Karmaveer Bhaurao Patil University, Satara

Syllabus for

B.Sc. I Instrumentation Science

Under

Faculty of Science and Technology

(As per NEP 2020)

With effect from Academic Year 2024-2025

Department of Instrumentation Science

Preamble: This syllabus is prepared for first year undergraduate students. At this level, to develop their interest towards Instrumentation techniques in science and also to prepare them for the academic, industrial exposure for global achievements. Introduction of instrumental techniques with the regular exercises will help to enhance analytical thinking of the students. The interdisciplinary approach with vigor and depth is compatible to the syllabi of other universities, at the same time is not rigid for the students at first year of their graduation.

General Objectives of the Program:

1. To develop the content of the syllabus according to the UGC norms.
2. To inculcate fundamental principle of Instrumentation in students.
3. Toestablishthelinkbetweentheoryandlaboratorypracticebyconductinglaboratoryexperiments which help students to improve the understanding of the concepts.
4. To enhance student's sense of enthusiasm for different instrumentsandtoinvolvetheminanintellectuallystimulatingexperienceoflearninginasupportive environment.

Program Outcomes:

1. Understand the theoretical and practical aspects of signal processing, sensor technology, and data acquisition systems.
2. Enhance the ability to analyze data from instruments and measurement systems to troubleshoot and solve engineering problems.
3. Learn to use software tools and programming languages relevant to instrumentation and control systems.
4. Develop the ability to adapt to new technologies and methodologies in the field

Program Specific Objectives:

1. Develop students' abilities to design and implement control systems.
2. Equip students with comprehensive knowledge of instrumentation principles and applications.
3. Encourage students to undertake research projects that address real-world challenges.
4. Train students in advanced data analysis and interpretation techniques.

Program Specific Outcomes: After completing this courses students shall be expert in following things:

1. Students will possess the skills to create and manage automated control systems, improving efficiency and precision in industrial processes.
2. Graduates will have a deep understanding of fundamental instrumentation concepts and their practical applications in various fields, such as manufacturing, healthcare, and environmental monitoring.
3. Students will be able to conduct independent research, contributing innovative solutions to contemporary problems in instrumentation science.

1. **Title: Instrumentation Science**
2. **Year of Implementation: The syllabus will be implemented from June, 2024 onwards.**

3. **Duration: The course shall be a full time.**
4. **Pattern: Semester examination.**
5. **Medium of Instruction: English.**

Structure of Course:

B.Sc. Sem - I (Instrumentation Science)

Sr. no.	Course Title	Theory			Practical		
		Course Code	Lectures Per week	Credits	Course Code	Lectures Per week	Credits
1.	Fundamental of Instrumentation	BIST 111	4	2	Practical Course I:BISP 113	4	2
2.	Applications of Instrumentation	BIST 112		2			

B.Sc. Sem - II (Instrumentation Sciences)

Sr. no.	Course Title	Theory			Practical		
		Course Code	Lectures Per week	Credits	Course Code	Lectures Per week	Credits
1.	Instrumentation for Electronics	BIST 121	4	2	Practical Course II:BISP 123	4	2
2.	Instrumentation for Physics and Chemistry	BIST 122		2			

Note: B: B. Sc. T=Theory and P= Practical

	B.Sc. I **Semester I**	
Credits 2	**Course I: Fundamental of Instrumentation** **Course Code: BIST111**	**Lectures 30Hrs.**
	Course Objectives: Students should be able to… Course Objectives: Student should be able to… 1. Provide comprehensive knowledge related to instrumentation 2. Provide conceptual understanding related to Signal Conditioning and Data Acquisition System. 3. Provide basic knowledge about circuit concepts 4. Understanding the analysis of circuit concepts	
Unit No.	**Fundamental of Instrumentation**	**Lectures Allotted**
I	**Instrumentation** • Overview of Instrumentation: Definition and purpose of instrumentation, functional elements of instruments, Instruments classification. • Measurement Process: Methods of measurements, performance characteristics, Static characteristics, Dynamic characteristics, Error in measurement, Types of Static Error, Sources of Error, Statistical Analysis, Standards, Electrical Standards. • Concept of Concept of single phase and three phase Power supply	**08**
II	**Signal Conditioning System** • Signal conditioning: Introduction to Signal conditioning, types of signal conditioning, signal conditioning elements, signal conditioning blocks, signal conditioning techniques. • Data Acquisition: Introduction to data acquisition, Types, Applications, Data Collection Methods, Data Acquisition Process, Data Storage and Analysis, applications.	**08**

