Rayat Shikshan Sanstha's

Yashavantrao Chavan Institute of Science,Satara (Autonomous)

(Lead college of Karmaveer Bhaurao Patil University,Satara)

Bachelor of Science

Part - II

INSTRUMENTATION

Syllabus

to be implemented w .e. f. June, 2024,

NEP 2020

Minor Syllabus

Course Structure for B. Sc II (Semester III)

Theory				Practical				
Course Title	**Course Code**	**Lecture per week**	**Credits**	**Course**	**Course Title**	**Course Code**	**Lecture per week**	**Credits**
Fundamentals and Applications of Sensors, Transducers, and Operational Amplifiers	**BIST 235**	**2**	**2**	**Practical I**	**Minor Practical I**	**BISPP 236**	**2**	**2**

Structure and Title of Courses of B. Sc. Course:

*** B. Sc. II Semester III ***

Course Number	Course Code	Course Name
V	BIST 235	Fundamentals and Applications of Sensors, Transducers, and Operational Amplifiers
Lab I	BISP 236	Minor Practical III**: Practical Applications in Sensors, Transducers, and Amplifiers (Hardware Lab)**

Semester III

BIST235: Fundamentals and Applications of Sensors, Transducers, and Operational Amplifier

Course Objectives: Student will able to…

1 Understand the fundamental principles and applications of sensors and transducers.

2 Analyze advanced technologies and applications of temperature, pressure, and optical transducers.

3 Study the basics of operational amplifiers and their configurations.

4 Explore advanced applications of operational amplifiers in Instrumentation.

Credits (Total Credits 2)	SEMESTER-III BIST 235 Fundamentals and Applications of Sensors, Transducers, and Operational Amplifiers	No. of hours per unit/credits 30
UNIT - I	**Introduction to Sensors and Transducers**	08
	• Definition of sensors and transducers, Difference between sensors and transducers, Overview of measurement systems and the role of transducers • Types of transducers based on physical quantities, Key characteristics of transducers, Factors influencing transducers performance (environmental conditions, calibration, aging) • Exploration of common transducers technologies: Resistive transducers (thermistors, strain gauges), Capacitive transducers (pressure sensors, humidity sensors), Inductive transducers (proximity sensors, position sensors), Optical transducers (photodiodes, phototransistors, fiber optics) • Transducers Applications and Selection: Real-world applications of sensors in various industries, Automotive, Healthcare, Manufacturing • Factors to consider when selecting transducersfor specific	

	applications	
UNIT - II	**Transducer Technologies and Applications**	08
	• Detailed study of temperature transducers: thermocouples, RTDs, thermistors. • Detail study of pressure transducers: piezoelectric, capacitive, strain gauge. • Exploration of optical transducers: photodiodes, phototransistors, fiber optics. • Case studies on transducer applications in industries such as automotive, healthcare, and manufacturing.	
UNIT - III	**Introduction to Operational Amplifiers**	07
	• Basics of Operational Amplifiers: Definition and characteristics of op-amps, Ideal vs. practical op-amp properties, Op-amp symbol, pin configuration. • Op-Amp Configurations: Inverting and non-inverting amplifier configurations, Buffer amplifier circuit (theory, analysis, and applications) • Op-Amp Circuits: Summing amplifier and difference amplifier Integrator and differentiator circuits ((theory, analysis, and applications))	
UNIT - IV	**Application of Op-Amps**	07
	• Oscillator circuits: Wien bridge oscillator, phase-shift oscillator • Op- amp as: an astable multivibrator, monostable multivibrator, bistable multivibrator,Schmitt Trigger • Active filters: Introduction, Classification of filters, Concept of passive and active filters, Qualitative study: low-pass, high-pass, band-pass, and band-stop filters • Three op amp Instrumentation amplifier(Circuit diagram, operation, advantages& application),	

