Developing a model of pneumatic circuits by using simulation software. **CO6** - Developing a model of hydraulic circuits by using simulation software.

SMRB1602	EMBEDDED SYSTEM DESIGN	L	T	P	EL	Credits	Total Marks
		3	1	0	0		

COURSE OBJECTIVES

- To impart knowledge on the Building Blocks of Embedded System, Various Embedded Development Strategies,
- To impart knowledge on Bus Communication in processors, Input/output interfacing and processor scheduling algorithms
- To understand Real time operating system

UNIT 1 INTRODUCTION TO EMBEDDED SYSTEMS

9 Hrs.

Embedded Systems - Overview - Structural units, selection of processor - memory devices - Memory management methods - Timer and Counting devices, Watchdog Timer, Real Time Clock

UNIT 2 EMBEDDED NETWORKING

9 Hrs.

Introduction - I/O Ports - Communication protocols: RS232, RS422, RS 485, CAN Bus - Serial Peripheral Interface (SPI) - Inter Integrated Circuits (I2C).

UNIT 3 EMBEDDED FIRMWARE DEVELOPMENT

9

Hrs.

Embedded Product Development Life Cycle- Objectives, Different Phases Of EDLC, Modelling of EDLC; Data Flow Graph, State Machine Model, Sequential Program Model, V Model

UNIT 4 EMBEDDED SYSTEM DESIGN

9 Hrs.

Introduction to basic concepts of RTOS-Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication shared memory, message passing

UNIT 5 EMBEDDED SYSTEM APPLICATION

9 Hrs.

Line Follower robot, Linear conveyor control system, Temperature monitoring and control system FOR

FURTHER READING Real Time Application, Device control using Mobile, Security Alert system Automatic Car Control system, Mobile operating Land Rover

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - To introduce the Building Blocks of Embedded System

CO2 - Analyze the internal hardware parts of embedded systems architecture

CO3 - Implement an embedded system for a given Networking application

CO4 - Execute the various Embedded Development Strategies

CO5 - Analyze various processor scheduling algorithms

CO6 - Analyze the basics of Real time operating system application

TEXT / REFERENCE BOOKS

1. Peckol, Embedded system Design, John Wiley & Sons, 2010
2. Lyla B Das, Embedded Systems-An Integrated Approach, Pearson, 2013
3. Shibu. K.V, Introduction to Embedded Systems, Tata McGraw Hill, 2017
4. Raj Kamal, Embedded System-Architecture, Programming, Design, Tata McGraw Hill, 2013
5. C.R.Sarma, Embedded Systems Engineering, University Press (India) Pvt. Ltd, 2013
6. Han-Way Huang, Embedded system Design Using C8051, Cengage Learning, 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**

2 Questions from each unit with internal choice, each carrying

80 Marks**PART B :**

16 marks

SMRB1603	MICRO ELECTRO SYSTEMS	AND	NANO MECHANICAL	L	T	P	EL	Credits	Total Marks
				3	0	0	0	3	100

COURSE OBJECTIVES

- To introduce the concepts of micro and nano electromechanical devices
- To know the fabrication process of Microsystems
- To know the design concepts of micro sensors and micro actuators and nano systems.

UNIT 1 INTRODUCTION TO MICRO NANO MECHANICAL SYSTEMS 9 Hrs.

Introduction to MEMS & materials, fabrication processes – Nano electro mechanical systems (NEMS) – a journey from MEMS to NEMS - MEMS vs. NEMS - MEMS based nanotechnology – fabrication, film formation and micromachining - NEMS physics.

UNIT 2 FABRICATION TECHNIQUES 9 Hrs.

Structure of silicon and other materials - Silicon wafer processing – bulk micromachining - Nano structuring- Nano defects - Nano particles and Nano layers-science and synthesis of Micro and Nano materials-lithography-based micromachining-Photolithography - vacuum systems - etching methods - deposition methods - LIGA and laser-assisted processing. Laws and Application of MEMS: Scaling effects - Scaling laws in miniaturization- Application of MEMS and Microsystems. Future Directions of MEMS.

UNIT 3 MICRO AND NANO SENSORS 9 Hrs.

Si active tactile sensor - Fabric tactile sensor and its application – accelerometer - capacitive silicon – wall in-tube flow sensor and its application- Inertial Sensors – Gyroscope – Pressure Sensors – Piezo resistive –Capacitive – micro channel heat sinks – optical MEMS – Visual Display– optical data switching – RF MEMS – MEMS variable capacitors – MEMS switches – Resonators- Pressure Sensor, Nano tweezers.

UNIT 4 MICRO AND NANO ACTUATORS 9 Hrs.