III	**Circuit Concepts** • Voltage and Current Sources, Resistors: Fixed and Variable resistors, • Construction, Characteristics & color coding of resistors, resistors in series and parallel, • applications of resistors. Inductors: Fixed and Variable inductors, Self and mutual inductance, • Inductance in series and parallel, Faraday"s law and Lenz"s law of electromagnetic induction, • Energy stored in an inductor. Capacitors: Working Principles of capacitance, Permittivity, • Dielectric Constant, Dielectric strength, types of Capacitor, Construction, Characteristics and • coding of capacitors, application of capacitors, capacitors in series and parallel, factors	**08**
IV	**Circuit Analysis** • Ohms Law, Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law • (KVL), Node Analysis, Mesh Analysis, star-delta conversion & delta-star conversion. • Network Theorem (DC Circuits): Principal of Duality, Superposition Theorem, Thevenin's Theorem, • Norton's Theorem, Reciprocity Theorem, Millman's Theorem, Maximum Power Transfer Theorem.	**06**

Course Outcomes: After completion of the course students will be able to…

1. Identify performance characteristics and evaluate sources of error in measurement.
2. To study the roles of Signal Conditioning and Data Acquisition System
3. Design the role of circuit concepts
4. Explain the analysis of circuit concepts

References:

1. H. S. Kalsi, 2018, Electronic Instrumentation, McGraw-Hill Education
2. Uday A. Bakshi, Late Ajay V. Bakshi, 2020, Electronic Measurements and Instrumentation, Technical Publication.
3. Norman A. Anderson, 2019, Instrumentation for Process Measurement and Control by, CRC Press, 4th Edition.
4. Robert L. Boylestad, Essentials of Circuit Analysis, Pearson Education (2004).
5. W. H. Hayt, J. E. Kemmerly, S. M. Durbin, Engineering Circuit Analysis, Tata McGraw Hill

Credits 2	Paper II: Applications of Instrumentation Course Code: BIST –112	Lectures30Hrs.
	Course Objectives: Students should be able to… 1. Provide a comprehensive understanding of the various types of analogue measuring instruments and their uses. 2. Familiarize learners with working principles and application areas of digital measuring instruments. 3.Understand the basic concepts associated with waveform generators. 4. Gain experience in the use of various special instruments and their capabilities.	
Unit No.	**Title and Syllabus**	**Lectures Allotted**
I	**Displacement and Speed Measurement** • Displacement Measurement: - a) Resistive Type: Linear and Angular (Rotary) Potentiometer, Strain Gauge: Bonded and Unbonded b) Inductive Type: Self inductive: Variable number of turns, Variable Reluctance Mutual Inductive: LVDT c) Piezoelectric Type: Quartz Crystal • Speed Measurement:- Tachometer, Stroboscope, Shaft speed Measurement	**07**
II	**Instrumentation for Spectroscopy:** • Introduction Classification of analytical methods Instrumental methods • Basics of selecting a method the “schematic instrument” • Introduction to Spectroscopy: Electromagnetic radiation Quantum • mechanical considerations Absorption and emission Diffraction, • dispersion, refraction, reflection. • Instrumentation for Spectroscopy: Sources Monochromators Sampling Detectors Signal processing.	**07**
III	**Electroanalytical Chemistry** • Electrochemical cells Electrode and Cell potentials and equilibrium considerations Reference and indicating electrodes Electrochemical current Electrochemical methods • **Potentiometry:** Direct and indirect potentiometric determinations Sources of electrochemical potential • **pH meter**: Introduction and applications • **Conductometry:** Introduction and applications	**08**