Course Outcomes: The students should be able to…

1 Define and identify key characteristics of sensors and transducers

2 Analyze case studies on sensor applications in automotive, healthcare, and manufacturing sectors.

3 Apply the theory and applications op-amp configuration and circuits

4 Explain the architecture, operation, advantages, and applications operational amplifiers in Instrumentation.

Reference Books:

1) Alciatore, David G., and Michael B. Histand. Introduction to Mechatronics and Measurement Systems. 5th ed., McGraw-Hill Education, 2018.
2) Barrett, Steven F. Principles of Engineering Measurement. 4th ed., Pearson, 2016.
3) Campbell, Joe. Sensor Technology Handbook. Elsevier, 2005.
4) Jones, David J. Measurement and Instrumentation: Theory and Application. Butterworth-Heinemann, 2015.
5) Johnson, Scott A. Op Amps for Everyone. 4th ed., Newnes, 2019.
6) Manoli, Yiannos. Analog Design Essentials. Springer, 2006.
7) Ramakant A. Gayakwad. Op-Amps and Linear Integrated Circuits. 6th ed., Prentice Hall, 2002.
8) Riaz, M. N., and Patrick F. Dunn. Sensors: An Introductory Course. CRC Press, 2009.
9) Siddiqi, Mohammad U. Practical Sensor Design for Environmental Control. IET, 2018.
10) Wolf, Stanley. Modern Electronic Instrumentation and Measurement Techniques. Pearson, 2005.

Semester III

Lab I: BISP236: Practical Applications in Sensors, Transducers, and Amplifiers (Hardware Lab)

Course Objectives: Student will able to…

1. Provide an overview of different types of transducers based on physical quantities and their key characteristics.
2. Introduce the basics of operational amplifiers, covering their definition, characteristics, ideal vs. practical properties, and pin configuration.
3. Explore the application of op-amps in oscillator circuits (Wien bridge oscillator, phase-shift oscillator), multivibrators (astable, monostable, bistable), Schmitt Triggers, and active filters.
4. Understand transducer applications in industries such as automotive, healthcare, and manufacturing.

Credits (Total Credits 2)	**Semester III Lab I Minor Practical -III BISP 236: Practical Applications in Sensors, Transducers, and Amplifiers (Hardware Lab)**		**No.of Hours per(60)**
	1	Study of the thermocouple transducer.	
	2	Study of Thermistor transducer	
	3	Studypiezoelectric transducer.	
	4	Study of the RTD transducer.	
	5	Design phase shift oscillator.	
	6	Design of Wein bridge oscillator.	
	7	Design of inverting amplifier.	
	8	Design of noninverting amplifier.	
	9	Construct an astable multivibrator circuit using operational amplifiers.	
	10	Construct bistable multivibrator circuit using operational amplifiers.	
	11	Construct monostable multivibrator circuit using operational amplifiers.	

	14	Study of capacitive transducer.	
	15	Study of strain guage transducer.	
	16	Study of Integrator circuit of op amp.	
	17	Study of Differentiator circuit of op amp.	
	18	Study of the optical transducer.	
	19	Study of the high pass filter.	
	20	Study of the low pass filter.	

Course Outcomes: The students should be able to…

1 Differentiate between sensors and transducers and understand their significance in measurement systems.

2 Understand the fundamental principles of operational amplifiers and their various configurations.

3 Demonstrate proficiency in designing and analyzing oscillator circuits, multivibrators, Schmitt Triggers, and active filters using operational amplifiers.

4 Analyze and interpret case studies to comprehend real-world applications of transducers in different industries.

Reference Books:

