



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

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School of Mechanical Engineering Department of Mechatronics

1.1.2 List of Courses Revised / New Courses Introduced in the Academic Year 2022 – 2023

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**School of Mechanical Engineering
Department of Mechatronics**

Minutes of Board of Studies Meeting held on 04-06-2022 (Saturday)

Meet Time: 9.30 a.m. to 11.30 noon

The meeting started with the welcome address delivered by Dr. S. Prakash, Professor and Dean (Session Chair). He introduced the new course and the revised courses offered to Mechatronics students to the BOS panel members. The following are the BOS members were present during the Mechatronics BOS meeting.

Sl. No.	Name	Designation	Institution	Role
1	Dr. S. Prakash	Professor and Dean	Sathyabama Institute of Science & Technology	Chair person
2	Dr. L. Vijayaraghavan	Professor	IIT Madras, Chennai	BoS Member (External)
3	Dr. N. GaneshKumar	Associate Professor	PSG Tech, Coimbatore	BoS Member (External)
4	Dr. B. Kanimozhi	Professor	Sathyabama Institute of Science & Technology	Member
5	Dr. M Sangeetha	Associate Professor	Sathyabama Institute of Science & Technology	Member
6	Dr. J. R. Deepak	Associate Professor	Sathyabama Institute of Science & Technology	Member

Agenda:

- Review of Curriculum for the upcoming semester courses for B.E. Mechatronics to be discussed
- Revision of Syllabi for the following Courses for B.E. Mechatronics
 - SMRA1602 Micro Electro Mechanical Systems
 - SMRA1601 Sensors and Instrumentation
 - SMRA2601 Sensors and Instrumentation Lab
 - SMRA1701 Robotics and Machine Vision System



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- New courses have been proposed for the Course for B.E. Mechatronics
 - SMRA1201 Fundamentals of Automation & Control
 - SMRA1401 Automation and Programmable Logic Controller
 - SMRA1402 Signal and Control System Engineering
 - SMRA2501 Mechatronics and Simulation lab
 - SMRA2701 Robotics and CAM Lab
- Common courses have been proposed for the Course for B.E. Mechatronics
 - SAIC4001 Industry 4.0
 - S19APT1 Professional Training
 - S19APT2 Inter Disciplinary Project
 - S19APROJ1 Project Phase - I
 - S19APROJ2 Project Phase – II

Dr. B Kanimozhi proposed the revised theory course entitled SMRA1602 Micro Electro Mechanical Systems (**Theory Course**) **2019 regulation** based on the futuristic requirements for the students in the field of MEMS, Robotics and Automation. The theory course **SMR1301 - Micro Electro Mechanical Systems** (Regulation 2018) has been revised as **SMRA1602 - Micro Electro Mechanical Systems** (Regulation 2019) according to the current industrial needs which enables the student to learn basics of COMSOL software and to design micro devices, micro systems for various applications.

Dr. J. R. Deepak proposed the revised theory course entitled SMRA1601 Sensors and Instrumentation (**Theory Course**) **2019 regulation** and SMRA2601 Sensors and Instrumentation Lab (**Practical Course**) **2019 regulation** based on the futuristic requirements for the students in the field of robotics and automation. The revised the theory course SMRA1601Sensors and Instrumentation (Regulation 2019) replaces the **SMR1302 - Sensors and Instrumentation** (Regulation 2018). Learning this course will help the student to design and calibrate the instruments for manufacturing industries. He also presented the revised practical course **SMRA2601 Sensors and Instrumentation Lab** (Regulation 2019) which replaces the **SMR4051 - Sensors and Instrumentation Laboratory** (Regulation 2018). On learning these courses students will be able to design and develop measurement devices for various process in manufacturing industries for various industrial automation applications. In also enables the students to select the appropriate measuring device for various process applications. This course enables the students to build his career in quality, automation and instrumentation engineering sectors.

Dr. S. Prakash proposed a new course entitled **SMRA1201 Fundamentals of Automation & Control (Theory Course)** and **SMRA1401 Automation and Programmable Logic Controller (Theory Course)** based on the current industrial requirements. The proposed in 2019 regulation



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SMRA1201 - Fundamentals of Automation and Control new (Theory Course) course replaces the **SMR1101 Digital Electronics** offered in 2018 syllabus in the second semester as the students has to learn the basics of Automation and Control which will be a prerequisite for the upcoming papers. Dr. S. Prakash also suggested a new course **SMRA1401 Automation and Programmable Logic Controller** in the fourth semester as the students has to learn the basics of PLC and Automation.

