Karmaveer Bhaurao Patil University, Satara

Syllabus for

B. Sc. III Instrumentation Science

Under

Faculty of Science and Technology

(As per NEP 2020)

With effect from Academic Year 2026-2027

Syllabus for Bachelor of Science (B. Sc.) Part – III Instrumentation science

PREAMBLE:

The B.Sc. Instrumentation science course under the autonomy framework will be introduced in the academic year 2026-2027. It has been designed to meet the specific needs of B.Sc. Instrumentation science students in accordance with the NEP 2020 guidelines. The curriculum has been developed to reflect the expanding scope of physical sciences. The focus is on equipping students with up-to-date knowledge while maintaining a strong foundation in classical instrumentation. The course also includes new practical exercises, providing students with hands-on experience with the latest techniques currently in use. Additionally, the course is intended to inspire students to pursue higher studies in instrumentation, become entrepreneurs and seek employment in instrumentation-based industries.

1. TITLE: **Instrumentation Science**

2. YEAR OF IMPLEMENTATION: **2026-2027**

3. DURATION: **01 year**

4. PATTERN: **Semester examination**

5. MEDIUM OF INSTRUCTION: **English**

6. STRUCTURE OF COURSE:
As per NEP-2020 (2.0)

Level	Sem	Subject				VSC/SEC	AEC	CEP/FP/CC/OJT	Total
		DSC		DSE*					
		T	P	T	P				
5.5	V	DSC IX (2) DSC X (2) DSC XI (2)	DSC P (2)	DSCXI I (E1) (2) DSCXI I (E2) (2)	DSE P (2)	VSC III (2)	AEC III (2)	OJT (4) CEP (2)	22
5.5	VI	DSC XIII (2) DSC XIV(2) DSC XV (2)	DSC P (2)	DSCX VI (E1) (2) DSC XVI (E2) (2)	DSE P (2)	VSC IV (2) SEC III (2)	AEC III (2)	FP (2) CC (2)	22

* DSE - 2 Courses out of four for each semester.7. COURSE TITLE

1) Fifth Semester

Sr. No.	Course	Theory				Practical		
		Course No. & Course Code	Title of Course	No. of lectures per week	Credits	Course No. & Course Code	No. of practical Per Hr	Credits
1.	DSC IX	BIST 351	Emerging technologies &IoT in instrumentation	2	2	BISP 356	4	2
2.	DSC X	BIST 352	Applied Physics and Mathematics in Instrumentation Science	2	2			
3.	DSC XI	BIST 353	Instrumentation of mass spectrometry	2	2			
4.	DSC XII (E1)	BIST 354	Analytical Instrumentation	2	2			
5.	DSC XII (E2)	BIST 355	Chromatographic and thermal analysis techniques	2	2	BISP 357	4	2
6.	VSC	--	Solar simulation and medical instrumentation	--	--	BISPVSC III	4	2
7.	AEC		English	2	2		-	-
8.	OJT	BISTOJT	On job Training	--	--	--	8	4
9.	CEP	BISTCEP	Community Engagement Program			--	4	2

2) Sixth Semester

Sr. No.	Course	Theory				Practical		
		Course No. & Course Code	Title of Paper	No. of lectures per week	Credits	Course No. & Course Code	No. of Lectures Per Hr	Credits
1.	DSC XIII	BIST 361	Process and analytical instrumentation	2	2	BISP 366	4	2
2.	DSC XIV	BIST 362	Optics and laser insrumentation	2	2			
3.	DSC XV	BIST 363	Industrial chemistry	2	2			
4.	DSC XVI (E1)	BIST 364	Industrial Physics	2	2	BISP 367	4	2
5.	DSC XVI (E2)	BIST 365	Industrial ethics for instrumentation	2	2			
6.	VSC	--	Python Programming	--	--	BISPVSC IV	4	2
7.	SEC	BISTSEC 3	Materials science instrumentation	--	--	BISPSEC 3	4	2
8.	AEC		English	2	2			
9.	FP	BISTFP	--	-	-	--	4	2
10.	CC	BISTCC	--	2	2	--		

EVALUATION STRUCTURE:

Semester V (5.5)

Vertical	Course Category	Course Code	Internal Evaluation			ESE	Total Marks	Credits
			CCE-I	CCE-II	CCE-III			
DSC	T	BIST 351	10	10	10	30	50	02
	T	BIST 352	10	10	10	30	50	02
	T	BIST 353	10	10	10	30	50	02
	P	BISP 356	20			30	50	02
DSE (1 Theory Papers Out of 2)	T	BIST 354	10	10	10	30	50	02
	T	BIST 355	10	10	10	30	50	02
	P	BISP 357	20			30	50	02
AEC	T	AEC III	10	10	10	30	50	02
VSC	P	BISPVSC III	20			30	50	02
CEP	P	BISPCEP I	20			30	50	02
OJT	P	BISPOJT I	40			60	100	04
Total							**550**	**22**

Semester VI

Vertical	Course Category	Course Code	Internal Evaluation			ESE	Total Marks	Credits
			CCE-I	CCE-II	CCE-III			
DSC	T	BIST 361	10	10	10	30	50	02
	T	BIST 362	10	10	10	30	50	02
	T	BIST 363	10	10	10	30	50	02
	P	BISP 366	20			30	50	02
DSE (1 Theory Papers Out of 2)	T	BIST 364	10	10	10	30	50	02
	T	BIST 365	10	10	10	30	50	02
	P	BISP 367	20			30	50	02
AEC	T	AEC IV	10	10	10	30	50	02
VSC	P	BISPVSC IV	20			30	50	02
SEC	P	BISPSEC III	20			30	50	02
CC	T	BISPCC I	10	10	10	30	50	02
FP	P	BISPFP I	20			30	50	02
Total							**550**	**22**

Abbreviations: DSC: Discipline Specific Course; DSE: Discipline Specific Elective; CCE: Continuous Comprehensive Examination; AEC: Ability Enhancement Course; VSC: Vocational Skill Course; SEC: Skill Enhancement Course; OJT: On Job Training; FP: Field Project; CEP: Community Engagement Program; CC: Co-curricular Course; T: Theory; P: Practical

9. OTHER FEATURES:

A) LIBRARY:

Reference books, Textbooks, journals, and Periodicals are available in Institute Library. (Separate reference lists are attached along with the respective course syllabus)

B) EQUIPMENT:

a) Computer, smart board

b) Laboratory Equipment:

1. Function Generator
2. Hot Air Oven
3. Digital weighing balance
4. Incubator
5. pH meter
6. Microscope
7. C.R.O
8. Furnace
9. gas sensing instrument
10. Spectrometer

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Electronics

Programme: B.Sc.	**Semester - V**
Type: DSC IX	**Marks: 50**
Credits: 2	**From: A. Y. 2026-27**

Name of the Course: BIST 351-Emerging technologies & IoT in instrumentation

Course Objectives: By the end of the course, students should be able to…

1. understand the evolution of instrumentation from traditional to smart and digital systems.
2. learn the fundamentals of IoT, its architecture, communication technologies, and platforms.
3. analyse sensors, embedded systems, signal conditioning, and IoT communication protocols.
4. study the integration of IoT with industrial instrumentation, smart factories, predictive maintenance, and digital twins.

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

1. explain the role of smart sensors, embedded systems, and CPS in modern industries.
2. develop basic IoT applications using sensors, microcontrollers, and cloud platforms.
3. analyze industrial parameters and apply AI/ML techniques for predictive maintenance.
4. identify and explain the applications of IoT and smart instrumentation in modern industries.