1) Alciatore, David G., and Michael B. Histand. Introduction to Mechatronics and Measurement Systems. 5th ed., McGraw-Hill Education, 2018.
2) Barrett, Steven F. Principles of Engineering Measurement. 4th ed., Pearson, 2016.
3) Campbell, Joe. Sensor Technology Handbook. Elsevier, 2005.
4) Jones, David J. Measurement and Instrumentation: Theory and Application. Butterworth-Heinemann, 2015.
5) Johnson, Scott A. Op Amps for Everyone. 4th ed., Newnes, 2019.
6) Manoli, Yiannos. Analog Design Essentials. Springer, 2006.
7) Ramakant A. Gayakwad. Op-Amps and Linear Integrated Circuits. 6th ed., Prentice Hall, 2002.
8) Riaz, M. N., and Patrick F. Dunn. Sensors: An Introductory Course. CRC Press, 2009.
9) Siddiqi, Mohammad U. Practical Sensor Design for Environmental Control. IET, 2018.
10) Wolf, Stanley. Modern Electronic Instrumentation and Measurement Techniques. Pearson, 2005.

Minor Syllabus

Cource Structure for B.Sc II (Semester IV)

Theory				Practical				
Cource Title	**Cource Code**	**Lecture per week**	**Credits**	**Cource**	**Cource Title**	**Cource Code**	**Lecture per week**	**Credits**
Instrumentation for Experimental Sciences	**BIST 245**	**2**	**2**	**Practical I**	**Minor Practical I**	**BISP 246**	**2**	**2**

Structure and Title of Courses of B. Sc. Course:

*** B. Sc. II Semester IV ***

Course Number	Course Code	Course Name
V	BIST245	**Instrumentation for Experimental Sciences**
Lab II	BISP246	Minor Practical II:**Practical Applications in Experimental Sciences**

Semester IV

BIST245: Instrumentation for Experimental Sciences

Course Objectives: Student will able to…

1 Familiarize students with the operation and applications of advanced physics laboratory instruments

2 understand and utilize electronics laboratory instruments for experimental design and analysis.

3 introduce students to essential chemical laboratory instruments and their applications in analytical chemistry.

4 equip students with the skills necessary to operate and interpret data from advanced life sciences laboratory instruments.

Credits (Total Credits 2)	**SEMESTER-IV** BIST 245 **Instrumentation for Experimental Sciences**	**No. of hours per unit/credits 30**
UNIT - I	**Physics Laboratory Instruments**	08
	Ultrasonicator,Potentiostat,Stroboscope,SEM (Scanning electron microscope),Electronspen coating machine,Silarcoating Technique,Magnetic stirrermachine,Dimmer stat.	
UNIT - II	**Electronics Laboratory Instruments**	08
	LCR Meter,Ph Meter,3D Printer,Microprocessor,Microcontroller,Power Supplies,UPS,constant current source, constant voltage source	
UNIT - III	**Chemical Sciences Laboratory Instruments**	07
	Conductometer,Potentiometer,Colorimeter,IR Spectrometer,UV Spectroscopy,Photometer	
UNIT - IV	**Life Sciences Laboratory Instruments**	07
	Incubator,PCR,Centrifuge,different types of microscopes,Lab Scale Fermenter Unit,Gel documentation,Flame Photometer,Laminar air flow meter,micro-oven	

Course Outcomes: The students should be able to…

1 Explain the differences in functionality between various physics laboratory instruments.

2	Utilize electronic instruments to measure and analyze circuit parameters.
3	Design experimental protocols utilizing multiple chemical instruments to solve analytical problems.
4	Evaluate the reliability and reproducibility of experimental data obtained from life sciences instruments.

Reference Books:

1) Cooper, James F. Advanced Laboratory Instrumentation. CRC Press, 2003.
2) Gonzalez, Rafael C., and Howard B. Pinch. Electronic Laboratory Instrumentation. Pearson, 2007.
3) Jones, David H. Modern Chemistry Laboratory Instruments: Techniques and Applications. Springer, 2005.
4) Kim, Hyun K., et al. Advanced Life Sciences Instrumentation: Principles and Applications. Wiley, 2010.
5) Lee, Sang C., and Young J. Park. Physics Laboratory Instrumentation for Advanced Studies. Cambridge University Press, 2008.
6) Martinez, Maria A. Chemical Analysis and Instrumentation in Modern Laboratories. Oxford University Press, 2012.
7) Smith, Robert L. Practical Electronics Laboratory Instruments. McGraw-Hill Education, 2006.
8) Taylor, John R. Laboratory Instrumentation in Biomedical Sciences. Academic Press, 2004.
9) Watson, Peter A. Instrumentation and Techniques for Physics and Chemistry Laboratories. Elsevier, 2015.
10) Young, David L. Laboratory Instruments and Techniques: Advances in Analytical Chemistry. Wiley-VCH, 2002.

