Shri Rawatpura Sarkar University, Raipur

Scheme of Teaching, Examination and Syllabus

for

M.Tech.
(Instrumentation & Control)

Semester-I

(Effective from the session: 2022-2023)

Two Years M.Tech. Programme

Scheme of Teaching and Examination

M.Tech. First Semester Instrumentation & Control

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the Academic Year 2022-2023)

S.No.	Course Code	Course Title	Hours / Week			Credits	Maximum Marks			Sem End Exam Duration (Hrs)
			L	T	P		Continuous Evaluation	Sem End Exam	Total	
1	MENIC101T	Industrial Transducers & Sensors	3	1	-	4	30	70	100	3
2	MENIC101P	Industrial Transducers & Sensors	-	-	2	1	15	35	50	-
3	MENIC102T	Bio-Medical Instrumentation	3	1	-	4	30	70	100	3
4	MENIC103T	Digital Measurement Techniques	3	1	-	4	30	70	100	3
5	MENIC104T	Control System Design	3	1	-	4	30	70	100	3
6	MENIC104P	Control System Design	-	-	2	1	15	35	50	-
7	MENIC105T	Elective – I	3	1	-	4	30	70	100	3
						22			600	

Elective-I

(A) Systems Optimization.
(B) Reliability Engineering.
(C) Robotics & Computer Vision.

Course Title	**Industrial Transducers & Sensors**				
Course Code	**MENIC101T**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**-**	**4**	
Prerequisites	**Basics of measuring instruments**				
Course Objectives	**This course will enable students to:** • To make students understand the Identification, types, construction, working principle and application of various transducers. • To make students understand the construction, working principle and application of various Mechanical transducers. • To make students understand the classification, construction, working principle and application of temperature transducers and Flow sensors				
.	**UNIT-I** Transducers Fundamentals: Transducer terminologies, principles, design and performance characteristics, criteria for transducer selection, static and dynamic characteristics, identification of sensor parameters. Classification of transducers. **UNIT-II** Types of Transducers: Mechanical Transducers, Passive Electrical transducers, Active Electrical Transducers, Feedback transducer systems, Resistive transducers, inductive transducers, capacitive transducers, Piezo-electric transducers, Nuclear Transducers. **UNIT-III** Mechanical Transducers: Displacement transducers, tachometers and velocity transducers, accelerometers and gyros, force and torque transducers, Angular and linear encoders. Strain gauges, Gauge Factor, Measurement of strain, Temperature compensation, Calibration, Load cells. Pressure Transducers: Terminology, Units; Manometers – Piezometer, U-Tube Double Column Manometer, Single Column Manometer, U-Tube Differential Manometer, Double Reservoir Manometer; Advantages and Limitations; Bourdan Gauge; Thermal Conductivity Gauge; Pirani Gauge; Dead Weight Piston Gauge. **UNIT-IV** Temperature Transducers: Liquid-in-glass thermometers; Bimetallic Thermometers; Thermocouples, Laws of thermocouples, Elements of thermoelectric pyrometers, General considerations in thermocouples, thermocouple instrumentation and circuits; Resistance thermometers; Thermistors; Radiation and Optical Pyrometers..				

	UNIT-V Flow Sensors: Nature of flow, Classification of flow measurement techniques, Theory of variable head meters (incompressible fluids), Venturi Flow meter, Flow Nozzle, Orifice Flow meter, Electromagnetic Flow meter, Hot Wire Anemometer. Optical Sensors: Photo tubes and photo diodes: photo-voltaic and photo-conductive cells, photo emission, photo electromagnetic detectors, pressure actuators, photo electronic detectors, design and operation of optical detectors, detector characteristics, different types of optical fiber sensors
Course Outcomes	**At the end of this subject student is able to:** • Know the fundamentals for transducers and its terminologies. • Get thorough understanding of various mechanical transducers measurement of low pressure and high pressure. • Get thorough understanding of Flow Sentor and various optical sensors.
Text Books	1. Transducers and Instrumentation, D.V.S. Murthy; Prentice Hall 2. Measurement systems: Application and Design – E.O. Doeblin; Tata McGraw Hill
Reference Books:	1. Sensors and Transducers- D. Patranabis; Prentice Hall 2. Instrumentation Devices and Systems - C.S. Rangan, G.R. Sharma, V S V Mani 3. Telemetry Principles, Patranabis; Tata McGraw Hill 4. Electronic Instrument Handbook, Clyde F Coombs; McGraw Hill Further Reading: 1. Intelligent Sensor Systems, John Brignell & Neil White 2. AIP Handbook of Modern Sensors, Jacob Fraden 3. Sensors and Signal Conditioning, Ramon Pallas-Areny and John G. Webster 4. Capacitive Sensors, Larry Baxtor 5. Electronic Distance Measurement, J.M. Rueger 6. http://www.sensorsportal.com/ 7. http://www.sensorsmag.com/