IV	**Special Instruments** • (Basic principle, design and working with suitable block/ circuit diagrams, applications, advantages and disadvantages) • Spectrum Analyzers • Frequency Synthesizers • Digital tachometer • Digital watt meter • Digital Capacitance meter	**06**

Course Outcomes: After completion of the course students will be able to…

1. Identify the various types of analogue measuring instruments and their uses
2. Describe the common applications and identify the working principles of digital measuring instruments
3. Identify different types of waveform generated by a waveform generator and their characteristics.
4. Apply appropriate instrument setup procedures, techniques and capabilities. for Special Instruments.

References:

1. H. S. Kalsi, 2018, Electronic Instrumentation, McGraw-Hill Education
2. Uday A. Bakshi, Late Ajay V. Bakshi , 2020, Electronic Measurements and Instrumentation, Technical Publication.
3. Norman A. Anderson, 2019, Instrumentation for Process Measurement and Control by, CRC Press, 4th Edition.
4. M.R. Welbourne& J.C. Ellis, 2001, Nonlinear Measurement and Instrumentation, Wiley.
5. A. E. Azevedo, 2010, Electronic Instrument Design: Wiley.
6. Anderson, 2019, An Introduction to Special Instruments, Oxford Publication.

Credits 2	**Practical Course Lab-I BISP–113 Signal Conditioning, Electronic Measurement and Instrumentation Techniques**	**Hours 60 Hr**
	Course Objectives: Students should be able to… 1. Understand and relate concepts learned in classroom to the real-world situations. 2. Study of scientific, analytical skills about modern instruments and tools 3. Familiar with the various protocols and standards used in signal conditioning and digital instruments. 4. Design and implement a working signal conditioning and instrumentation system	

	Signal Conditioning, Electronic Measurement and Instrumentation Techniques	Hours Allotted
	1. Study of Resistor Color Code System. 2. Study and Identification of Electronics Component for instrumentation 3. Study of Norton's theorem. 4. Study of Thevenin's theorem 5. Study of Superposition theorem 6. Study of Kirchhoff's Current law 7. Study of Kirchhoff's Voltage law 8. Study of Potentiometer 9. Study of Voltage follower 10. Study of Precision rectifier 11. Study and use of CRO- I : AC Voltage and frequency measurement 12. Study and use of CRO- II : DC Voltage and Phase measurement 13. Study of low pass filter 14. Study of high pass filter 15. To verify Lambert's beers law using Spectro photometer. 16. Study of Electro deposition method 17. Study of pH meter. 18. Study of 5V Regulated Power supply. 19. Study of function Generator 20. Study of Digital Multimeter	

Course Outcomes: After completion of the experiments students will be able to…

1. describe and Explain Characteristics of signal conditioning and Electronics instruments.
2. utilize various instruments and extend their analytical abilities with exposure to learn and use modern instruments and tools.
3. understanding of the operational principles of signal conditioning and instrumentation
4. ability to identify the necessary components for a signal conditioning and instrumentation system

References:

1. H. S. Kalsi, 2018, Electronic Instrumentation, McGraw-Hill Education
2. Uday A. Bakshi, Late Ajay V. Bakshi, 2020, Electronic Measurements and Instrumentation, Technical Publication.
3. Norman A. Anderson, 2019, Instrumentation for Process Measurement and Control by, CRC Press, 4th Edition.
4. M.R. Welbourne& J.C. Ellis, 2001,Nonlinear Measurement and Instrumentation, Wiley.
5. A. E. Azevedo, 2010, Electronic Instrument Design: Wiley.