Requirement for Micro Actuators - Nano Positioners - Micro Mechanical Testing Apparatus - Classification of Micro Actuator-Electrostatic Distributed Actuator-Force Distance various Actuators– Inch Worm, Zipper and Scratch Drive -Thermal Actuation - Bimorph - Buckle Beam -Electro thermal Actuator - Electro Thermal Relay with Mechanical Latch – Piezoelectric Actuation Advantages - MEMS Switch -Thin Film Bulk Acoustic Resonator (FBAR) - Magnetic Actuation- External Magnetic Field Actuators - Variable Reluctance Actuators -Shape Memory Actuators- micro valves - micro pumps, Micro Fluids: Fundamentals of fluid mechanics- Basic components of a micro fluidic system- Micro flows Micro pumps- Capillarity and Surface Tension- Micro pumping methods- Micro dispensers Micro nozzles.

UNIT 5 MICRO AND NANO SYSTEMS 9 Hrs.

Micro engine driven by electro statically actuated comb drive – Micro robots and Nano robots –Micro insects - Night Vision System – Bio MEMS-MEMS as Gas sensors – Development of Proximity Sensor - MEMS based Current sensors - MEMS for Smart homes - MEMS for Visually impaired -MEMS Sensors for object detection - MEMS based touch sensors.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Interpret the basics of micro/nano electromechanical systems including their applications and advantages

CO2 - Recognize the use of materials in micro fabrication

CO3 - Describe the fabrication processes including surface micromachining, bulk micromachining and LIGA.

CO4 - Analyze the key performance aspects of electromechanical transducers

CO5 - Analyze the key performance aspects of sensors and actuators

CO6 - Comprehend the theoretical foundations of quantum mechanics and Nano systems

TEXT / REFERENCE BOOKS

1. Qing-An Huang, " Micro Electro Mechanical Systems ", Springer Nature Singapore, 2018.
2. Sergey Edward Lyshevski, —Nano- and Micro-Electromechanical SystemsII, CRC Press, 2018.
3. Sergey Edward Lyshevski, —MEMS and NEMS Systems, Devices, and StructuresII, CRC Press , 2018
4. James J. Allen, " Micro Electro Mechanical System DesignII, CRC Press, 2005

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

2 Questions from each unit with internal choice, each carrying

80 Marks

PART B : 16 marks

SMRB1702	ROBOTICS AND MACHINE VISION SYSTEM	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To know about the principles and applications of vision system in modern manufacturing environment.
- To learn about the algorithms in vision.
- To know about the recognition of object.

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 grippers 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 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Knowledge or gadgets of vision systems

CO2 - Ability to understand the image capturing and processing techniques **CO3** - Ability to apply the vision system in other machines **CO4** - Knowledge for recognizing the objects.

CO5 - Knowledge in application of vision and image processing in robot operations.

CO6 - Perform hands- on experience of Palletizing Operations

TEXT / REFERENCE BOOKS

1. Sathya Ranjan Deb, robotics Technology & flexible Automation Sixth edition, Tata Mcgraw-Hill Publication, 2003.
2. Gordon M.Dair, Industrial Robotics, PHI 1988.
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. M.P.Groover, Industrial robotics- Technology, programming and Applications, McGraw-Hill, 1986

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 80 Marks
carrying 16 marks**

SMEB2101	COMPUER AIDED DESIGN LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To gain practical knowledge in engineering modeling through computer aided systems.
- To understand the functioning of 2D drafting and 3D modeling software's.
- To Study the capabilities of software for Drafting and Modeling.

INTRODUCTION TO CAD

Basics, Fundamentals of feature - based modeling

TWO DIMENSIONAL OBJECTS

Create basic drawing objects: Points, Lines, Circles, Arcs, Planes and their combinations Layout and sketching

Setup a drawing with correct scales

Draw with precision using Coordinate input and object Snaps

Isometric drawings, Orthographic projections, Auxiliary views

Dimensioning, Dimension styles

Various other AutoCAD commands and relevant keyboard shortcuts

THREE DIMENSIONAL OBJECTS

Creating and editing 3D solid objects.

Max. 30 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamentals of computer aided design.

CO2 - Implement the knowledge in creating a model.

CO3 - Understand the various limits and tolerances.

CO4 - Understand various dimensioning styles.

CO5 - Implement the knowledge to model various 2D and 3D models.

CO6 - Understand various commands and keyboard shortcuts for faster modeling skills.

SMRB2601	MODELING AND ANALYSIS LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To create complex engineering assemblies using appropriate assembly constraints.
- To generate freeform shapes in part mode to visualize components.
- To develop 'G' and 'M' codes for turning and milling components and to generate automated tool paths for a given engineering component.