Course Title	**Biomedical Instrumentation**				
Course Code	**MENIC102T**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**-**	**4**	
Prerequisites	**Electrical and Electronic Instrumentations**				
Course objectives	**This course will enable students-** • To learn about latest biomedical instruments available in industry • To learn about signal conditioning and its process • To demonstrate an understanding of biomedical instruments for diagnostic measurements • To learn about Cardiac instruments and other advanced topic which covers safety aspects and current developments of medical electronics				
Course Contents	**UNIT-I** Introduction: Brief introduction to human physiology, Basic components of bio-medical instruments, bioelectric signals and recording electrodes, Biomedical Transducers: displacement, velocity, force, acceleration, flow, temperature, potential, dissolved ions and gases **UNIT-II** Bio-Potentials and Their Measurement: EEG, ECG, EMG, EOG and their nature. Bio-electrodes and Biopotential Amplifiers. **UNIT-III** Cardiac Instrumentation – Measurement of blood pressure, blood flow, stroke volume, Impedance Plethysmography, Cardiac output, heart sound etc. Instrumentation for respiratory and nervous systems. **UNIT-IV** Non-invasive Diagnostic Measurements: Temperature measurements, X-ray diagnosis, Ultrasonic and Nuclear Medical Imaging Systems, Digital Radiographic Equipment, Prostheses and aids: Pacemakers, Defibrillators, Heart-Lung Machine, Lithotripters, artificial kidney, Anesthesia Machine, Ventilators, Radiotherapy Equipment, Automated Drug Delivery System, aids for the handicapped.				

	UNIT – V Advanced Topics in Medical Electronics: Safety aspects. Recent advances in Bio-Medical Instrumentation, Microprocessor based systems, Laser and optical fiber systems.
Course outcomes	**At the end of this course students will be able to-** • know basic components and terminologies of medical instruments • understand biomedical transducers • understand construction, working principle and application of cardiac instruments • understand construction and working of various non-invasive diagnostic measurements.
Text Books	1. Biomedical Instrumentation & Measurement, L. Cromwell, F.J. Weibell and E.A. Pfeiffer, 2nd Ed., PHI 2. Handbook of Biomedical Instrumentation, R.S. Khandpur, Tata McGraw Hill Pub. Co.
Reference Books	1. Electronics in Medicine and Biomedical Instrumentation, Nandini K. Jog, Prentice Hall [I] 2. Biomedical Instrumentation, Dr. A. Arumugam, Anuradha Agencies, Chennai. 3. Introduction to Biomedical Engineering, Domach, Pearson Education 4. Principles of Medical Electronics & Biomedical Instrumentation, C Raja Rao & S.K Guha, University Press. 5. Handbook of Medical Electronics, J.G. Webster Further Reading: 1. IEEE Transactions on Medical Electronics

<table>
<tr><td>Course Title</td><td colspan="5">Digital Measurement Techniques</td></tr>
<tr><td>Course Code</td><td colspan="5">MENIC103T</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>3</td><td>1</td><td>-</td><td>4</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">Digital Electronics</td></tr>
<tr><td>Course objectives</td><td colspan="5">This course will enable students-
to understand fundamental of digital measurement
to understand different digital frequency measurement methods
to know about PLC, its different units and ladder diagram.
to understand the data acquisition system, signal conditioning and single and multichannel DAS.</td></tr>
<tr><td>Course Contents</td><td colspan="5">UNIT – I
DIGITAL TIME MEASUREMENT: Introduction, measurement of time between two events, error in time interval, Vernier techniques, measurement of periodic time, phase measurement, capacitance measurement, quality factor measurement.