B.Sc.I Part I, Semester II		
Credits 2	**Fundamental Instrumentation for Physics** **Course Code: BIST 121**	**Lectures 30Hrs.**

	Course Objectives: Students should be able to… 1. Develop an intuitive understanding different measuring parameters by emphasizing the physics. 2. Introduce fundamental aspects of fluid flow behavior. 3. Provide the students a thorough understanding of the temperature measurement.. 4. Impart the knowledge applied optics through LASER and fiber optics.	
Unit No.	**Fundamental Instrumentation for Physics**	**Lectures Allotted**
I	**Weight Measurement** • Electrical Weighting Matchine: Importance in quantitative analysis, Components, Working principle and operation, calibration and standardization, accuracy and precision in weight measurement • Introduction to measurement unit and conversions • Refractometry: Principle and applications, components, working principle and operation	**07**
II	**Pressure and Flow Measurement** • Pressure Measurement: - Concept of Pressure, Units and their relations, barometer, monometer and their types, Concept of vacuum, High pressure gauges, vacuum gauges. • Flow Measurement:- Concept of Surface tension and viscosity, Newtonian and non –Newtonian fluids, Reynolds's number , laminar and turbulent flow, velocity profile (flow of liquid through capillary tube), Bernoulli's principle and its applications (orifice, venturimeter, pitot's tube)	**08**
III	**Temperature Measurement** • Temperature scales, units and their relations • Liquid filled thermometer and bimetallic thermometer • Platinum Resistance Thermometer • Resistance temperature detectors (RTD) and their types • Thermistors (PTC and NTC with characteristics) • Thermocouples (Seebeck effect and Peltier effect) • Pyrometers, Temperature IC sensors.	**07**

IV	**Laser, Fiber Optics Fundamental and Measurements** • Lasers, Spontaneous and Stimulated emissions, Lasing action, Characteristics of Laser, Determination of wavelength of laser, Applications of laser. • Fundamentals of fiber optics (Numerical aperture and acceptance angle) • Fiber optic communication system • optical time domain reflectometer (OTDR), time and frequency domain dispersion measurement.	**08**

Course Outcomes: After completion of the course students will be able to…

1. gain in depth knowledge about basic concepts of different measuring parameters such as displacement, pressure, temperature etc.
2. explain the dynamics of fluid flow with the help of Bernoulli's Equation.
3. distinguished between NTC and PTC by studying their characteristics.
4. describe the applied optics through LASER and fiber optics.

References:

1. Rangan, Mani and Sarma, Instrumentation Device and System (Madison: University of Wisconsin, Tata McGraw Hill Publication,1983)
2. Nakra, Choudhari, Instrumentation Measurement and Analysis (New Delhi: Tata McGraw Hill India Publication,2009)
3. D.Patranabis, Sensors and Transducers (New Delhi : Prentice Hall of India Publications,2005)
4. AnuradhaDe,Optical Fibers and Laser:-Principles and Applications,(New Delhi: New age International,2003)

B.Sc.I Part I, Semester II		
Credits2	**Course II: Fundamental of Instrumentation for Electronics** **Course Code: BIST –122**	**Lectures 30Hrs.**
	Course Objectives: Students should be able to… 1. Provide a comprehensive understanding of the various types of analogue measuring instruments and their uses. 2. Familiarise learners with working principles and application areas of digital measuring instruments. 3.Understand the basic concepts associated with waveform generators. 4. Gain experience in the use of various special instruments and their capabilities.	