Dr. M. Sangeetha proposed a new theory course entitled **SMRA1402 Signal and Control System Engineering (Theory Course)** a new practical course entitled **SMRA2501 Mechatronics and Simulation lab (Practical Course)** and **SMRA2701 Robotics and CAM Lab (Practical Course)** based on the futuristic requirements for the students **SMRA2501 Mechatronics and Simulation lab** course was revised and proposed from the **2018 regulation** practical course **SME4058 Mechatronics Lab** as the students has to learn the basics of Fluid Sim Software enhances the programing skill which will help the student to become a Hydraulic and pneumatic system Designer for automation industries. Students will be able simulation package by constructing the system models for the specified

Dr. S. Prakash proposed the **common courses** that are followed throughout the university such as SAIC4001 INDUSTRY 4.0, S19APT1 Professional Training, S19APT2 Inter Disciplinary Project, S19APROJ1 Project Phase – I, S19APROJ2 Project Phase – II. Conducting the project as Phase one and phase two was appreciated by the external board members.

Dr. N. Ganesh Kumar, Associate Professor from PSG Tech appreciated the idea of introducing the courses **SMRA2701 - Robotics and CAM Lab (Practical Course)** and **SMRA1701 - Robotics and Machine Vision System (Theory Course)** saying that skill set of the mechatronics engineering students of Sathyabama Institute of science and technology will match the current needs of the robotics and Automation Industry.

Dr. L. Vijayaraghavan, Professor from IIT Madras, Chennai and Dr. N. Ganesh Kumar, Associate Professor from PSG Tech (External BOS members) reviewed all the course and approved the inclusion of the new course in 2019 Regulation. The Board members appreciated the inclusion of the new courses in 2019 Regulation.

Convener/Dean

HOD

Dr. N. Ganesh Kumar N

Expert Members



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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 Ant striction 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.



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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 familiarize 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



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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 tacho-drag up type tacho, D.C and A.C tacho 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.



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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



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SMRA2601

SENSORS AND INSTRUMENTATION LAB

L T P Credits Total Marks

0 0 3 2 100

COURSE OBJECTIVES

To understand the working of sensors and transducers.

To understand the characteristics of sensors.

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.



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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 grippers- 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



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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" 6

th 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



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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.



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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

1. Automation, Production Systems and Computer Integrated Manufacturing- M.P.Groover, Pearson Education.5th Edition, 2009.
2. Computer Based Industrial Control- Krishna Kant, EEE-PHI, 2nd Edition, 2010.
3. An Introduction to Automated Process Planning Systems- Tiess Chiu Chang & Richard A. Wysk.
4. 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



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SMRA1401 AUTOMATION AND PROGRAMMABLE LOGIC CONTROLLER

L T P Credits Total Marks

3 0 0 3 100

COURSE OBJECTIVES

To familiarize 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-counts.



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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 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



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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



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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 signal 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



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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

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



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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, rotomim etc.

Use of AutoCAD software and MATLAB 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



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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 preform manufacturing.



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SAIC4001

INDUSTRY 4.0

2 credits for 4 hours per week

L T P Credits Total Marks

2 - 2 2 100

UNIT 1 ADVANCED TECHNOLOGY AND ADVANCED MATERIALS 7 Hrs.

Advanced electro-optical sensing technology-active, passive multi-spectral and hyper spectral imaging; electronic beam steering; vacuum technology, surface and coating technology, health care technology, Nanotechnology- Nano mechanics, Nano optoelectronics; energy storage technology-next generation Li-based Batteries, Hydrogen storage, solar photovoltaics', Flexible electronics. Intellectual Property Rights - case studies governing/pertaining to Materials/Technology.

UNIT 2 TRANSFORMING TECHNOLOGIES IN BIOENGINEERING 7 Hrs.

Establishment of smart biotechnology factory, Artificial intelligence in Bioprocess technology, Omics – Big data analysis through automation, 3D bio printing for tissue engineering. Simulation tools, RSM and Box model. Cyber physical system-based telemedicine, diagnosis and therapeutics through real time biosensors. Bio nanotechnology. Intellectual Property rights (IPR): Case Studies.

UNIT 3 ADVANCEMENTS IN SUSTAINABLE BUILT ENVIRONMENT 7 Hrs.

Introduction – Technological developments in Architectural, Engineering and Construction (AEC) - Building Information Modelling (BIM) using Cloud computing technology and Internet of things (IoT) – Unmanned Aerial Vehicles, sensors – Additive manufacturing in construction – Concrete 3D printing - Materials used - Lightweight and functionally graded structures - Net Zero Energy buildings, Bioswales, Biofiltration pond, Ecosan systems- Recent developments in Waste water Management, Air pollution control, waste disposal - Integration of energy, water and environmental systems for a sustainable development- Emerging Technologies: Robot Highway- Vertical farming - Intellectual Property rights: Case studies.

UNIT 4 SMART MANUFACTURING 8 Hrs.