UNIT – II
DIGITAL FREQUENCY MEASUREMENT: Introduction, basics of frequency measurement, measurement of ratio of two frequency, product of two frequency measurement, high frequency measurement, low frequency measurement, low frequency measurement in a narrow band.

UNIT – III
PROGRAMMABLE LOGIC CONTROLLER: Introduction to PLC, input and output system of PLC, processor unit of PLC, memory types used in the PLC, understanding of PLC using ladder diagram, implementation of logic gates using PLC’s</td></tr>
</table>

	UNIT – IV DISCRETE STATE PROCESS CONTROL & MEASUREMENT: Basics of discrete state process control, characteristic of the systems, relay controllers and ladder diagrams, Design of process control using PLC's **UNIT – V** DATA AQUISITION SYSTEM: Microprocessor based data acquisition system; Signal conditioning, single channel data acquisition system, multi-channel data acquisition system, and data conversion using ADC and DAC in data acquisition system.
Course outcomes	**At the end of this course student will be able to:** • understand and working of digital time measurement and its application in different aspects. • know about digital frequency measurement, its concept and various methods to measure it. • know working of PLG and students will able to design ladder diagram for industries • know applicability of DAS system in industries.
Text Books	1. Digital Measurement Techniques: T.S. Rathore, Narosa Publishing House 2. Process Control: Curtis Johnson, Prentice Hall
Reference Books	1. Instruments in Systems: Coombs 2. Digital Instrumentation, Bouwnes, Tata McGraw Hill Book Pub. Co. Further Reading: 1. Advanced Practical Process Control, Brian Roffel

Course Title	**Control System Design**				
Course Code	**MENIC104T**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**-**	**4**	
Prerequisites	**Control System and fundamental of controller**				
Course objectives	**This course will enable students-** • to know about basic terminologies, fundamentals and paramenter of control system design • to conceptualize the SISO control design and advanced SISO control • to conceptualize the MIMO control and advanced MIMO control				
Course Contents	**UNIT– I** SISO Control Fundamentals: Feedback, Modeling, Continuous-Time Signals and Systems. SISO Control Essentials, Analysis of SISO Control Loops, Classical PID Control, Synthesis of SISO Controllers. **UNIT-II** SISO Control Design: Fundamental Limitations in SISO Control, Frequency-Domain Design Limitations, Architectural Issues in SISO Control, Dealing with Constraints. Digital Computer Control, Models for Sampled-Data Systems, Digital Control, Hybrid Control. **UNIT-III** Advanced SISO Control: SISO Controller Parameterizations, Control Design Based on Optimization, Linear State Space Models, Synthesis via State Space Methods, Introduction to Nonlinear Control.				

	UNIT-IV MIMO Control Essentials: Analysis of MIMO Control Loops, Exploiting SISO Techniques in MIMO Control. MIMO Control Design, Design via Optimal Control Techniques, Model Predictive Control, Fundamental Limitations in MIMO Control. **UNIT-V** Advanced MIMO Control: MIMO Controller Parameterizations, Decoupling, Field Applications.
Course outcomes	**At the end of this course students will be able to-** • understand SISO control fundamentals and its analysis • modeling of SISO control design and parameterization of advanced SISO control • design of MIMO control and understand essentials of MIMO control
Text Books	1. Control System Design, Graham C. Goodwin, Stefan F. Graebe, Mario E. Salgado; Pearson Ed.
Reference Books	1. Numerical Methods for Linear Control Systems & Analysis, Biswa Datta 2. Advanced Practical Process Control, Brian Roffel Further Reading: 1. The Control Handbook, William S. Levine