A. CAD LAB

- 1 Drafting: Development of part drawings for various components in the form of orthographic and isometric. Representation of dimensioning and tolerances.
2. Part Modeling: Generation of various 3D Models through Protrusion, revolve, sweep. Creation of various features. Study of parent child relation.
3. Feature based and Boolean based modeling and Assembly Modeling. Study of various standard Translators. Design of simple components.
4. Introduction to solid modeling and Finite Element Analysis software Basics, Fundamentals of modeling and analysis. Need and importance of Analysis.
- 5 Exercises on modeling and assembly. Creation of higher end 3D solid models like Knuckle Joint, Cotter joint. Creation of assembled views of joints and couplings.

B. ANALYSING LAB

Exercises on Structural Analysis Practice on Ansys Software for the following exercises:

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

Max. 30 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the basics of cad modeling operations.

CO2 - Construct the part modeling of a given part drawings and create the assembly of the part drawings for the given mechanical components.

CO3 - Solve simple structural, heat and fluid flow problems using standard software

CO4 - Solve simple structural, heat and fluid flow problems using standard software.

CO5 - Apply and develop the solution or to do the Research in the area of Design and Simulation.

CO6 - Design and validate the technological solution to defined problem and communicate clearly and effectively for the practical applications

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks:100

Duration:3 Hrs

Exam

CAE Evaluation of Regular Lab class

50 Marks

Model practical exam

ESE University Practical exam

50Marks

SMRB2701	ROBOTICS AND CAM LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To write programming for simple operations like pick and place.
- To expose students to modern control systems (Fanuc).
- To know the application of various CNC machines like CNC lathe, CNC Milling etc.

LIST OF EXPERIMENTS

A. ROBOTICS LAB

1. Basic cylinder sequencing operations using Pneumatic trainer Kit.
2. Simulation of basic Hydraulic and Pneumatic circuits using software.
3. Experiment on cylinder sequencing for A+ B+ A- B- using pneumatic trainer kit.
4. Assembly language programming of 8085 – Addition – Subtraction – Multiplication – Division – Sorting – Code Conversion.
5. Design and testing of fluid power circuits to control (i) Velocity (ii) direction and (iii) force of single and double acting actuators.
6. Proportional Integral Derivative (PID) controller interfacing.
7. Study of Boolean operations in Lab view and interfacing of Sensors in Lab view.
8. Speed control of stepper and servo motor using micro processor kit.
9. A/D and D/A Conversion.
10. Study of Image Processing Technique.
11. Basic operations on pick and place robot using (i) linear mode (ii) Re-orient mode.

B. CAM LAB

- 1 Study of CNC Machines.
 - 2 Study of G-codes and M-codes.
- CNC Milling**
1. Part Programming for Linear Milling Cycle.
 2. Part Programming for Drilling Cycle.
 3. Part Programming for Contouring Cycle.
 4. Part Programming for Circular Pocketing Cycle.
 5. Part Programming for Rectangular Pocketing.
 6. Part Programming for Mirroring Cycle.
- CNC Lathe**
7. Part Programming for Facing and Turning Cycle and Step turning cycle.
 8. Part Programming for Profile Turning.
 9. Part Programming for Taper Turning Cycle.
 10. Part Programming for Grooving Cycle.
 11. Part Programming for Thread Cutting Cycle

Max. 30 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

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 - Generate CNC part program for milling of component.

CO5 - Generate CNC part program for turning of component.

CO6 - Perform machining of complex profiles on CNC machine using auto generated CNC code.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks:100

Exam

Duration:3 Hrs

CAE	Evaluation of Regular Lab class	50
	Model practical exam	Marks
ESE	University Practical exam	50Marks

SMEB3026	COMPUTATIONAL FLUID DYNAMICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To understand the flow, temperature field in engineering problems and □
To understand diffusion in mass transfer operations.
- Students can develop a Computational Fluid Dynamics code to solve chemical engineering problems.

UNIT 1 OUTLINE OF CFD AND CONSERVATION LAWS

9 Hrs.

Need of CFD, Problem solving in CFD, Elements of CFD Software, Governing Equations of Fluid flow and Heat Transfer, Mass conservation, Momentum and Energy equation, Differential and Integral forms, Conservation and non-conservation form.

UNIT 2 TURBULENCE MODELLING

9 Hrs.

Transition from Laminar to Turbulent flow, Effect of turbulence on time-averaged Navier-Stokes equations, Characteristics of simple turbulent flows, Free turbulent flows, Flat plate boundary layer and pipe flow, Turbulence models, Mixing length model, Reynolds stress equation models.