Smart factories and interconnection, Smart Manufacturing – automation systems, Additive Manufacturing, Smart grids, Micro Electro Mechanical Systems (MEMS), Stealth technology, Metal Finishing, Self-propelled vehicles, e mobility, green fuels, drones – unmanned aerial vehicles (UAVs), aerodynamics. Robotic Automation and Collaborative Robots – Augmented reality and haptics, engineering cybernetics and artificial intelligence (AI), Disruptive Technologies – Frugal Innovations – Emerging Technologies - Autonomous Robots, Swam Robot, Modular Robotics, Space craft, Intellectual Property Rights (IPR): Case Studies.

UNIT 5 SMART WORLD 8 Hrs.

Smart Sensors and IIOT, Smart grid, Hybrid renewable energy systems, Electronics in Smart city, Integration of Sensors in Robots and Artificial Intelligence, 5G Technology, Communication protocols, Human-Machine Interaction, Virtual Reality, Quantum Computing: Changing trends in



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transistor technology: Processor, Emerging Trends: Deep Space, Swarm Robots, Cyborg, Geofencing, Pervasive Computing, Intellectual Property Rights- Case Studies.

UNIT 6 CYBER PHYSICAL SYSTEMS 8 Hrs.

Introduction to Cyber Physical Systems (CPS), Architecture of CPS, Data science and technology for CPS, Prototypes of CPS, Emerging applications in CPS including social space, crowd sourcing, healthcare and human computer interactions, Industrial Artificial Intelligence, Networking systems for CPS applications, Wearable cyber physical systems and applications, Domain applications of CPS: Agriculture, Infrastructure, Disaster management, Energy, Transportation, Intellectual Property Rights (IPR): Case Studies.

Max. 45 Hrs.

TEXT / REFERENCE BOOKS

1. William D. Callister, "Materials Science and Engineering, An Introduction, John Willey and Sons Inc. Singapore, 2001.
2. V. Raghavan, "Physical Metallurgy: Principle and Practice, Prentice Hall India Pvt Ltd, 2006.
3. Flavio Craveiro, Jose Pinto Duarte, Helena Bartolo and Paulo Jorge Bartolo, "Additive manufacturing as an enabling technology for digital construction: A perspective on Construction 4.0", Automation in Construction, Vol. 103, pp. 251- 267, 2019.
3. Klaus Schwab, "Fourth Industrial Revolution", Random House USA Inc, New York, USA, 2017.
4. Oliver Grunow, "SMART FACTORY AND INDUSTRY 4.0. The current state of Application Technologies", Study lab Publications, 2016.
5. Alasdair Gilchrist, "INDUSTRY 4.0: Industrial Internet of Things", Apress, 2016.
6. Sang C. Suh, U. John Tanik, John N Carbone, Abdullah Eroglu, "Applied Cyber-Physical Systems", Springer Publications, New York, 2013.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 Exam Duration: 3 Hrs.

PART A: 11 Questions of 2 marks each-No choice 22 Marks

PART B: 2 Questions from each unit with internal choice, each carrying 13 marks 78 Marks



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S19APT1

PROFESSIONAL TRAINING

Professional Training : 2 credits for 4 hours per week

PROFESSIONAL TRAINING

- Every student is required to undergo Industrial Visits during every semester of the Programme. HoDs shall take efforts to send the students to industrial visits in every semester.
- The students will have to undergo Professional training for a minimum period of 2 weeks during the semester Holidays at the end of second year.
- This could be internship in an industry approved by the School Dean or Professional Enrichment courses (like attending Summer Schools, Winter Schools, Workshops) offered on Campus or in Registered Off Campus recognized Training Centers approved by the School Dean for a minimum period of 3 weeks.
- A report on Training undergone by the student, duly attested by the coordinator concerned from the industry / Organization, in which the student has undergone training and the Head of the Department concerned, shall be submitted after the completion of training. The evaluation of report and viva voce examination can be computed as per norms for the End Semester examination.
- The evaluation of training will be made by a three-member committee constituted by Head of the Department in consultation with year coordinator and respective Training Coordinator. A presentation should be made by the student before the Committee, based on the Industrial Training or Professional Enrichment undergone.

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S19APT2	INTER DISCIPLINARY PROJECT
S19APROJ1	PROJECT PHASE - I
S19APROJ2	PROJECT PHASE – II

Interdisciplinary project	: 3 credits for six hours per week in sixth semester
Project Work phase I	: 3 credits for 6 hours of project work (Phase - I) per week.
Project Work phase II	: 7 credits for 14 hours of project work (Phase - II) per week.

FINAL YEAR PROJECT WORK

- Project work has to be done by each student in the final year. The project work has been divided in to two phases (Phase - I and II). Project work Phase - I has to be done in the pre-final semester and Phase - II during the final semester.
- Project work may be allotted to a single or two students as a group. In special cases, the number of students in a project group cannot exceed three, if it can be justified by the project supervisor and HoD, that the project work content is large enough.
- For project work, assessment is done on a continuous basis by 3 reviews for 50 marks and final viva voce carries 50 Marks.
- There shall be three project reviews (conducted during the pre-final semester and final semester) to be conducted by a review committee. The student shall make presentation on the progress made, before the committee. The head of the department shall constitute the review committee for each branch in consultation with school dean. The members of the review committee will evaluate the progress of the project and award marks.