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<tr><td>Course Title</td><td colspan="5">Industrial Transducers & Sensors</td></tr>
<tr><td>Course Code</td><td colspan="5">MENIC101P</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>-</td><td>-</td><td>2</td><td>1</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">Instrumentations and Control</td></tr>
<tr><td>Course objectives</td><td colspan="5">This course will enable students-
• To know the objective of this course is to make students to learn principlesand characteristics of different types of transducers
• To design measuring circuit by using transducers</td></tr>
<tr><td>Course Contents</td><td colspan="5">LIST OF EXPERIMENTS
List of Experiments based on syllabus:
1. Measurement of linear displacement using linear variable differential transformer (LVDT)
2. Measurement of displacement using light dependent resistor (LDR)
3. Measurement of speed of motor shaft with the help of non-contact type of pickup.
4. Variable reluctance tachometer
5. Photo electric pickup and also plot the graphs and percentage error from
6. To study the characteristics of filament lamp
7. To study the characteristics of photovoltaic cell
8. To study the characteristics of photoconductive cell
9. To study the characteristics of photo-transistor
10. To study the characteristics of optically controlled switching system
11. To study the characteristics of IC temperature sensor (LM 335)
12. To study the characteristics of NTC bridge circuit
13. To study that the thermistor is one of the feedback resistances in a non-inverting op-amp circuit
14. To demonstrate how a standard diode can be used as a thermoresistive or thermoelectric device.
15. To demonstrate the use of a general-purpose transistor as a temperature sensor. 16. To study the LVDT characteristics.
16. To study LDR as part of a voltage divider.</td></tr>
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Course outcomes	**At the end of this course students will be able to-** 1. plot characteristics of different types of transducers. through which, working of transducers can be understood. 2. Analyze the circuit of measuring instruments

Course Title	**Control System Design Lab**				
Course Code	**MENIC104P**				
Course Credits	**L**	**T**	**P**	**TC**	
	-	**-**	**2**	**1**	
Prerequisites	**Control System design**				
Course objectives	**This course will enable students-** • to design the practical loop for various control				
Course Contents	**LIST OF EXPERIMENTS** 1. Synthesize a typical SISO control loop. 2. Design a practical loop for Classical PID control. 3. Design a practical loop for Digital Computer Control. 4. Design a practical Sampled-Data System. 5. Design a practical loop for Digital Control. 6. Design a practical loop for Hybrid Control. 7. Design a practical loop for Advanced SISO Control 8. Design a practical loop for control using Optimization Based Design. 9. Design a practical loop for Nonlinear Control. 10. Design a practical loop for MIMO Control. 11. Design a practical loop for SISO Techniques in MIMO Control. 12. Design a practical loop for MIMO Control Design via Optimal Control Techniques. 13. Design a practical loop for Model Predictive Control. 14. Design a practical loop for Advanced MIMO Control. 15. Design a practical loop for decoupling in Advanced MIMO Control.				
Course outcomes	**At the end of this course students will be able to-** 1. Achieve Knowledge of programming development and experimentalskills in 8051 microcontrollers. 2. Develop their logics and programming skills of microcontroller				

Elective-I

Course Title	**System Optimization**				
Course Code	**MENIC105TA**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**-**	**4**	
Prerequisites	**Applied Mathematics**				
Course objectives	**This course will enable students-** • To understand basic concept of optimization, classification • To understand the minimization technique • To understand various optimization methods and its mathematical modeling. • to get to know application of optimization methodologies in engineering				
Course Contents	**UNIT–I** Basics of Optimization: Need for optimization and historical development. Classification and formulation of optimization problem, classical optimization methods: Differential calculus. Lagrangian theory, Kuhn Tucker conditions. **UNIT-II** Unconstrained minimization techniques: one-dimensional minimization; Fibonacci, Golden section and quadratic interpolation methods. **UNIT-III** Multi-dimensional minimization: Univariate, conjugate direction, gradient and variable metric methods. Constrained minimization techniques. **UNIT-IV** Methods of Optimization: Penalty function methods, feasible direction and gradient projection method. Introduction to geometric programming. Linear programming and simplex method.				

	UNIT-V Applications of Optimization methods: Examples and applications of the above methods in the recent engineering design literature.
Course outcomes	**At the end of this course students will be able to-** • know fundamental of optimization, its methods and application in engineering.
Text Books	1. Optimization - Theory and Applications, S.S.Rao, Wiley Eastern Ltd., 1978 2. Optimization Methods for Engineering Design, R.L. Box, Addison Wesley,
Reference Books	1. Encyclopedia of Optimization, C.A. Floudas, Panos M. Pardalos; Kluwer Academic Pub 2. Instrument Engineers' Handbook, Fourth Edition, Volume Two: Process Control and Optimization, Béla G. Lipták Further Reading: 1. Parallel Processing of Discrete Optimization Problems: Dimacs Workshop April 28-29, 1994, Panos M. Pardalos, Mauricio G. C. Resende, K.G. Ramakrishnan 2. Optimization and Industry: New Frontiers, Panos M. Pardalos; Kluwer Academic Pub