Module	Title and Contents	Hrs
Module -1:	**Introduction to emerging technologies** 1.1 Introduction 1.2 Evolution of industrial instrumentation and automation 1.3 Shift from conventional instrumentation to digital systems 1.4 Role of embedded systems, microcontrollers, and sensors 1.5 Applications in manufacturing, medical, automotive, and energy sectors.	**07**
Module -2:	**Fundamentals of IoT** 2.1 IoT protocols and communication technologies 2.2 Wi-Fi, Bluetooth, Zigbee, NB-IoT, RFID 2.3 IoT hardware platforms: Arduino, ESP32, Raspberry Pi, industrial IoT controller 2.4 Cloud platforms for IoT: AWS IoT, Microsoft Azure IoT, Google Cloud IoT	**08**
Module -3:	**IoT in industrial instrumentation** 3.1 Smart factories and Industry 4.0 3.2 SCADA, DCS, and IoT integration 3.3 Wireless sensor networks (WSN) in industrial environments 3.4 Data logging, dashboards and analytics	**07**
Module -4:	**Applications of IoT** 4.1 IoT applications 4.2 Healthcare (wearable sensors, remote patient monitoring) 4.3 Smart cities (traffic, pollution , energy management) 4.4 Agriculture (precision farming , soil sensors , irrigation control) 4.5 Environment monitoring (air quality , water quality)	**08**

Reference Books:-

1. S. C. Mukhopadhyay, Intelligent Sensing, Instrumentation and Measurements, Springer, 2013
2. Sharma, S. K. Jangir, M. Kumar, D. K. Choubey, T. Shrivastava, S. Balamurugan (Eds.), Industrial Internet of Things: Technologies and Research Directions, CRC Press, 2022
3. S. Jha, U. Tariq, G. P. Joshi, V. K. Solanki (Eds.), Industrial Internet of Things: Technologies, Design, and Applications, CRC Press, 2022
4. S. Ziegler, R. Radócz, A. Q. Rodriguez, S. N. M. Garcia (Eds.), Springer Handbook of Internet of Things, Springer, 2024

Evaluation Pattern 40:60	
Total Marks: 50 M	
Internal Continuous Evaluation: (20 M) • CCE-I: 10 M • CCE-II: 10 M • CCE-III: 10 M • Total marks : 20 marks (Best of two CCE marks will be considered)	**End Semester Examination: (50 M)** • Question -1 :10 M (2x5=10 M) • Question -2 :20 M (2x10=20 M) • Question -3 :20 M (4x5 =20 M) (Convert 50M into 30 M)

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Faculty of Science and Technology

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Board of Studies in Electronics

Programme: B.Sc.	**Semester - V**
Type: DSC X	**Marks: 50**
Credits: 2	**From: A. Y. 2026-27**

Name of the Course: BIST 352- Applied physics and mathematics in instrumentation science

Course Objectives: By the end of the course, students should be able to….

1. describe the working principles and characteristics of photovoltaic cells, lithium-ion batteries, and supercapacitors.
2. apply matrix methods, eigenvalues, and eigenvectors to solve engineering and instrumentation-related problems.
3. analyze matrix-based engineering problems and interpret the significance of eigenvalues and eigenvectors in instrumentation systems.
4. design or propose suitable matrix-based solutions and renewable energy systems for specific instrumentation and engineering applications.

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

1. determine eigenvalues and eigenvectors and apply them to analyze engineering systems.
2. explain the principles, characteristics, and applications of photovoltaic materials, batteries and supercapacitors.
3. apply matrix techniques to model and analyze instrumentation systems.
4. evaluate the performance and suitability of photovoltaic materials, batteries, and supercapacitors for different energy applications.

Module	Title and Contents	Hrs
Module -1:	**Matrix algebra and its applications in instrumentation science** 1.1 Basic Matrix Algebra 1.2 Inverse of a matrix such as Orthogonal, Hermitian, Unitary matrices 1.3 Eigenvalues, Eigenvectors 1.4 Matrix Representation of Systems 1.5 Applications in Instrumentation	**07**
Module -2:	**Differential equation** 2.1 First Order Differential Equations 2.2 Second Order Differential Equations, 2.3 Applications to LCR circuits 2.4 Laplace Transform Method 2.5 Properties of Laplace Transform	**08**
Module -3:	**Renewable energy materials** 3.1 Introduction to Renewable Energy Materials 3.2 Solar Energy Materials **:**Photovoltaic (PV) materials , Silicon solar cell 3.3 Energy Storage Materials: Battery materials (Lithium-ion), Supercapacitors 3.4 Applications in Instrumentation- Energy monitoring systems, Smart sensors in Smart sensors in renewable systems, Data acquisition in energy plants	**07**

Module -4:	**Superconductivity** 4.1 Introduction to Superconductivity 4.2 Properties of Superconductors 4.3 Types of Superconductors 4.4 Magnetic Properties 4.5 Applications of Superconductivity	**08**

Reference Books:-

1. G. Strang, Introduction to Linear Algebra, Wellesley-Cambridge Press, 2016
2. E. Kreyszig, Advanced Engineering Mathematics, Wiley, 2011
3. C. S. Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, PHI Learning, 2015
4. B. E. Conway, Electrochemical Supercapacitors: Scientific Fundamentals and Technological Applications, Springer, 1999
5. C. P. Poole Jr., H. A. Farach, Superconductivity, Academic Press, 1995

Evaluation Pattern: 40:60

Total Marks: 50 M

Internal Continuous Evaluation: (20 M)	**End Semester Examination: (50 M)**
• CCE-I: 10 M • CCE-II: 10 M • CCE-III: 10 M • Total marks : 20 marks (Best of two CCE marks will be considered)	• Question -1 :10 M (2x5=10 M) • Question -2 :20 M (2x10=20 M) • Question -3 :20 M (4x5 =20 M) (Convert 50M into 30 M)

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Board of Studies in electronics

Programme: B.Sc.	**Semester - V**
Type: DSC XI	**Marks: 50**
Credits: 2	**From: A. Y. 2026-27**

Name of the Course: BIST 353- Instrumentation of Mass Spectrometry

Course Objectives: By the end of the course, students should be able to….

1. understand the fundamental principles of mass spectrometry, including ionization, mass-to-charge ratio, resolution, sensitivity, and the role of vacuum systems.
2. study the construction and working of key components of mass spectrometers such as ion sources, sample inlet systems, mass analyzers, detectors, and data systems.
3. learn and compare various ionization techniques gas-phase, desorption-based, soft ionization and determine their suitability for different sample types.
4. analyze the operation, performance parameters, and applications of common mass analyzers and detection systems, including advanced hybrid and hyphenated MS techniques.

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

1. explain the basic working principles of mass spectrometry and define key concepts such as m/z ratio, resolution, sensitivity, and isotopic abundance.
2. describe the purpose and functioning of vacuum systems, ion sources, mass analyzers, detectors, and associated instrumentation components.
3. select appropriate ionization techniques (EI, CI, ESI, MALDI, APCI, etc.) based on sample properties and analytical requirements.
4. evaluate the performance of different mass analyzers (quadrupole, TOF, ion trap, Orbitrap, FT-ICR) and detectors and interpret data obtained from hyphenated techniques like GC–MS and LC–MS.

Module	Title and Contents	Hrs
Module -1:	**Fundamentals of mass spectrometry** 1.1 Basic principles of mass spectrometry 1.2 Basic Concepts: Ion, mass-to-charge ratio (m/z), Isotopes, isotopic abundance, Resolution and resolving power, Sensitivity, dynamic range 1.3 General Components of a Mass Spectrometer: Sample inlet system,Ion source, Mass analyser, Detector,Data system.	**08**
Module -2:	**Ionization techniques** 2.1 Gas Phase Ionization: Electron Ionization (EI),Chemical Ionization (CI),Photoionization (PI) 2.2 Desorption-Based Ionization:Field Desorption (FD),Field Ionization (FI),Fast Atom Bombardment (FAB) 2.3 Soft Ionization Methods:Electrospray Ionization (ESI), Matrix-Assisted Laser Desorption Ionization (MALDI), Atmospheric Pressure Chemical Ionization (APCI)	**07**

Module -3:	**Mass analyzers and detectors** 3.1 Mass Analyzers:Magnetic sector analyzer,Quadrupole mass analyzer,Time-of-flight (TOF) analyzer,Ion trap analyzer,Orbitrap, Fourier-transform ion cyclotron resonance (FT-ICR) 3.2 Performance Parameters: Accuracy, Mass resolution, Mass range, Scan speed 3.3 Detectors: Electron multipliers, Faraday cup, Microchannel plates, Photomultiplier detectors	**08**
Module -4:	**Data analysis & applications of MS** 4.1 Mass Spectral Interpretation: Fragmentation patterns, Molecular ion identification, Isotopic patterns, Base peak, neutral loss 4.2 Quantitative and Qualitative Analysis: Internal vs external calibration, Selected Ion Monitoring (SIM), Multiple Reaction Monitoring (MRM) 4.3 Applications of Mass Spectrometry: Pharmaceutical analysis, Proteomics & metabolomics, Environmental monitoring, Forensic science (toxicology, explosive detection), Petrochemical and polymer analysis	**07**

Reference Books:-

1. W.J. Throck, and O. David Sparkman. Introduction to Mass Spectrometry: Instrumentation, Applications, and Strategies for Data Interpretation. 4th ed. Chichester: John Wiley & Sons, 2007.
2. M.D.Dominic , N. M. Nibbering. Mass Spectrometry: Instrumentation, Interpretation and Applications. Hoboken, NJ: John Wiley & Sons, 2009.
3. S.M.Lee, ed. Mass Spectrometry Handbook. 1st ed. Hoboken, NJ: John Wiley & Sons, 2012.
4. G.John, John Roboz. Mass Spectrometry for the Novice. Boca Raton, FL: CRC Press, 2014.