	PROJECT REVIEWS			FINAL PROJECT VIVA VOCE
	1	2	3	
Max. Marks	5	15	30	50

- The total marks obtained in the three reviews, rounded to the nearest integer is the continuous assessment marks out of 50. There shall be a final viva-voce examination at the end of final semester conducted by one internal examiner, one external examiner and the supervisor concerned.
- A student is expected to attend all the project reviews conducted by the institution on the scheduled dates. It is mandatory for every student to attend the reviews, even if they are working on a project in an industry based outside Chennai city. It is their duty to inform the organization about the project reviews and its importance, and get permission to attend the same. If a student does not attend any of the project reviews, he / she shall not be allowed for the successive reviews and thereby not allowed to appear for the final viva voce.



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- The final project viva-voce examination shall carry 50 marks. Marks are awarded to each student of the project group based on the individual performance in the viva-voce examination. The external examiner shall be appointed by the controller of examinations. The internal and external examiner will evaluate the project for 20 Marks each. The project report shall carry a maximum of 10 marks.
- The candidate is expected to submit the project report as per the guidelines of the institution on or before the last day of submission. If a candidate fails to submit the project report on or before the specified deadline, he/she can be granted an extension of time up to a maximum limit of 5 days for the submission of project work, by the head of the department.
- If he/she fails to submit the project report, even beyond the extended time, then he/she is deemed to have failed in the project work and shall register for the same in the subsequent semester and re-do the project after obtaining permission from the HoD and school dean.



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School of Mechanical Engineering Department of Mechatronics

Minutes of Board of Studies Meeting held on 10-12-2022 (Saturday)

Meet Time: 10.30 a.m. to 12.00 noon

The meeting started with the welcome address delivered by Dr. S. Prakash, Professor and Dean (Session Chair). He introduced the new course and the revised courses offered to Mechatronics students to the BOS panel members. The following are the BOS members were present during the Mechatronics BOS meeting.

Sl. No.	Name	Designation	Institution	Role
1	Dr. S. Prakash	Professor and Dean	Sathyabama Institute of Science & Technology	Chair person
2	Dr. L. Vijayaraghavan	Professor	IIT Madras, Chennai	BoS Member (External)
3	Dr. N. GaneshKumar	Associate Professor	PSG Tech, Coimbatore	BoS Member (External)
4	Dr. B. Kanimozhi	Professor	Sathyabama Institute of Science & Technology	Member
5	Dr. M Sangeetha	Associate Professor	Sathyabama Institute of Science & Technology	Member
6	Dr. J. R. Deepak	Associate Professor	Sathyabama Institute of Science & Technology	Member

Agenda:

- Review of Curriculum for the upcoming semester courses for B.E. Mechatronics to be discussed
- Professional Electives Courses proposed for B.E. Mechatronics
 - SMRA3001 Instrumentation in Industries
 - SMRA3004 Medical Mechatronics
 - SMRA3005 Experimental stress analysis



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- SMRA3003 Artificial Intelligence and Expert systems
- SMRA4001 Flexible Manufacturing systems
- SMRA3002 Virtual Instrumentation

Dr. S. Prakash proposed the following **Professional Electives Courses** such as SMRA3001 Instrumentation in Industries, SMRA3004 Medical Mechatronics, SMRA3005 Experimental stress analysis, SMRA3003 Artificial Intelligence and Expert systems, SMRA4001 Flexible Manufacturing systems, SMRA3002 Virtual Instrumentation to the board members. The Board members appreciated the inclusion of the Professional Electives new courses in 2019 Regulation.

Dr. L. Vijayaraghavan, Professor from IIT Madras, Chennai and Dr. N. Ganesh Kumar, Associate Professor from PSG Tech (External BOS members) reviewed all the course and approved the inclusion of the new course in 2019 Regulation. The Board members appreciated the inclusion of the new courses in 2019 Regulation.

Convener/Dean

HOD

Dr. N. Ganesh Kumar N

Expert Members



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SMRA3001

INSTRUMENTATION IN INDUSTRIES

L T P Credits Total Marks

3 0 0 3 100

COURSE OBJECTIVES

To introduce the complete operation of various industries.

To provide an exposure to the process and instrumentation & control applications in various industries like

paper, petrochemical, iron and steel, mining, pharmaceutical, nuclear and power plant industries.

UNIT 1 OVERVIEW DESCRIPTION OF INDUSTRIAL PROCESSES 11 Hrs.

Description of process in Paper Industries Description of process in petrochemical industries: Description of process in iron and steel and mining industries - Description of process in pharmaceutical and nuclear industries.