Elective-I

Course Title	**Reliability Engineering**				
Course Code	**MENIC105TB**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**-**	**4**	
Prerequisites	**Applied Mathematics**				
Course objectives	**This course will enable students-** • to know basics of Reliability and reliability functions . • to know different reliability models and system • to know failure preparedness and				
Course Contents	**UNIT-I** Basics of reliability: Mathematics of Reliability, Reliability function, Models of failure. Failure data Analysis, System reliability. **UNIT-II** Reliability models and systems: Basic Reliability Models, Covariate Models, Hazard Rate Functions including Exponential, Weibull, Normal and Lognormal, System Reliability including redundant, standby and load sharing systems, **UNIT-III** Reliability and failure: Failure mode, effect and criticality analysis, fault tree analysis, reliability and maintainability design methods based on availability and life cycle costs, Preventive maintenance **UNIT-IV** Failure preparedness: Spares Provisioning Models, Renewal and Minimal Repair Models, treatment of censored data, reliability growth testing, Probability Tests and curve fitting, Maintaining likelihood estimation and goodness of fitness tests, Series configuration. Parallel configuration r-out-of-n structure.				

	UNIT-V Improvement and checks: Reliability improvement. Redundancy. Reliability allocation. Reliability testing.
Course Outcome	**At the end of this course students will be able to-** • understand concept of probability, concept, theory and models. • know failure preparedness and reliability improvement.
Text Books	1. An Introduction to Reliability and Maintainability Engineering - Ebeling; Tata McGraw Hill **2.** Probabilistic Reliability - An Engineering Approach, M.L. Shooman, McGraw-Hill Publ
Reference Books	1. Fault-Diagnosis Systems: An Introduction from Fault Detection to Fault Tolerance, Rolf Isermann 2. Engineering Design Reliability Handbook, Boca Raton; CRC Press Further Reading: 1. Encyclopedia and Handbook of Process Capability Indices: A Comprehensive Exposition of Quality Control Measures, W. L. Pearn

Elective-I

Course Title	**Robotics & Computer Vision**				
Course Code	**MENIC105TC**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**-**	**4**	
Prerequisites	**Fundamental of Mechanics, Instrumentation**				
Course objectives	**This course will enable students-** • To give knowledge of basics of Robotics • To give knowledge of Dynamics and kinematics • To give knowledge of Application of sensor in robotics • To give knowledge of Automation				
Course Contents	**UNIT-I** Basic concepts: Robotics concepts and problems, Robot Kinematics: Position Analysis, The Arm Equation **UNIT-II** Robo-Kinematics: Direct Kinematics, Inverse Kinematics, Forces, Moments, Euler's Laws, Workspace Analysis. **UNIT-III** Robo-Dynamics: Differential Motion and Velocities, Manipulator Dynamics, Dynamic Analysis and forces, Trajectory Planning and control. **UNIT-IV** Robo-Automation: Sensors and instrumentation in robotics, Actuators and power transmission, Sensors. **UNIT-V** Vision and Intelligence: Image Processing and Analysis with Vision Systems, Fuzzy Logic Control.				

Course Outcome	**At the end of this course students will be able to-** • get knowledge of fundamentals of robotics • applicability of sensors in robotics • image processing and analysis with vision system in robotics model
Text Books	1. Introduction to Robotics, Saeed B. Niku; Prentice Hall 2. Fundamentals of Robotics: Analysis and Control, Robert J. Schilling; PHI
Reference Books	1. Analytical Robotics and Mechatronics, Wolfram Stadler; McGraw Hill 2. Computer Vision, David A. Forsyth, Jean Ponce; Prentice Hall 3. Robotics - Control, Sensing, Vision & Intelligence, K.S. Fu, C.S.G. Lee, Ralph Gonzales; McGraw Hill 4. Understanding Electromechanical Engineering: An Introduction to Mechatronics, Lawrence J. Kamm; Prentice Hall Further Reading: 1. http://www.cs.indiana.edu/robotics/world.html 2. Robotics : A Bibliography with Indexes, Peter J. Benne 3. Sensors for Mobile Robots, H.R. Everett 4. Intelligent Sensor Systems, John Brignell & Neil White