Evaluation Pattern: 40:60

Total Marks: 50 M

Internal Continuous Evaluation: (20 M)	**End Semester Examination: (50 M)**
• CCE-I: 10 M • CCE-II: 10 M • CCE-III: 10 M • Total marks : 20 marks (Best of two CCE marks will be considered)	• Question -1 :10 M (2x5=10 M) • Question -2 :20 M (2x10=20 M) • Question -3 :20 M (4x5 =20 M) (Convert 50M into 30 M)

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Board of Studies in Electronics

Programme: B.Sc.	**Semester - V**
Type: DSC Practical	**Marks: 50**
Credits: 2	**From: A. Y. 2026-27**

Name of the Course: BISP 356: Practical Lab V(Practical based on BIST 351,BIST 352,BIST 353)

Course Objectives: By the end of the course, Students should be able to….

1. develop skills in sensor interfacing with Arduino, ESP32 and ESP8266.
2. learn IoT communication protocols and real-time data monitoring.
3. understand the fundamentals and operation of mass spectrometry.
4. familiarize students with basic software interface and command-window operations.

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

1. interface sensors with microcontrollers and monitor real-time data using IoT dashboards.
2. implement IoT-based automation and data-logging systems using communicsation protocols.
3. identify mass spectrometer components, perform calibration, and interpret mass spectra.
4. apply GC–MS and MS library techniques for identification of unknown compounds.

Sr. No	List of Experiments	Hrs
1	Interfacing a Temperature Sensor (LM35/DS18B20) with ESP32	60
2	Study of Charging/Discharging of Supercapacitor	
3	Wi-Fi-Based Data Logging Using ESP8266	
4	Study of MRM in Tandem Mass Spectrometry	
5	Perform addition, multiplication, transpose using MATLAB	
6	Find inverse using Gauss-Jordan method and verify A·A−1=IA \cdot A^{-1} = IA·A−1=I.	
7	Study of Basic Components of a Mass Spectrometer	
8	Determination of Molecular Mass using Mass Spectrometry	
9	Study and Plot I-V and P-V characteristics of a silicon solar cell	
10	Simulate Meissner effect or magnetic susceptibility vs temperature.	
11	Identification of Isotopic Patterns	
12	Study of Ionization Techniques	
13	IoT Data Transmission using Wi-Fi (ESP32)	
14	Interfacing of pressure Sensors with Arduino	
15	Interfacing of 7 segment display with Arduino	

Reference Books:-

1. G.H.Christopher , A. W. Johnstone. Mass Spectrometry Basics. 1st ed. Boca Raton: CRC Press, 2002.
2. M.T.James. Mass Spectrometry. 1st ed. Singapore: Jenny Stanford Publishing, 2018.
3. S.N.Norman.Control Systems Engineering. 8th ed. Hoboken: John Wiley & Sons, 2019.
4. W. Bolton, Programmable Logic Controllers. 6th ed. Oxford: Newnes (Elsevier), 2015.
5. Bahga, Arshdeep, and Vijay Madisetti. Internet of Things: A Hands-On Approach. 1st ed. Blacksburg: VPT, 2014.

Evaluation Pattern:40:60	
Total Marks: 50 M	
Internal Continuous Evaluation: (20 M) • Journal: 10 M • Students Performance: 05 M • Viva : 05 M	**End Semester Examination: (30 M)** • **Q. -1 = 30M**

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Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Electronics

Programme: B.Sc.	**Semester - V**
Type: DSC XII (E1)	**Marks: 50**
Credits: 2	**From: A. Y. 2026-27**

Name of the Course: BIST 354- Analytical instrumentation

Course Objectives: By the end of the course, Students should be able to….

1. understand the fundamental concepts of analytical chemistry, including qualitative/quantitative analysis, types of errors, sampling, and data quality parameters.
2. study the principles, instrumentation, and applications of various spectroscopic techniques such as UV–Vis, IR, AAS, fluorescence, and Raman spectroscopy.
3. learn the construction, working, and analytical applications of spectrometric instruments including FTIR and Fluorescence.
4. gain foundational knowledge of advanced analytical techniques such as mass spectrometry and AAS.

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

1. describe the principles of analytical chemistry, identify various types of analytical errors, and apply appropriate sampling and calibration methods.
2. explain the operational principles and instrumentation of major spectroscopic techniques and interpret basic UV–Vis, IR, AAS, fluorescence, and Raman spectra.
3. apply spectroscopic techniques for qualitative and quantitative analysis in environmental, industrial, and biological samples.
4. evaluate the advantages, limitations, and practical applications of different spectroscopic analytical instruments.

Module	Title and Contents	Hrs
Module -1:	**UV Visible Spectroscopy** 1.1 Introduction to UV–Visible Spectroscopy 1.2 Principle of UV–Vis Spectroscopy 1.3 Beer–Lambert Law 1.4 Instrumentation of UV–Vis Spectrophotometer 1.5 Applications of UV–Vis Spectroscopy	**07**
Module -2:	**Infrared (IR) Spectroscopy** 2.1 Infrared (IR) Spectroscopy: Molecular vibrations, FTIR instrumentation, Interpretation of IR spectra 2.2 Fundamentals of Infrared Radiation and Electromagnetic Spectrum 2.3 Principles of Molecular Vibrations and IR Absorption 2.4 Instrumentation of IR Spectroscopy: IR Sources, Monochromators, Sample Handling Techniques, Detectors.	**08**

Module -3:	**Fluorescence spectroscopy** 3.1. Introduction 3.2. Basic Principles 3.3. Instrumentation 3.4. Fluorescence Measurement Techniques 3.5. Applications and Advantages and Limitations	**07**
Module -4:	**Atomic absorption spectroscopy** 4.1. Introduction 4.2. Principle and Instrumentation 4.3. Working Mechanism 4.4. Types of AAS 4.5. Applications and Advantages and Limitations	**08**

Reference Books:-

1. A.S.Douglas , F. J. Holler, S. R. Crouch. Principles of Instrumental Analysis. 7th ed. Boston: Cengage Learning, 2017.
2. D.Christian, Gary D., Purnendu K. Dasgupta, Kevin A. Schug. Analytical Chemistry. 7th ed. Hoboken, NJ: John Wiley & Sons, 2013.
3. C.Daniel Quantitative Chemical Analysis. 9th ed. New York: W. H. Freeman, 2015.
4. S.M. Hopkar, Basic Concepts of Analytical Chemistry. 3rd ed. New Delhi: New Age International Publishers, 2008.

Evaluation Pattern: 40:60

Total Marks: 50 M

Internal Continuous Evaluation: (20 M)	**End Semester Examination: (50 M)**
• CCE-I: 10 M • CCE-II: 10 M • CCE-III: 10 M • Total marks : 20 marks (Best of two CCE marks will be considered)	• Question -1 :10 M (2x5=10 M) • Question -2 :20 M (2x10=20 M) • Question -3 :20 M (4x5 =20 M) (Convert 50M into 30 M)

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Programme: B.Sc.	**Semester - V**
Type: DSC XII (E2)	**Marks: 50**
Credits: 2	**From: A. Y. 2026-27**

Name of the Course: BIST 355- Chromatographic and thermal analysis techniques

Course Objectives: By the end of the course, Students should be able to….

1. introduce the fundamental principles and types of Gas Chromatography (GC) and their analytical applications.
2. develop understanding of the instrumentation, detectors, and working methodology of High Performance Liquid Chromatography (HPLC).
3. explain the concepts, materials, and techniques involved in thin layer chromatography (TLC).
4. gain foundational knowledge of advanced analytical techniques such as mass spectrometry and AAS.