UNIT 2 INSTRUMENTATION IN PAPER INDUSTRIES 7 Hrs.

Measurement of Basic weight, thickness, density, Porosity, smoothness, softness, hardness and compressibility; selection of suitable measurement hardware for flow, pressure, level, temperature, density, solids, consistency – moisture analyzers oxidation - reduction potential and pH.

UNIT 3 INSTRUMENTATION IN PETROCHEMICAL INDUSTRIES 7 Hrs.

P & I diagram of petroleum refinery, measurement and control of absolute pressure, density, conductivity, differential pressure and flow of evaporators. Measurement and control of column pressure, liquid distillate, vapor distillate.

UNIT 4 INSTRUMENTATION IN IRON AND STEEL AND MINING INDUSTRIES 11 Hrs.

Iron and steel: Selection of suitable measurement hardware for temperature, pressure, level, flow, weighing and proportioning – special gauges for measurement of thickness and shape. Mining Industry: Weighing - conveyor belts - metal detectors – level sensors – nuclear density detectors – flow meters, Coal analyzer - thermogravimetry – gross calorific value - total Sulphur analysis - ash analyzer - online monitor- air quality monitoring- Sampling of ambient air – general air sampling system - Flue gas oxygen analyzer - analysis of impurities in feed water and steam - dissolved oxygen analyzer - chromatography - PH Meter - pollution monitoring instruments.

UNIT 5 INSTRUMENTATION IN PHARMACEUTICAL, NUCLEAR AND POWER PLANT INDUSTRIES 9 Hrs.

Pharmaceutical Industries: Flow measurement - pressure measurement – smoke detector Nuclear Industries: Radiation detection instruments – Area monitors and in-place detectors – Temperature measuring devices – level sensors. Power Plant Industries: Metal temperature measurements, flow of feed water – fuel, air, steam with correction factor for temperature and pressure.



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Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - List the basic operation of various industries.

CO2 - Summarize the process parameters with appropriate sensors/transducers.

CO3 - Explain the measurement of different process parameters for specified industries.

CO4 - Analyze the working of different Instruments used in specified industries.

CO5 - Compare diverse measurement techniques/control of process parameters.

CO6 - Develop an appropriate measurement technique in an industry.

TEXT / REFERENCE BOOKS

1. Liptak B G, "Instrumentation in the processing industries", Chilton book Company, 1973.
2. Considine D. M., "Process/Industrial Instruments and control Handbook", McGraw Hill, 5th Edition 1999.
3. Hower P. Kallen, "Hand Book of Instrumentation and Control", Tata McGraw Hill, 1961.
4. Liptak B G, "Instrument Engineer's Handbook, Vol. 2: Process Control and Optimization", CRC Press, 2006.
5. Baskara Rao, "Petrochemicals", Khanna Publishers, New Delhi, 1987.
6. Liptak B.G, "Process Measurement and Analysis", 3rd Edition, Chilton Book Co., 2003.
7. Considine D. M, "Hand Book of Applied Instrumentation", Tata McGraw Hill, 1984.

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



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SMRA3004

MEDICAL MECHATRONICS

L T P Credits Total Marks

3 0 0 3 100

COURSE OBJECTIVES

To identify different types of biomedical units such as pathological, diagnostic, therapeutic and prosthetic devices.

To educate students the different mechanism to measure and monitor different biomedical parameters.

UNIT 1 INTRODUCTION 9 Hrs.

Cell structure – electrode – electrolyte interface, electrode potential, resting and action potential
Different electrodes for measurement, Classification of Biomedical instruments, ECG, EEG, EMG – machine description – methods of measurement.

UNIT 2 SENSORS AND TRANSDUCERS 9 Hrs.

Basic transducer principles Types — resistive, inductive, capacitive, fiber-optic, photoelectric, chemical, active and passive transducers and their description and feature applicable for biomedical instrumentation Sensor applications in medicine – External and implantable sensors.

UNIT 3 ORTHOTICS AND PROSTHETICS 9 Hrs.

Need and Classification of orthotics and prosthetics, Gait Cycle, Upper and Lower limb Prosthetic devices. Upper and Lower limb Orthotic devices, FES system, Design of manual and powered wheelchairs.

UNIT 4 MEDICAL IMAGING 9 Hrs.

Computed Tomography, Spiral or Helical, Angiography., Magnetic resonance imaging, Nuclear medical imaging, Ultrasound Imaging, Thermography, Endoscopy, Laparoscopy.

UNIT 5 APPLICATIONS & CASE STUDIES 9 Hrs.

Robots in surgery, Nano robots in medicine, Rehabilitation robots, Navigation Handheld snake like robots, Smart sensors for detecting kidney stones, Active prosthetic Knee, Smart system for cardiovascular plaque detection.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Comment on various measurement systems used in diagnostics.

CO2 - Describe the sensors and transducers used in biomedical engineering.