UNIT 3 FINITE VOLUME METHODS AND SOLUTIONS

9 Hrs.

Introduction, One dimensional steady state diffusion, Two-dimensional diffusion problems, Discretized equations for diffusion problems, One-dimensional unsteady state heat conduction, Discretization of transient convection-diffusion equation, Solution procedures for unsteady flow calculations, Implementation of Inlet, outlet and wall boundary conditions, Constant pressure boundary condition.

UNIT 4 CFD METHODS

9 Hrs.

CFD Methods for the Euler Equation- Linearization and Jacobian Matrix, Eigen values and Eigenvectors, Flux Splitting Methods. CFD Methods Navier-Stokes Equations-Beam Warming Algorithm, Mac Cormack's scheme, Upwind Techniques.

UNIT 5 GRID GENERATION

9 Hrs.

Structured Grid generation, Unstructured Grid generation, Adaptive Grid generation, Physical aspects, simple and multiple connected regions, grid generation by PDE solution.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the basic concept of CFD and conservation laws in chemical engineering.

CO2 - Ability to develop model for a given fluid flow system.

CO3 - Adapt finite volume techniques for fluid flow and heat transfer models.

CO4 - Apply finite difference method for mass transfer problems.

CO5 - Solve computational fluid flow problems using finite volume techniques.

CO6 - Get familiarized to develop grid generation and analysis of complex fluid-flow systems.

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

2 Questions from each unit with internal choice, each carrying **80 Marks**

PART B :

16 marks

SMRB3004	VIRTUAL AND AUGMENT REALITY IN INDUSTRY 4.0	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To introduce augmented reality, the tool of industry 4.0. □ To describe the history and recent developments of AR
- To provide the technological components needed for AR

UNIT 1 INTRODUCTION TO AUGMENTED REALITY

9 Hrs.

History of AR - Augmented reality characteristics – Difference between Augmented Reality and Virtual Reality – AR technological components – Technologies used in AR – Feature Extraction – Hardware components – AR devices – Importance of AR - Real world uses of AR – AR types – Software tools available for AR.

UNIT 2 TECHNOLOGIES NEEDED FOR AUGMENTED REALITY

9

Hrs.

Hardware technology – virtual scenes – 3D objects – AR components – Display – HMD – Eyeglasses –

Contact Lenses – significance of AR – AR powered devices – AR application development drawbacks – Compatibility – Performance – AR libraries – Motion tracking – Environmental understanding – Anchors.

UNIT 3 TECHNOLOGY INTEGRATION AND IMPLEMENTATION OF AUGMENTED REALITY

9 Hrs.

Technology use and integration in industrial settings – Assistive training to faculty members – Planning and administration for implementation – AR implications – Practical data – AR labs – Platforms to form AR content – Coordinated utilization of AR applications – Hands-on preparation.

UNIT 4 AUGMENTED REALITY AND VIRTUAL REALITY FOR MICRO LEARNING

9

Hrs.

Micro learning techniques – Utilizing VR for learning – VR for Practical online assessment – VR info graphics – Virtual case considerations - Utilizing AR for learning – Accessible learning – sensible data – elevated learner engagement - VR technology – Components of VR – VR Hardware – VR applications – Civil Engineering – Real Estate – Biology and Medicine – Virtual Mall – VR in Education – Virtual Laboratory – Factory Planning – Automobile Industry.

UNIT 5 TOOLS AND APPLICATIONS OF AUGMENTED REALITY

9 Hrs.

Tools available for Augmented Reality and Recognition – Software Tools – Google Poly – Unity – software approaches – recognition types – native software solutions – ARKit – ARCore – software development kit - Cloud services - AR business applications – weather prediction – market prediction – smart cities - AR application for Education - AR application for Healthcare sector – Agriculture – Civil Engineering – Architecture – Archaeology – Crime and Security – Games – IoT - – Use cases – Social Media – Gaming – Education – Healthcare – Shopping and Business.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the characteristics of AR and VR

CO2 - Describe how VR systems work and list the application of VR

CO3 - Understand the design and implementation of the hardware that enables VR systems

CO4 - Understand the system of human vision and its implication on perception and rendering

CO5 - Explain the concepts of motion and tracking in VR systems

CO6 - Describe the importance of interaction and audio in VR systems.