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

1. study the basic principles and types of Gas Chromatography (GC) and interpret its applications..
2. explain the instrumentation, detectors, and working methodology of High Performance Liquid Chromatography (HPLC).
3. apply the concepts of Thin Layer Chromatography (TLC) for separation, identification, and analysis of compounds.
4. evaluate the advantages, limitations, and practical applications of different spectroscopic analytical instruments.

Module	Title and Contents	Hrs
Module -1:	**Gas chromatography (GC)** 1.1. Introduction to Gas Chromatography 1.2. Principle of Gas Chromatography 1.3. Types of Chromatography (Gas–Liquid, Gas–Solid) 1.4. Instrumentation 1.5. Detectors 1.6. Applications	**07**
Module -2:	**High Performance Liquid Chromatography (HPLC)** 2.1. Introduction to HPLC 2.2. Instrumentation 2.3. Detectors: Photodiode Array (PDA) Detector and Refractive Index Detector 2.4. Working and Methodology 2.5. Applications and Advantages and Limitations	**08**

Module -3:	**Thin Layer Chromatography (TLC)** 3.1. Introduction to TLC 3.2. Types of Chromatography related to TLC 3.3. Components and Materials : Stationary Phase, Mobile Phase and TLC Plates 3.4. Methodology and Detection and Analysis 3.5. Applications	**07**
Module -4:	**Thermogravimetric Analysis (TGA)** 4.1. Introduction to TGA 4.2. Instrumentation and Working and Methodology 4.3. Data Analysis 4.4. Applications	**08**

Reference Books:-

1. M. M. James,Chromatography: Concepts and Contrasts. 2nd ed. Hoboken: John Wiley & Sons, 2004.
2. A.S.Douglas , F. J.SSHoller, and Stanley R. Crouch. Principles of Instrumental Analysis. 6th ed. Belmont: Thomson Brooks/Cole, 2007.
3. G.R. Chatwal, Analytical Chromatography. Mumbai: Himalaya Publishing House, 2017
4. Gour, Rajesh, P. K. Mohanty, V.Shrivastava, Mahadev Kanere. A Textbook on Chromatography: An Overview. New Delhi: Deep Science Publishing, 2024.
5. S.Omprakash, S. K. Sharma, Yogesh Sharma. Chromatographic Techniques for Analytical Applications. New Delhi: Academic Press/Research Publications, 2023.

Evaluation Pattern: 40:60

Total Marks: 50 M

Internal Continuous Evaluation: (20 M)	**End Semester Examination: (50 M)**
• CCE-I: 10 M • CCE-II: 10 M • CCE-III: 10 M • Total marks : 20 marks (Best of two CCE marks will be considered)	• Question -1 :10 M (2x5=10 M) • Question -2 :20 M (2x10=20 M) • Question -3 :20 M (4x5 =20 M) (Convert 50M into 30 M)

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Board of Studies in Electronics

Programme: B.Sc.	**Semester - V**
Type: DSE Practical	**Marks: 50**
Credits: 2	**From: A. Y. 2026-27**

Name of the Course: BISP 357: Practical Lab Based on Elective paper (Practical Based on BIST 354)

Course Objectives: By the end of the course, Students should be able to….

1. understand the fundamental concepts of analytical chemistry, including qualitative/quantitative analysis, types of errors, sampling, and data quality parameters.
2. study the principles, instrumentation, and applications of various spectroscopic techniques such as UV–Vis, IR, AAS, fluorescence, and Raman spectroscopy.
3. learn the construction, working, and analytical applications of spectrometric instruments including FTIR and Fluorescence,.
4. gain foundational knowledge of advanced analytical techniques such as mass spectrometry and AAS.

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

1. describe the principles of analytical chemistry, identify various types of analytical errors, and apply appropriate sampling and calibration methods.
2. explain the operational principles and instrumentation of major spectroscopic techniques and interpret basic UV–Vis, IR, AAS, fluorescence, and Raman spectra.
3. apply spectroscopic techniques for qualitative and quantitative analysis in environmental, industrial, and biological samples.
4. evaluate the advantages, limitations, and practical applications of different spectroscopic analytical instruments.

Sr. No	List of Experiments	Hrs
1.	Determination of wavelength of maximum absorption (λmax) using UV–Visible Spectroscopy	60
2.	Verification of Beer–Lambert Law	
3.	Determination of concentration of unknown solution using UV–Vis spectrophotometer	
4.	Study of excitation spectrum and emission spectrum	
5.	Study of FTIR instrument and sample preparation techniques	
6.	Identification of functional groups using Infrared Spectroscopy	
7.	Study of FTIR instrument and sample preparation techniques	
8.	Study of Atomic Absorption Spectroscopy instrument and its components	

9.	Determination of metal ions (Na, K, Ca) using AAS
10.	Study of basic instrumentation of Fluorescence
11.	Measurement of fluorescence intensity of given sample
12.	Study of flame and graphite furnace atomization techniques
13.	Determination of concentration using fluorescence method
14.	Calibration curve preparation using Atomic Absorption Spectroscopy
15.	Determination of concentration of unknown solution using UV–Vis spectrophotometer

Reference Books:-

1. Skoog, Douglas A., F. James Holler, and Stanley R. Crouch. Principles of Instrumental Analysis. 7th ed. Boston: Cengage Learning, 2017.
2. D.C.Gary , Purnendu K. Dasgupta, and Kevin A. Schug. Analytical Chemistry. 7th ed. Hoboken, NJ: John Wiley & Sons, 2013.
3. C.H Daniel . Quantitative Chemical Analysis. 9th ed. New York: W. H. Freeman, 2015.
4. S.M.Hopkar, Basic Concepts of Analytical Chemistry. 3rd ed. New Delhi: New Age International Publishers, 2008.
5. W.R. James , Ernest M. Skelly Frame, and George M. Frame II. Undergraduate Instrumental Analysis. 7th ed. Boca Raton, FL: CRC Press, 2014.
6. H.W.Hobart , Lynne L. Merritt Jr., John A. Dean, and Frank A. Settle. Instrumental Methods of Analysis. 7th ed. Belmont, CA: Wadsworth Publishing, 1988.

Evaluation Pattern:40:60

Total Marks: 50 M

Internal Continuous Evaluation: (20 M)	**End Semester Examination: (30 M)**
• Journal: 10 M • Students Performance: 05 M • Viva : 05 M	• **Q. -1 = 30 M**

Karmaveer Bhaurao Patil University, Satara

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Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Electronics

Programme: B.Sc.	**Semester - V**
Type: VSC Practical	**Marks: 50**
Credits: 2	**From: A. Y. 2026-27**

Name of the Course: BISPVSC III: Vocational Skill Course in Solar simulation and medical Instrumentation

Course Objectives: By the end of the course, Students should be able to….

1. understand the fundamentals of photovoltaic devices and basic solar cell structure using simulation software.
2. analyze the effect of physical parameters such as doping concentration, thickness, and band gap on solar cell performance.
3. study electrical characteristics including I–V, P–V curves, quantum efficiency, and fill factor.
4. investigate recombination mechanisms, interface defects, and their impact on device efficiency.

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

1. Model and simulate basic and advanced solar cell structures using simulation software.
2. Evaluate the influence of material properties and device parameters on efficiency and current output.
3. Analyze spectral response and quantum efficiency for different photovoltaic materials.
4. Interpret the effects of temperature, illumination, and resistive losses on solar cell performance.

Sr. No	List of Experiments	Hrs
1.	Installation, interface overview, and creation of a basic solar cell structure.	60
2.	Create and simulate a simple device (e.g., Glass/FTO/TiO_2/Perovskite/Spiro-OMeTAD/Au).	
3.	Plot and analyze the J–V curve under AM1.5G illumination.	
4.	Determine Voc, Jsc, Fill Factor (FF), Efficiency (PCE), and Maximum Power Point (MPP).	
5.	Study how changing the absorber thickness affects device performance.	
6.	Investigate the influence of donor/acceptor concentration on photovoltaic parameters.	
7.	Analyze the effect of temperature on efficiency, Voc, and Jsc.	
8.	Simulate and interpret the External Quantum Efficiency (EQE) spectrum.	
9.	Observe energy band alignment at equilibrium and under illumination.	
10.	Study the effect of bulk defect density on solar cell efficiency.	
11.	Investigate changes in J–V characteristics with varying series resistance.	
12.	Analyze the influence of shunt resistance on device performance.	
13.	Evaluate the effect of carrier mobility on photovoltaic performance.	