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- CO3 - Design suitable orthotic and prosthetic devices and applications.
CO4 - Explain the working of different imaging techniques in Biomedical Engineering.
CO5 - Analyse the applications of mechatronics in medicine.
CO6 - Design medical equipment using the mechanical aspects gained.

TEXT / REFERENCE BOOKS

1. Siamak Najarian "Mechatronics in Medicine – A Bio medical Engg. approach", McGraw – Hill Education, 2011.
2. R.S. Khandpur, Handbook of biomedical Instrumentation, Tata McGraw Hill Publication company Ltd, New Delhi, 2014.
3. Joseph J. Carr, John Michael Brown, Introduction to Biomedical Equipment Technology 4th Edition, Pearson Education, 2012.
4. John G. Webster, Biomedical Instrumentation, Wiley Publications.2007.
5. Textbook of rehabilitation, Sunder, Jaypee Publications, 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



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SMRA3005

EXPERIMENTAL STRESS ANALYSIS

L T P Credits Total Marks

3 0 0 3 100

COURSE OBJECTIVES

To understand the fundamental concepts and gain experimental knowledge of stress/strain developed in engineering materials and structures.

To gain knowledge of stress/strain measuring gauges.

To handle measuring gauges to measure stress/strain and apply various methods.

To gain the knowledge of Moire and Photoelasticity techniques.

To gain the knowledge of Brittle and Birefringent coating methods.

UNIT 1 OVERVIEW OF EXPERIMENTAL STRESS ANALYSIS 7 Hrs.

Introduction - Concept of stress and strain – stress and strain relations - Experimental stress analysis - Advantages – Methods - Simplification of problems - Selection of Experimental Techniques.

UNIT 2 STRAIN MEASUREMENT AND RECORDING INSTRUMENTS 10 Hrs.

Introduction - Principle - Types of strain gauges – Applications – Materials - Strain Sensitivity - Bridge Sensitivity - Gauge factor – Calibration and Temperature compensation - Wheatstone Bridge and Potentiometer Circuits - Rosettes strain gauges and analysis - Strain Gauge Selection - Stress Gauges - Load Cells - Data Acquisition - Six Component Balance - Recording Instruments - Static and Dynamic recording at various frequencies.

UNIT 3 MOIRE METHODS 10 Hrs.

Introduction - Mechanism of formation of Moire fringes - Geometrical approach to Moire fringe analysis - Displacement field approach to Moire fringe analysis - Out of plane measurements Tardy's Method - Babinet Soleil Method - Sharpening and multiplication of Moire - Fringes, Experimental procedure and techniques.

UNIT 4 PHOTO ELASTICITY METHODS 10 Hrs.

Introduction – Two- and three-dimensional photoelasticity - Concept of light - Methods - Materials for Photo elasticity - Photo elastic Effects -Temporary double refraction - Stress optic law - Effects of stressed model in a plane Polariscopes - Fringe multiplication - Isochromatic fringe patterns - Isoclinic fringe patterns - Compensation techniques - Calibration methods - Separation and Shear Difference Methods - Scaling model to prototype stresses.

UNIT 5 BRITTLE AND BIREFRINGENT COATING METHODS 8 Hrs.

Introduction - Types of Coating methods – Brittle and Birefringent coatings -Test procedures– applications – Failure theories - Coating Materials- Coating stresses and strains - effect of coating thickness -Crack pattern –Crack detection– Calibration procedures –Brittle coating data analysis- Fringe-order determinations and stress separation method.



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Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the basics of experimental stress analysis.

CO2 - Remember and explain overall concepts of stress/strain analysis and recording instruments by using experimental means of stress and strain gauges.

CO3 - Discuss the theory and practice of Moire methods and evaluate stress/strain.

CO4 - Analyze the theory and practice of Photoelasticity analysis methods for various materials.

CO5 - Describe and compare the Brittle and Birefringent coatings and working of strain gauges.

CO6 - Develop a procedure to solve the practical problems.

TEXT / REFERENCE BOOKS

1. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, ISBN: 9788174091826, 2015.

2. James W. Dalley and William. F. Riley, "Experimental Stress Analysis", ISBN-13: 978 - 0970067586, College House Enterprises Llc, June 30, 2001.

3. Jindal, U C, "Experimental Stress Analysis", ISBN-9332501246, 9789332501249, Pearson Education, India, 2012.

4. Srinath. L. S, Raghava. M. R., Lingaiah. K, Gargasha. G, Pant. B and Ramachandra, K, "Experimental Stress Analysis", ISBN: 9780074519264, Tata McGraw Hill, New Delhi, 1984.

5. Richard C. Dove and Paul H. Adams, "Experimental Stress Analysis and Motion Measurement: Theory, Instruments and Circuits, Charles E. Merrill, 1964, Digitized: 30 Nov 2007.