Semester IV

Lab I: BISP246: Practical Applications in Experimental Sciences

Course Objectives: Student will able to…

1 Understand the principles behind various laboratory instruments used in physics experiments.
2 Explore applications of electronic instrumentation in fields such as telecommunications, automation, and instrumentation.
3 Learn to operate laboratory instruments for chemical measurements, titrations, and spectroscopic analysis.
4 Understand the importance of maintaining sterile conditions and safety protocols in life sciences laboratories.

Credits (Total Credits 2)	**Semester IV Lab I Minor Practical -IV BISP246: Practical Applications in Experimental Sciences**		**No. of hours per (60)**
	1	Study of ultrasonicator operating principlesand applications.	
	2	Demonstrate Potentiostat function.	
	3	Study sample preparation techniques of SEM.	
	4	Study of operating procedures, and image analysis of SEM.	
	5	Study silarcoating technique.	
	6	Study dimmerstat use in controlling the intensity of light sources and electrical circuits.	
	7	Study how to measure inductance, capacitance, and resistance by using LCR meter.	
	8	Study Ph meter calibration and usage in measuring the acidity or alkalinity of solutions.	
	9	Study of tinker CAD software/free CAD software for 3D print design.	
	10	Study development boardof Microprocessor.	
	11	Study programming and interfacing techniques for microcontroller.	
	12	Studyconductometer use in measuring the conductivity of solutions.	
	13	StudyColorimeter operation for quantitative analysis of colored substances in solution.	

	14	Study cell culture and microbial growth by using incubator.
	15	Study of light microscopy/fluorescence microscopy/electron microscopy techniques.
	16	Study and use of Flame photometer.
	17	Study of DNA/protein gels for analysis and documentation.
	18	Study of Lab scale fermenter unit.
	19	Study Centrifuge operation for separating components of a mixture.
	20	Study Spectrophotometer use in quantitative analysis of chemical compounds.

Course Outcomes: The students should be able to…

1 Understand the role of laboratory instrumentation in advancing scientific knowledge and technology.

2 Understand the importance of calibration, accuracy, and precision in electronic measurements.

3 Demonstrate competence in operating chemical laboratory instruments for quantitative and qualitative analysis.

4 Understand safety protocols and ethical guidelines when working with biological materials in laboratory settings.

Reference Books:

1) Cooper, James F. Advanced Laboratory Instrumentation. CRC Press, 2003.
2) Gonzalez, Rafael C., and Howard B. Pinch. Electronic Laboratory Instrumentation. Pearson, 2007.
3) Jones, David H. Modern Chemistry Laboratory Instruments: Techniques and Applications. Springer, 2005.
4) Kim, Hyun K., et al. Advanced Life Sciences Instrumentation: Principles and Applications. Wiley, 2010.
5) Lee, Sang C., and Young J. Park. Physics Laboratory Instrumentation for Advanced Studies. Cambridge University Press, 2008.

6) Martinez, Maria A. Chemical Analysis and Instrumentation in Modern Laboratories. Oxford University Press, 2012.
7) Smith, Robert L. Practical Electronics Laboratory Instruments. McGraw-Hill Education, 2006.
8) Taylor, John R. Laboratory Instrumentation in Biomedical Sciences. Academic Press, 2004.
9) Watson, Peter A. Instrumentation and Techniques for Physics and Chemistry Laboratories. Elsevier, 2015.
10) Young, David L. Laboratory Instruments and Techniques: Advances in Analytical Chemistry. Wiley-VCH, 2002.

BoS Chairman
Instrumentation