14.	Compare silicon, CIGS, CdTe, and perovskite absorber layers using SCAPS.
15.	Optimize layer thickness, doping, and defect density to achieve maximum efficiency.

Reference Books:-

1. N.Jenny. The Physics of Solar Cells. London: Imperial College Press, 2003.
2. A.G. Martin, Solar Cells: Operating Principles, Technology, and System Applications. Englewood Cliffs, NJ: Prentice Hall, 1982.
3. L. Antonio, Steven Hegedus, eds. Handbook of Photovoltaic Science and Engineering. 2nd ed. Chichester: Wiley, 2011.
4. W.Peter, U. Würfel. Physics of Solar Cells: From Basic Principles to Advanced Concepts. 2nd ed. Weinheim: Wiley-VCH, 2016.
5. J.F.Stephen, Solar Cell Device Physics. 2nd ed. Burlington, MA: Academic Press, 2010.

Evaluation Pattern: 40:60

Total Marks: 50 M

Internal Continuous Evaluation: (20 M)	**End Semester Examination: (30 M)**
• Journal: 10 M • Students Performance: 05 M • Viva : 05 M	• **Q. -1 = 30M**

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Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Electronics

Programme: B.Sc.	**Semester - V**
Type: OJT	**Marks: 100**
Credits: 4	**From: A. Y. 2026-27**

Name of the Course: BISPOJT: On-Job Training Program in Instrumentation

Course Objectives: By the end of the course, Students should be able to….

1. provide students with practical exposure to professional work environments in industries, business organizations, healthcare, and government sectors.
2. bridge the gap between theoretical knowledge and real-world applications through hands-on experience.
3. develop technical, analytical, and problem-solving skills required for professional practice.
4. enhance communication, teamwork, leadership, and ethical work practices in multidisciplinary environments.

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

1. apply theoretical concepts and technical knowledge to solve real-world problems in a professional workplace.
2. demonstrate effective communication, teamwork, interpersonal skills while working in multidisciplinary environments.
3. perform assigned tasks responsibly by following organizational policies, professional ethics, safety practices.
4. analyze workplace challenges and propose appropriate technical or managerial solutions using critical thinking.

An On-Job Training (OJT) Program in Instrumentation provides students with practical exposure to real industrial or laboratory environments. It helps students apply classroom knowledge of sensors, transducers, measurement systems, electronics, process instrumentation, control systems, calibration, and industrial safety to actual workplace situations.

The main purpose of OJT is to develop industry-ready technical and professional skills by allowing students to work under the guidance of experienced professionals.

Evaluation Pattern:40:60

Total Marks: 100 M

Internal Continuous Evaluation: (40 M)	**End Semester Examination: (60 M)**
Q.1 40 M	• **Q. -1 = 60M**

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Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Electronics

Programme: B.Sc.	**Semester - V**
Type: CEP	**Marks: 50**
Credits: 2	**From: A. Y. 2026-27**

Name of the Course: BISPCEP: Community Engagement Program in Instrumentation

Course Objectives: By the end of the course, Students should be able to….

1. create awareness among students about the role of instrumentation in addressing community and societal needs.
2. encourage students to apply basic instrumentation knowledge for solving local problems related to health, agriculture, environment, and public utilities.
3. develop social responsibility, ethical values, and community participation through field-based activities.
4. enhance communication, teamwork, leadership, and organizational skills while interacting with community stakeholders.

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

1. identify community problems that can be addressed using basic instrumentation and technological solutions.
2. demonstrate effective communication and teamwork while planning and executing community engagement activities.
3. apply fundamental instrumentation concepts to support community awareness, monitoring, and problem-solving initiatives.
4. exhibit professional ethics, social responsibility, and environmental consciousness during community-based projects.

A Community Engagement Program in Instrumentation is a practical, community-oriented activity in which students use their knowledge of sensors, measurement systems, electronics, automation, and IoT to identify and address real-life problems faced by local communities.

The program connects academic learning with social responsibility and helps students develop technical, communication, teamwork, and problem-solving skills.

Evaluation Pattern:40:60

Total Marks: 50 M

Internal Continuous Evaluation: (20 M)	**End Semester Examination: (30 M)**
Q.1 20 M	• **Q. -1 = 30M**

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Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Electronics

Programme: B.Sc.	**Semester - VI**
Type: DSC XIII	**Marks: 50**
Credits: 2	**From: A. Y. 2026-27**

Name of the Course: BIST 361- Process and analytical instrumentation

Course Objectives: By the end of the course, students should be able to….

1. develop fundamental knowledge of sensors, transmitters, measurement techniques used in industrial processes.
2. gain knowledge of automation technologies such as PLC, DCS, SCADA used in modern industries.
3. study instruments used for analyzing chemical composition, quality, and properties of materials in process industries.
4. learn how to select appropriate instruments based on process requirements and operating conditions.

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

1. explain the basic principles of process measurement and instrumentation.
2. identify and explain the working of analytical instruments used in process industries.
3. gain knowledge of installation, calibration, and implementation of instrumentation systems.
4. interpret process data and use it for monitoring and control purposes.

Module	Title and Contents	Hrs
Module -1:	**Fundamentals of process instrumentation** 1.1 Purpose and scope of process instrumentation in industries 1.2 Process variables: temperature, pressure, flow, level, pH, conductivity, viscosity. 1.3 Transmission protocols: wiring, shielding, grounding, noise red 1.4 uction. 1.5 Error analysis, accuracy, precision, repeatability.	**07**
Module -2:	**Process control systems & automation** 2.1 Control Systems Basics 2.2 On/Off control, Proportional (P), Proportional-Integral (PI), Proportional-Integral-Derivative (PID) control 2.3 Distributed Control Systems (DCS) / PLC / SCADA 2.4 Alarm instrumentation, interlocks, safety shutdown systems	**08**

Module -3:	**Analytical instruments in process industries** 3.1 Spectroscopic Instruments for Process Analysis 3.2 Chromatographic Techniques 3.3 Electrochemical & pH/Conductivity Measurement 3.4 Process Analytical Technology (PAT)	**07**
Module -4:	**Process instrumentation implementation & data management** 4.1 Calibration protocols for process sensors and analytical devices 4.2 Data logging, SCADA interfaces, real-time monitoring dashboards 4.3 Mechanical installation of sensors, piping, wiring.	**08**

Reference Books:-

1. Anderson, Norman A. Instrumentation for Process Measurement and Control. 3rd ed. New York: Taylor & Francis, 2007.
2. McMillan, Gregory K., and Douglas M. Considine. Process/Industrial Instruments and Controls Handbook. 5th ed. New York: McGraw-Hill, 2009
3. A.P.Kulkarni, Process Instrumentation and Control. 21st ed. Pune, India: Nirali Prakashan, 2023.
4. T.R.Padmanabhan Industrial Instrumentation: Principles and Design. Berlin and Heidelberg: Springer-Verlag, 2000.
5. O.N.Pandey, Instrumentation and Process Control. 1st ed. New Delhi: S. K. Kataria & Sons, 2008.

Evaluation Pattern: 40:60

Total Marks: 50 M

Internal Continuous Evaluation: (20 M)	**End Semester Examination: (50 M)**
• CCE-I: 10 M • CCE-II: 10 M • CCE-III: 10 M • Total marks : 20 marks (Best of two CCE marks will be considered)	• Question -1 :10 M (2x5=10 M) • Question -2 :20 M (2x10=20 M) • Question -3 :20 M (4x5 =20 M) (Convert 50M into 30 M)

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Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Electronics

Programme: B.Sc.	**Semester - VI**
Type: DSC XIV	**Marks: 50**
Credits: 2	**From: A. Y. 2026-27**

Name of the Course: BIST 362- Optics and laser instrumentation

Course Objectives: By the end of the course, Students should be able to….

1. understand the fundamental concepts of wave optics such as interference, diffraction, polarization, coherence their applications in measurement systems.
2. develop knowledge of optical fibers and interferometric techniques and their role in modern instrumentation and sensing applications.
3. study the principles and working of lasers, including different types of lasers and their practical applications in scientific and industrial instrumentation.
4. apply geometrical optics concepts such as image formation, magnification, and resolving power in the design and analysis of optical instruments.

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

1. analyze the working and applications of optical fibers and interferometers used in instrumentation systems identify and explain the working of analytical instruments used in process industries.
2. evaluate resolving power and distinguish it from magnifying power in optical instruments using appropriate criteria.
3. explain the fundamental principles of wave optics, including interference, diffraction, polarization, and coherence, and their role in measurement techniques.
4. interpret process data and use it for monitoring and control purposes.