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



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SMRA3003

ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

L T P Credits Total Marks

3 0 0 3 100

COURSE OBJECTIVES

To understand Basic Concepts of Artificial Intelligence and Expert Systems.

To provide knowledge on Various Techniques and Tools involved in Artificial Intelligence.

UNIT 1 INTRODUCTION 9 Hrs.

Introduction: History, Definition of AI, Emulation of human cognitive process, knowledge search tradeoff, stored knowledge, semantic nets. An abstract view of modeling, elementary knowledge. Computational logic, analysis of compound statements using simple logic connectives, predicate logic, knowledge organization and manipulation, knowledge acquisition.

UNIT 2 PROGRAMMING AND LOGICS IN ARTIFICIAL INTELLIGENCE 9 Hrs.

LISP and other programming languages- introduction to LISP, syntax and numerical function, LISP and PROLOG

distinction, input output and local variables, Interaction and recursion, property list and arrays alternative languages,

formalized symbolic logics- properties of WFRS, non-deductive inference methods. Inconsistencies and uncertainties- Truth maintenance systems, default reasoning and closed world assumption, Model and temporary logic.

UNIT 3 SEARCH METHODS AND KNOWLEDGE REPRESENTATION 9 Hrs.

Fuzzy logic - concepts, Introduction to Fuzzy logic with examples, probabilistic reasoning, Bayesian probabilistic inference, Dempster Shafer theory, possible world representation, Ad-Hoc methods. Structure knowledge: Graph, frames and related structures, Object oriented representation- object classes, message and methods, simulation examples using OOPS programs, OOP languages. Search and control strategies - Concepts, search problems, uniformed or Blined search, searching AND – OR graphs.

UNIT 4 KNOWLEDGE ORGANISATION AND COMMUNICATION IN EXPERT SYSTEMS 9 Hrs.

Matching techniques- Need for matching, matching problem, partial matching, Fuzzy matching, RETE matching algorithm. Knowledge organization- Indexing and retrieval techniques, integration of knowledge in memory organization systems, Perception, communication and Expert systems. Overview of Linguistics, Basic passim techniques, semantic analysis and representation structures, natural language generation and system.

UNIT 5 PATTERN RECOGNITION AND LEARNING TECHNIQUES 9 Hrs.

Pattern recognition system- understanding speech recognition, Image transformation, low level



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processing, medium and high-level processing, vision system architecture, Rule based system architecture, knowledge acquisition and validation, knowledge system building tools, use of AI and ES in manufacturing and design, types of learning- general learning model, performance measures, learning automate genetic algorithm, learning by induction - LEX, ID3, INDUCE systems.

Max. 45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will be able to

CO1 - Understand the Basics about Artificial Intelligence and Expert Systems.

CO2 - Understand the Programming Logics in Artificial Intelligence.

CO3 - Understand Various search methods in Artificial Intelligence.

CO4 - Understand the Knowledge about the Expert Systems.

CO5 - Understand the Image processing and analysis.

CO6 - Understand the latest developments in Knowledge systems and Tools.

TEXT / REFERENCE BOOKS

1. Russel (Stuart), 'Artificial Intelligence- Modern approach, Pearson Education series in AI', 3rd Edition, 2009.
2. Dan W Patterson, 'Introduction to Artificial intelligence and Expert systems', Prentice Hall of India Pvt. Ltd, 2001
3. Eugene Charniak, Drew Mc Dermot, 'Introduction to Artificial intelligence', Addison Wesley Longman Inc., 2009
4. George. F, William. A. Stubblefield, 'Artificial intelligence and the design of expert systems', The Benjamin Cummins Publishing Co., Inc 2nd Edition, 1992.
5. Robert J Schalkoff, 'Artificial intelligence An Engineering Approach', McGraw Hill International Edition, 1990.

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



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SMRA4001

FLEXIBLE MANUFACTURING SYSTEMS

L T P Credits Total Marks

3 0 0 3 100

COURSE OBJECTIVES

To understand and develop knowledge on the various flexible manufacturing systems and its applications.

To get introduced to the simulation process and FMS database.

To explore the future prospects of AI and Expert systems in FMS.

UNIT 1 INTRODUCTION 9 Hrs.

FMS– development of manufacturing systems – benefits – major elements – types of flexibility– part selection problems – FMS application and flexibility – single product, single batch, N – batch scheduling problem – knowledge-based scheduling system.

UNIT 2 COMPUTER CONTROL AND SOFTWARE FOR FLEXIBLE MANUFACTURING SYSTEMS 9 Hrs.

Introduction – composition of FMS– hierarchy of computer control –computer control of work center and assembly lines – FMS supervisory computer control – types of software specification and selection – Object oriented control architecture trends.

UNIT 3 FMS SIMULATION AND DATA BASE 9 Hrs.

Application of simulation–model of FMS–simulation software – limitation – manufacturing data systems–data flow–FMS database systems–planning for FMS database- predictive control algorithms for on line scheduling of FMS.