Unit No.	Fundamental of Instrumentation for Electronics	Lectures Allotted
I	**Analog Measuring Instruments** • Introduction, Classification, essential requirements(Basic principle, design and working with suitable block/ circuit diagrams, applications, advantages and disadvantages) • Permanent magnet moving coil instrument • Moving iron instrument • Multirange voltmeters and Ammeters • Electronic voltmeters and ohm meter • Cathode ray oscilloscope • Analogue frequency and Phase meter	**07**
II	**Digital Measuring Instruments** • Introduction, Classification, essential requirements (Basic principle, design and working with suitable block/ circuit diagrams, applications, advantages and disadvantages) • Digital frequency meter. • Digital voltmeter. • Digital multimeters. • Digital phase meter. • Digital storage oscilloscope	**08**
III	**Waveform Generators** • Introduction, Classification, essential requirements (Basic principle, design and • working with suitable block/circuit diagrams, applications, advantages and disadvantages) • A.F. Sine/Square wave Generator. • R.F. Signal Generator. • Standard signal Generator. • Function Generator.	**07**
IV	**Shaking and Vacuum Equipment** • Rotary Shakers: Introduction, Importance, working, types and applications, common issues and their solutions • Vacuum pumps: Principle of creating a vacuum, key components and types, safety • Gel system: Definition and types of gels, importance, Basic principles, Structure and properties of gels	**08**

Course Outcomes: After completion of the course students will be able to…

1. Identify the various types of analogue measuring instruments and their uses
2. Describe the common applications and identify the working principles of digital measuring instruments
3. Identify different types of waveform generated by a waveform generator and their characteristics.

4. Apply appropriate instrument setup procedures, techniques and capabilities for Special Instruments.

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1. H. S. Kalsi, 2018, Electronic Instrumentation, McGraw-Hill Education
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3. Norman A. Anderson, 2019, Instrumentation for Process Measurement and Control by, CRCPress, 4th Edition.
4. M.R. Welbourne& J.C. Ellis, 2001, Nonlinear Measurement and Instrumentation, Wiley.
5. A. E. Azevedo, 2010, Electronic Instrument Design: Wiley.

Credits 2	**Practical Course Lab II** **BISP–123** **Fundamental Instrumentation for Physics and Fundamental of Instrumentation for Electronics**
	Course Objectives: Students should be able to… 1. Understand Basic Measurement Principles: Students will grasp the fundamental principles of measurement, including accuracy, precision, and calibration, as applied to physical quantities. 2. Operate Standard Physics Instruments: Students will gain hands-on experience with common physics instruments, such as oscilloscopes, spectrometers, and particle detectors. 3. Analyze Experimental Data: Students will learn to analyze data obtained from physical measurements, including error analysis and statistical methods.
	Fundamental Instrumentation for Physics and Fundamental of Instrumentation for Electronics
	1. Study of Astable multivibrator using IC 555. 2. Study of Monostable multivibrator using IC 555. 3. Study of Cathode ray Oscilloscope with their waveforms. 4. Study of Function Generator. 5. Study of Bistable multivibrator using IC 555. 6. Study of AND gate with truth table. 7. Study of OR gate with truth table. 8. Study of NOT gate with truth table 9. Study of NAND gate with truth table. 10. Study of NOR gate with truth table.

	11. Study of Function Generator. 12. Study of LCR meter. 13. Study and Design 5V regulated power supply. 14. Study of Colorimeter. 15. Study of LASER beam diameter. 16. Study of Square Wave Generator. 17. Study of Analogue frequency and Phase meter 18. Study of Sedimentation process. 19. Study of RF Signal Generator. 20. Study of RTD(Resistance Temperature Detector.

Course Outcomes:

After completion of the experiments students will be able to…

1. Students can accurately describe and apply measurement techniques for quantities such as length, mass, time, and temperature, ensuring proper calibration of instruments.
2. Students demonstrate the ability to correctly set up and use these instruments to conduct experiments and gather data effectively.
3. Students are able to interpret experimental data, apply error analysis techniques, and present results in a clear and scientifically accurate manner.

Reference Books:

1. Experimental Methods for Scientists by C. P. Kothari
2. Instrumentation and Measurement in Electrical Engineering by James W. Nilsson and Susan Riedel
3. Introduction to Instrumentation and Measurements by Robert B. Northrop