Module	Title and Contents	Hrs
Module -1:	**Wave optics for measurement** 1.1. Nature of light and Optical properties of materials 1.2. Interference and its applications 1.3. Diffraction techniques 1.4. Polarization and its use in sensing 1.5. Coherence and fringe formation	**07**
Module -2:	**Fiber Optic and Interferometry in Instrumentation** 2.1. Structure and working of optical fibers 2.2. Types of optical fibers (single-mode, multi-mode) 2.3. Michelson interferometer 2.4. Fabry–Perot interferometer	**08**

Module -3:	**Fundamentals of laser for instrumentation** 3.1. Basics of Laser operation and Properties of laser 3.2. Beam characteristics (divergence, intensity profile) 3.3. Ruby Laser 3.4. He–Ne Laser 3.5. Laser Applications	**07**
Module -4:	**Geometrical Optics** 4.1 Definition and properties of cardinal points of a lens system, coincidence of principal points and nodal points. 4.2 Image formation by cardinal points, Newton's formula, 4.3 Relation between focal lengths of an optical system, axial, lateral and angular magnifications Abbe's sine condition. 4.4 Resolving power Resolving power, Rayleigh's criterion for the limit of resolution.	**08**

Reference Books:-

1. K.Gerd. Optical Fiber Communications. 5th ed. New York: McGraw-Hill, 2021.
2. Bahaa E. A.and Malvin Carl Teich. Fundamentals of Photonics. 2nd ed. Hoboken, NJ: Wiley, 2007.
3. L.A.David Photonics: Scientific Foundations, Technology and Applications. Hoboken, NJ: Wiley, 2015.
4. K.K.Sharma Optics: Principles and Applications. New Delhi: Academic Press, 2006.
5. Pandey, Onkar N.Instrumentation and Process Control. 1st ed. New Delhi: S. K. Kataria & Sons, 2008.

Evaluation Pattern:40:60

Total Marks: 50 M

Internal Continuous Evaluation: (20 M)	**End Semester Examination: (50 M)**
• CCE-I: 10 M • CCE-II: 10 M • CCE-III: 10 M • Total marks : 20 marks (Best of two CCE marks will be considered)	• Question -1 :10 M (2x5=10 M) • Question -2 :20 M (2x10=20 M) • Question -3 :20 M (4x5 =20 M) (Convert 50M into 30 M)

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Board of Studies in Electronics

Programme: B.Sc.	**Semester - VI**
Type: DSC XV	**Marks: 50**
Credits: 2	**From: A. Y. 2026-27**

Name of the Course: BIST 363- Industrial Chemistry

Course Objectives: By the end of the course, Students should be able to….

1. understand the roles and responsibilities of chemists and chemical engineers in chemical industries.
2. develop understanding of the production processes of important inorganic industrial chemicals such as fertilizers, cement, lime, and ceramics.
3. know knowledge about sources, types, and preparation of raw materials used in chemical industries.
4. introduce petroleum refining processes such as cracking, reforming, and polymerization in the petrochemical industry.

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

1. identify the roles of chemists and chemical engineers in industrial production and process management.
2. classify different types of polymers and explain their industrial applications.
3. analyze various industrial chemical processes including catalytic reactions and separation techniques.
4. understand the importance of quality control and process optimization in chemical industries.

Module	Title and Contents	Hrs
Module -1	**Introduction to industrial chemistry** 1.1 Definition, scope, and importance in manufacturing and technology 1.2 Differences between laboratory chemistry and industrial chemistry 1.3 Role of chemical engineers and chemists in industry 1.4 Sources, types, and preparation of raw materials for chemical industries 1.5 Industrial Raw Materials	**07**
Module -2	**Inorganic industrial chemistry** 2.1 Production of nitrogenous (ammonia, urea), phosphatic, and potash fertilizers 2.2 Manufacture of Portland cement, lime, and ceramic materials 2.3 Role of chemistry in quality control 2.4 Types of glass and refractories, raw materials, and preparation methods 2.5 Production and uses of oxygen, nitrogen, hydrogen, carbon dioxide, and acetylene	**08**

Module -3	**Organic Industrial Chemistry** 3.1 Refining of crude oil, cracking, reforming, and polymerization processes. 3.2 Production of fuels, lubricants, and petrochemical intermediates. 3.3 Types of polymers (thermoplastics, thermosets, elastomers). 3.4 Polymerization techniques (addition and condensation) and industrial applications	**07**
Module -4	**Industrial Chemical Processes** 4.1 Batch vs continuous processes. 4.2 Catalysts and catalytic processes in industry. 4.3 Distillation, crystallization, filtration, extraction, and membrane separation. 4.4 Nylon, polyester, acrylics, and synthetic rubber. 4.5 Industrial processes and quality control	**08**

Reference Books:-

1. C. A. Heaton, An Introduction to Industrial Chemistry. 3rd ed. London: Blackie Academic & Professional, 1996.
2. Davis, Mark E., and Robert J. Davis. Fundamentals of Chemical Reaction Engineering. 1st ed. New York: McGraw-Hill, 2003.
3. L.B.Theodore , H. Eugene LeMay, Bruce E. Bursten, and Catherine J. Murphy. Chemistry: The Central Science. 14th ed. Boston: Pearson, 2018.
4. Speight, James G. The Chemistry and Technology of Petroleum. 5th ed. Boca Raton, FL: CRC Press, 2014.

Evaluation Pattern:40:60

Total Marks: 50 M

Internal Continuous Evaluation: (20 M)	**End Semester Examination: (50 M)**
• CCE-I: 10 M • CCE-II: 10 M • CCE-III: 10 M • Total marks : 20 marks (Best of two CCE marks will be considered)	• Question -1 :10 M (2x5=10 M) • Question -2 :20 M (2x10=20 M) • Question -3 :20 M (4x5 =20 M) (Convert 50M into 30 M)

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Board of Studies in Electronics

Programme: B.Sc.	**Semester - VI**
Type: DSC Practical	**Marks: 50**
Credits: 2	**From: A. Y. 2026-27**

Name of the Course: BISP 366: Practical's Based on Theory Course BIST 361, BIST 362, BIST 363

Course Objectives: By the end of the course, Students should be able to….

1. analyze signal transmission, wiring techniques, grounding, and noise reduction methods used in industrial instrumentation systems.
2. provide knowledge of different sensors and analytical instruments used in chemical and environmental industries.
3. develop understanding of the production processes of important inorganic industrial chemicals such as fertilizers, cement, lime, and ceramics.
4. describe skills in data acquisition, calibration, real-time monitoring, and quality control in industrial systems.

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

1. understand the basic concepts of process instrumentation and industrial chemistry.
2. identify and operate different types of sensors and industrial instruments.
3. measure and analyze key process variables used in industrial operations.
4. evaluate resolving power and distinguish it from magnifying power in optical instruments using appropriate criteria.
5. study the importance of quality control and process optimization in chemical industries.

Sr. No	List of Experiments	Hrs
1.	Study of beam divergence of He–Ne Laser	60
2.	Study of interference using Newton's Rings	
3.	Determination of wavelength using diffraction grating	
4.	Study of diffraction pattern using single slit	
5.	Determination of wavelength of light using Young's Double Slit Experiment	
6.	Determination of wavelength using laser diffraction	
7.	Verification of Malus's Law using polarizers	
8.	Study of filtration process in chemical separation.	
9.	Demonstration of liquid-liquid extraction technique.	
10.	Determination of refractive index using liquid lens method	
11.	Study of polarization using Brewster's Law	
12.	Measurement of displacement using Fabry–Perot Interferometer	

13.	Measurement of dissolved oxygen in water**.**	
14.	Measurement of soil moisture using soil sensor**.**	
15.	Demonstration of UV–Visible spectrophotometer for process analysis.	

Reference Books:-

1. D.J. Curtis . Process Control Instrumentation Technology. 8th ed. Upper Saddle River, NJ: Pearson Education, 2006.
2. P.B.John. Principles of Measurement Systems. 4th ed. Harlow, UK: Pearson Education, 2005.
3. W.Bolton, Programmable Logic Controllers. 6th ed. Oxford: Newnes (Elsevier), 2015.
4. J. A. George . Shreve's Chemical Process Industries. 5th ed. New York: McGraw-Hill, 1984.
5. McCabe, Warren L., Julian C. Smith, and Peter Harriott. Unit Operations of Chemical Engineering 7th ed. New York: McGraw-Hill Education, 2005.