TEXT / REFERENCE BOOKS

1. Gerard Jounghyun Kim, —Designing Virtual Systems: The Structured ApproachII, 2005.
2. Doug A Bowman, Ernest Kujiff, Joseph J LaViola, Jr and Ivan Poupyrev, —3D User Interfaces, Theory and Practicell, Addison Wesley, USA, 2005.
3. Oliver Bimber and Ramesh Raskar, —Spatial Augmented Reality: Meging Real and Virtual WorldsII, 2005.
4. Burdea, Grigore C and Philippe Coiffet, —Virtual Reality TechnologyII, Wiley Interscience, India, 2003.
5. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016

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

2 Questions from each unit with internal choice, each carrying

80 Marks

PART B :

16 marks

SMRB3024	INDUSTRY 4.0 AND 5.0 TECHNOLOGIES APPLICATIONS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand different contributing technologies that enable industry 4.0 and 5.0.
- To make aware of how the industry 4.0 and 5.0 technologies can be applied to diverse applications.
- Learn the design and analysis of Industry 4.0 systems for Energy and various applications.

UNIT 1 INTRODUCTION TO INDUSTRY 4.0 AND 5.0

13 Hrs.

History of industrial revolutions, Industry 4.0: Definition, core values, contributing technologies, and challenges. Industry 5.0: Definition, core values, contributing technologies, and challenges. Industrial internet of things, 5G, Smart sensors, Digital twins and simulations, Augmented reality, Virtual Reality, Computer vision systems, Robotics and automation, 3D Printing, Cloud computing, Cyber security, and Big data analytics.

UNIT 2 INDUSTRY 4.0 FOR DESIGN, MANUFACTURING & FACTORY OPERATIONS 9 Hrs.

Cyber-physical systems, Product development: AR/VR enabled CAD, Customized CAD, Cloud based CAD, Digital twin and live simulation, and Additive manufacturing. Smart Manufacturing: Digital manufacturing, Cloud based manufacturing, IoT based manufacturing, Advanced CNC machines and programming, and Micro electro mechanical systems.

UNIT 3 ADDITIONAL CONTRIBUTING TECHNOLOGIES TO INDUSTRY 5.0 9 Hrs.

Extended reality, Cobots and exoskeletons, Smart sensors and bio-based technologies, Artificial intelligence and machine learning, enhanced additive manufacturing (4D printing), Cloud, cognitive and edge computing, 6G and beyond, Internet of everything, Industrial block chain, Network slicing, Private mobile networks, and Individualized human-machine interaction technologies, Autonomous Vehicles like self-propelled vehicles, drones, and unmanned vehicles.

UNIT 4 INDUSTRY 5.0 FOR MASS PERSONALIZATION, SOCIETY 5.0 AND SDGs 9 Hrs.

Realization of sustainable development goals (SDGs), Society 5.0, and Mass personalization with industry 5.0 technologies, Focus on customer experiences, Hyper-customization, Responsive and distributed supply chain management, Interactive products, Human cyber-physical systems, Collaborative production, Smart and sustainable logistics, Automated accounting, Preventive and predictive maintenance, End-to-end engineering, Mobile and autonomous transportation.

UNIT 6 CASE STUDIES

5 Hrs.

Case studies on the diverse applications of Industry 4.0 and Industry 5.0 like transportation, energy, infrastructure, factory operations, logistics, autonomous mobility, product design, smart cities, smart nation, clean environment, etc.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Explain the core values, contributing technologies, and challenges of industry 4.0 and 5.0.

CO2 - Justify how different technologies contribute to industry 4.0.

CO3 - Recommend the industry 4.0 technologies to product design, manufacturing, and factory operations.

CO4 - Justify how different technologies contribute to industry 5.0.

CO5 - Recommend industry 5.0 contributing technologies to realize SDGs, Society 5.0 and mass personalization.

CO6 - Prepare a report with the current trends, what industry 4.0 and/or 5.0 technologies can help make these operations smarter, and the benefits and challenges of their implementation for the given case study/ application.

TEXT / REFERENCE BOOKS

1. Uthayan Elangovan, —Industry 5.0: The Future of the Industrial Economyll, CRC Press, 2021.
2. Mahmoud Numan Bakkar and Elspeth McKay, "Advanced Research and Real-World Applications of Industry 5.0", IGI Global Publisher, 2023.
3. Klaus Schwab, —Fourth Industrial Revolutionll, Random House USA Inc, New York, USA, 2017.
4. Jean-Claude André, —Industry 4.0: Paradoxes and Conflictsll, Wiley Publications, 2019.
5. Oliver Grunow, —Smart Factory and Industry 4.0. The current state of Application Technologiesll, Studylab Publications, 2016
6. Sang C. Suh, U. John Tanik, John N Carbone, and Abdullah Eroglu, —Applied Cyber-Physical Systemsll, Springer Publications, New York, 2013.

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

2 Questions from each unit with internal choice, each carrying **80 Marks**

PART B : 16 marks