UNIT 4 GROUP TECHNOLOGY AND JUSTIFICATION OF FMS 9 Hrs.

Introduction – matrix formulation – mathematical programming formulation –graph formulation – knowledge-based system for group technology – economic justification of FMS- application of possibility distributions in FMS systems justification Measuring flexibility and performance of FMS.

UNIT 5 APPLICATIONS OF FMS AND FACTORY OF THE FUTURE 9 Hrs.

FMS application in machining, sheet metal fabrication, prismatic component production – aerospace application – Case studies. FMS development towards factories of the future – artificial intelligence and expert systems in FMS – design philosophy and characteristics for future.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Identify the need and role of Flexible Manufacturing System in Industry.



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- CO2 - Assess the concepts and linkage of software in FMS.
- CO3 - Demonstrate the simulation process involved and its data flow.
- CO4 - Justify the importance of FMS and its importance in group technology.
- CO5 - Compare and categories the level of FMS needed in an manufacturing industry.
- CO6 - Appreciate and explore the penetration of AI in FMS.

TEXT / REFERENCE BOOKS

- 1 Jha, N.K. "Handbook of flexible manufacturing systems", Academic Press Inc., 2012.
- 2 Radhakrishnan P. and Subramanyan S., "CAD/CAM/CIM", Wiley Eastern Ltd., New Age International Ltd., 2010.
- 3 Raouf, A. and Ben-Daya, M., Editors, "Flexible manufacturing systems: recent development", Elsevier Science, 2015.
- 4 Jan Beier, "Simulation approach towards energy flexible manufacturing systems", Springer Publications, 2017.
- 5 H.K. Shivanand, "Flexible Manufacturing System", New Age International Publishers, 2011.
- 6 Taiichi Ohno, "Toyota production system: beyond large-scale production", Productivity Press (India) Pvt. Ltd. 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

PART B: 2 Questions from each unit with internal choice, each carrying 16 marks 80 Marks



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SMRA3002

VIRTUAL INSTRUMENTATION

L T P Credits Total Marks

3 0 0 3 100

UNIT 1 REVIEW OF DIGITAL INSTRUMENTATION 6 Hrs.

Representation of analog signals in the digital domain – Review of quantization in amplitude and time axes, sample and hold, sampling theorem, ADC and DAC.

UNIT 2 FUNDAMENTALS OF VIRTUAL INSTRUMENTATION 10 Hrs.

Concept of virtual instrumentation – PC based data acquisition – Typical on board DAQ card – Resolution and sampling frequency - Multiplexing of analog inputs – Single-ended and differential inputs – Different strategies for sampling of multi-channel analog inputs. Concept of universal DAQ card - Use of timer-counter and analog outputs on the universal DAQ card.

UNIT 3 CLUSTER OF INSTRUMENTS IN VI SYSTEM 10 Hrs.

Interfacing of external instruments to a PC – RS232, RS 422, RS 485 and USB standards - IEEE 488 standard – ISO-OSI model for serial bus – Introduction to bus protocols of MOD bus and CAN bus.

UNIT 4 GRAPHICAL PROGRAMMING ENVIRONMENT IN VI 10 Hrs.

Concepts of graphical programming – Lab-view software – Concept of VIs and sub VI - Display types – Digital – Analog – Chart – Oscilloscopic types – Loops – Case and sequence structures - Types of data – Arrays – Formulae nodes –Local and global variables – String and file I/O.

UNIT 5 ANALYSIS TOOLS AND SIMPLE APPLICATIONS IN VI 9 Hrs.

Fourier transform - Power spectrum - Correlation – Windowing and filtering tools – Simple temperature indicator – ON/OFF controller – P-I-D controller - CRO emulation - Simulation of a simple second order system – Generation of HTML page.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recall Digital Instrumentation.

CO2 - Understand the concept of Virtual Instrumentation.

CO3 - Select an appropriate interfacing technique.

CO4 - Apply the knowledge of programming in VI.

CO5 - Develop a program using VI.

CO6 - Design a system using VI.

TEXT / REFERENCE BOOKS

1. S. Gupta and J.P Gupta, 'PC Interfacing for Data Acquisition and Process Control', Instrument



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society of America, 1994.

2. Peter W. Gofton, 'Understanding Serial Communications', Sybex International.

3. Robert H. Bishop, 'Learning with Lab-view', Prentice Hall, 2003.

4. Kevin James, 'PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control', Newness, 2000.

5. Gary W. Johnson, Richard Jennings, 'Lab-view Graphical Programming', McGraw Hill Professional Publishing, 2001.

6. Jerome J., Virtual Instrumentation using Lab VIEW, Prentice Hall India Private Ltd., New Delhi, 2010.

7. Sanjay Gupta, Virtual Instrumentation using Lab view, Tata McGraw-Hill Education, 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

 New Course