Evaluation Pattern:40:60

Total Marks: 50 M

Internal Continuous Evaluation: (20 M)	**End Semester Examination: (30 M)**
• Journal: 10 M • Students Performance: 05 M • Viva : 05 M	• **Q. -1 = 30M**

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Programme: B.Sc.	**Semester - VI**
Type: DSC XVI (E1)	**Marks: 50**
Credits: 2	**From: A. Y. 2026-27**

Name of the Course: BIST 364- Industrial physics

Course Objectives: By the end of the course, students should be able to….

1. understand the fundamental principles of mechanics and material properties such as stress, strain, elasticity, and friction in industrial applications.
2. develop knowledge of thermal physics and heat transfer processes including thermodynamics, heat engines, and cooling systems.
3. introduce the concepts of optics, lasers, ultrasonics and their role in modern industrial technologies.
4. explain the working principles of electrical and magnetic systems such as motors, transformers, and generators.

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

1. analyze and apply concepts of stress, strain, and material properties in engineering and industrial contexts.
2. explain and evaluate heat transfer mechanisms and the performance of thermal systems like boilers and heat exchangers.
3. demonstrate understanding of optical and ultrasonic techniques used in industrial inspection and communication systems.
4. describe the operation and applications of electrical machines and magnetic systems in industry.

Module	Title and Contents	Hrs
Module -1:	**Mechanics and properties of materials** 1.1 Stress, strain, elasticity, plasticity 1.2 Tensile, compressive, and shear stresses 1.3 Young's modulus, shear modulus, bulk modulus 1.4 Hardness, toughness, fatigue 1.5 Types of friction, lubrication techniques 1.6 Wear mechanisms in industrial machinery	**07**
Module -2:	**Thermal physics and heat transfer** 2.1 Laws of thermodynamics, internal energy, enthalpy 2.2 Industrial heat engines and refrigerators 2.3 Conduction, convection, radiation 2.4 Thermal conductivity, heat exchangers, insulation 2.5 Boilers, furnaces, heat treatment of metals 2.6 Cooling of electrical machines and reactors	**08**

Module -3:	**Optics, lasers & ultrasonics** 3.1 Reflection, refraction, diffraction, interference 3.2 Industrial applications: lenses, optical fibers, imaging systems 3.3 Principles of laser operation 3.4 Generation and detection of ultrasonic waves 3.5 Industrial applications: non-destructive testing (NDT), cleaning, welding	**08**
Module -4:	**Electrical, magnetic and nuclear physics applications** 4.1 Electric and magnetic fields, Faraday's law, Induction 4.2 Industrial motors, transformers, and generators Hysteresis, magnetic circuits, solenoids 4.3 Radioactivity, half-life, radiation safety 4.4 Industrial applications: radiography, material testing, energy production	**07**

Reference Books:-

1. R.Prasad, Physics and Technology for Engineers: Understanding Materials and Sustainability. Cham: Springer, 2023.
2. Bueche, Frederick J. Technical Physics. 4th ed. New York: John Wiley & Sons, 1994.
3. W.A.Neil., N. David Mermin. Solid State Physics. 1st ed. San Francisco: Saunders College Publishing, 1976.
4. H.N.John., IV, and John H. Lienhard, V. A Heat Transfer Textbook. 5th ed. Mineola, NY: Dover Publications, 2019.
5. D.J.John Classical Electrodynamics. 3rd ed. Hoboken, NJ: John Wiley & Sons, 1999.

Evaluation Pattern:40:60	
Total Marks: 50 M	
Internal Continuous Evaluation: (20 M) • CCE-I: 10 M • CCE-II: 10 M • CCE-III: 10 M • Total marks : 20 marks (Best of two CCE marks will be considered)	**End Semester Examination: (50 M)** • Question -1 :10 M (2x5=10 M) • Question -2 :20 M (2x10=20 M) • Question -3 :20 M (4x5 =20 M) (Convert 50M into 30 M)

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Programme: B.Sc.	**Semester - VI**
Type: DSC XVI (E2)	**Marks: 50**
Credits: 2	**From: A. Y. 2026-27**

Name of the Course: BIST 365- Industrial ethics for instrumentation

Course Objectives: By the end of the course, students should be able to….

1. know the fundamental concepts, scope and importance of industrial ethics in instrumentation and engineering practices.
2. develop awareness of professional ethics, integrity, moral values, and responsibilities toward employers, clients, and society.
3. understand ethical decision-making, conflict of interest, intellectual property rights (IPR), patents, confidentiality, and data protection.
4. study knowledge of industrial safety, risk assessment, hazard analysis, and ethical responsibilities in the design and operation of instrumentation systems.

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

1. explain the principles, scope, and significance of ethics in industrial and instrumentation practices.
2. apply professional ethical principles and demonstrate responsible behavior toward employers, clients, colleagues and society.
3. analyze ethical issues involving conflict of interest, IPR, patents, confidentiality, data protection, and professional decision-making.
4. evaluate safety risks, hazards, and ethical considerations associated with the design, installation, operation, and maintenance of instrumentation systems.

Module	Title and Contents	Hrs
Module -1:	**Introduction to industrial ethics** 1.1 Definition and scope of ethics 1.2 Importance of ethics in industry and instrumentation 1.3 Moral values, integrity, and professional responsibility 1.4 Ethics vs law and compliance 1.5 Role of ethics in technological development	**07**
Module -2:	**Professional ethics in instrumentation** 2.1. Code of ethics for engineers and instrumentation professionals. 2.2 Responsibilities towards employers, clients, and society. 2.3 Conflict of interest and ethical decision-making 2.4 Intellectual property rights (IPR) and patents 2.5. Confidentiality and data protection	**08**

Module -3:	**Safety, standards and quality ethics** 3.1 Industrial safety practices and ethical responsibility 3.2 Risk assessment and hazard analysis 3.3 Ethical issues in design and operation of instruments 3.4 Quality control, calibration, and accuracy standards 3.5 National and international standards (ISO, BIS)	**08**
Module -4:	**Environmental and social ethics** 4.1 Environmental impact of industrial instrumentation 4.2 Sustainable development and green technologies 4.3 Waste management and pollution control 4.4 Ethical responsibility towards society and environment 4.5 Corporate Social Responsibility (CSR)	**07**

Reference Books: -

1. C. E. Harris Jr., M. S. Pritchard, M. J. Rabins, R. W. James, E. E. Englehardt, Engineering Ethics: Concepts and Cases, Cengage Learning, 2014
2. C. B. Fleddermann, Engineering Ethics, Pearson, 2011
3. A. Brunelli, Calibration Handbook of Measuring Instruments, International Society of Automation (ISA), 2017
4. M. W. Martin, R. Schinzinger, Ethics in Engineering, McGraw-Hill, 2005

Evaluation Pattern: 40:60

Total Marks: 50 M

Internal Continuous Evaluation: (20 M)	**End Semester Examination: (50 M)**
• CCE-I: 10 M • CCE-II: 10 M • CCE-III: 10 M • Total marks : 20 marks (Best of two CCE marks will be considered)	• Question -1 :10 M (2x5=10 M) • Question -2 :20 M (2x10=20 M) • Question -3 :20 M (4x5 =20 M) (Convert 50M into 30 M)

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Electronics

Programme: B.Sc.	**Semester - VI**
Type: DSE Practical	**Marks: 50**
Credits: 2	**From: A. Y. 2026-27**

Name of the Course: BISP 367: Practical Lab based on BIST 364 &BIST 365 (Elective)

Course Objectives: By the end of the course, students should be able to….

1. evaluate mechanical properties of materials such as elasticity, hardness, and wear using standard experimental methods.
2. analyze heat transfer mechanisms and determine thermal properties like conductivity and radiation characteristics.
3. study optical and modern physics concepts including focal length determination and the Photoelectric effect.
4. understand electrical and magnetic behavior through experiments on circuits and field measurements.

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

1. determine material properties like Young's modulus, shear modulus, and hardness with accuracy.
2. gain practical knowledge of heat transfer processes and calculate thermal conductivity and radiative heat loss.
3. develop skills in analyzing optical systems and quantum phenomena experimentally.
4. measure and interpret electrical circuit responses and magnetic field distributions.

Sr. No	List of Experiments	Hrs
1	Determination of Young's Modulus using Searle's apparatus	60
2	Determination of Young's Modulus by cantilever bending	
3	Determination of shear modulus using torsion pendulum	
4	Hardness test using Brinell Hardness Test	
5	Wear analysis using pin-on-disc apparatus	
6	Determination of thermal conductivity (Lee's disc method)	
7	Determination of thermal conductivity of metal rod (Searle's method)	
8	Verification of Stefan–Boltzmann Law	
9	Ultrasonic cleaning experiment	
10	Measurement of magnetic field using Hall effect sensor	
11	Experimental verification of Hooke's law	

12	Determination of focal length using lens displacement method
13	Study of photoelectric effect (simulation/kit)
14	Study of RL and RC circuits response
15	Renewable energy experiment (solar panel characteristics)

Reference Books:-

1. P. B. Ferdinand , E. Russell Johnston Jr., John T. DeWolf, and David F. Mazurek. Mechanics of Materials. New York: McGraw-Hill Education, 2020.
2. J. P. Holman, Heat Transfer. New York: McGraw-Hill Education, 2010.
3. H.Eugene. Optics. 5th ed. Boston: Pearson Education, 2017.
4. J.G. David , Introduction to Electrodynamics. 4th ed. Cambridge: Cambridge University Press, 2017.

Evaluation Pattern:40:60	
Total Marks: 50 M	
Internal Continuous Evaluation: (20 M) • Journal: 10 M • Students Performance: 05 M • Viva : 05 M	**End Semester Examination: (30 M)** • **Q. -1 = 30M**

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Programme: B.Sc.	**Semester - VI**
Type: DSC Practical	**Marks: 50**
Credits: 2	**From: A. Y. 2026-27**

Name of the Course: BISPVSC IV: Python Programming

Course Objectives: By the end of the course, students should be able to….

1. develop a strong foundation in Python programming with an emphasis on mathematical problem-solving and scientific simulations.
2. enable students to apply programming concepts for solving algebraic, numerical, and physics-related problems.
3. introduce students to data visualization techniques using Python for analyzing mathematical functions and physical phenomena.
4. foster computational thinking through simulations of real-world scientific experiments like projectile motion, wave functions, and quantum mechanics.

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

1. write Python programs to solve mathematical problems involving arithmetic operations, number theory, and algebraic equations.
2. apply control structures, functions, and iterative techniques to generate mathematical series, Fibonacci sequences, and prime number evaluations.
3. implement Python-based simulations for visualizing physical phenomena such as projectile motion, wave functions, and quantum energy levels.
4. utilize Python libraries for plotting graphs and simulating scientific experiments like the double-slit interference pattern and harmonic oscillators.

Sr. No	List of Experiments	Hrs
1	Write a program to swap two numbers using temporary Variable.	60
2	Write a program to find the largest of two numbers.	
3	Write a program to find the largest of three numbers.	
4	Write a program to find even number between 1 to 50	
5	Write a program to find odd numbers between 1 to n where n is a positive Integer.	
6	Write a program to find sum of series 1+2+3+…..+N.	
7	Write a program to find sum of series 1+3+5+…..+N, Where N is positive odd integer.	
8	Write a program to find sum of series 1 – X + X2 –X 3 ….XN	
9	Write a program to print multiplication Table of a number.	
10	Write a program to generate first n Fibonacci terms 0,1,1,2,3,5…n (n>2).	

11	Write a program to find sum and average of given series of numbers.
12	Write a program to find roots of quadratic equations AX2+BX+C=0
13	Write a program to find if a number is prime or not.
14	Write a program to find GCD and LCM of two numbers
15	Write a program to find Factorial of number n (n!=1x2x3x…n).

Reference Books:-

1. Lutz, Mark. Learning Python. 5th ed. Sebastopol, CA: O'Reilly Media, 2013.
2. Zelle, John M. Python Programming: An Introduction to Computer Science. 2nd ed. Franklin, Beedle & Associates, 2010.
3. Downey, Allen B. Think Python: How to Think Like a Computer Scientist. 2nd ed. Needham, MA: Green Tea Press, 2015.
4. Langtangen, Hans Petter. A Primer on Scientific Programming with Python. 5th ed. Cham: Springer, 2016.

Evaluation Pattern:40:60	
Total Marks: 50 M	
Internal Continuous Evaluation: (20 M) • Journal: 10 M • Students Performance: 05 M • Viva : 05 M	**End Semester Examination: (30 M)** • **Q. -1 = 30 M**

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Programme: B.Sc.	**Semester - VI**
Type: DSC Practical	**Marks: 50**
Credits: 2	**From: A. Y. 2026-27**

Name of the Course: BISPSEC III: Material science instrumentation

Course Objectives: By the end of the course, students should be able to….

1. develop practical skills in electrochemical characterization techniques such as Galvanostatic Charge–Discharge (GCD), Linear Sweep Voltammetry (LSV), Chronoamperometry (CA), Chronopotentiometry (CP), and Electrochemical Impedance Spectroscopy (EIS).
2. provide hands-on experience in gas sensing measurements and evaluation of sensor performance parameters including sensitivity, selectivity, response time, and recovery time.
3. train students in thin-film deposition using Physical Vapor Deposition (PVD), thickness measurement, and particle size analysis using ImageJ software.
4. develop competency in scientific data analysis, graph plotting, curve fitting, and interpretation of experimental results using Origin software.

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

1. perform electrochemical characterization of materials using GCD, LSV, CA, CP and EIS techniques and interpret the obtained results.
2. evaluate the gas sensing performance of materials by analysing sensitivity, selectivity, response characteristics, and stability.
3. analyse XRD data to calculate crystallite size, determine interplanar spacing and identify crystal phases using JCPDS/ICDD standard data cards.
4. fabricate thin films using PVD techniques and characterize their thickness, morphology and particle size using ImageJ software.

Sr. No	List of Experiments	Hrs
1	Study and calibration of a gas sensing measurement system for resistance-based gas sensors.	60
2	Measurement and analysis of gas sensing performance (sensitivity, response time, recovery time, and selectivity).	
3	Galvanostatic Charge–Discharge (GCD) analysis for determination of specific capacitance and cycling stability.	
4	Linear Sweep Voltammetry (LSV) for evaluation of electrochemical behavior and oxidation/reduction potential.	
5	Cyclic Voltammetry (CV) for investigating the electrochemical characteristics of electrode materials.	
6	Chronoamperometry (CA) for studying current–time response under constant potential.	
7	Chronopotentiometry (CP) for analyzing potential–time response under constant current.	
8	Electrochemical Impedance Spectroscopy (EIS) for determination of solution resistance, charge transfer resistance, and equivalent circuit analysis.	
9	Calculation of crystallite size using the Scherrer equation from X-ray diffraction (XRD) data.	

10	Determination of interplanar spacing (d-spacing) from XRD peaks using Bragg's law.
11	Identification and indexing of crystal planes from XRD diffraction patterns.
12	Matching experimental XRD patterns with standard JCPDS/ICDD data cards for phase identification.
13	Measurement of particle size using ImageJ software from SEM/TEM micrographs.
14	Analysis of particle size distribution and histogram generation using ImageJ software.
15	Measurement of thin-film thickness using profilometer or cross-sectional SEM analysis.

Reference Books:-

1. A. J Bard and L. R. Faulkner. Electrochemical Methods: Fundamentals and Applications. 2nd ed. New York: John Wiley & Sons, 2001.
2. B. D Cullity,., and S. R. Stock. Elements of X-Ray Diffraction. 3rd ed. Upper Saddle River, NJ: Prentice Hall, 2001.
3. C.Wang, L. Yin, L. Zhang, D. Xiang, and R. Gao. Metal Oxide Gas Sensors: Sensitivity and Influencing Factors. Sensors, 2010.
4. Ohring, M. Materials Science of Thin Films: Deposition and Structure. 2nd ed. San Diego: Academic Press, 2002.

Evaluation Pattern:40:60

Total Marks: 50 M

Internal Continuous Evaluation: (20 M)	**End Semester Examination: (30 M)**
• Journal: 10 M • Students Performance: 05 M • Viva : 05 M	• **Q. -1 = 25M**

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Programme: B.Sc	**Semester - VI**
Type: FP	**Marks: 50**
Credits: 2	**From: A. Y. 2026-27**

Name of the Course: BISPFP: Field Project in Instrumentation

Course Objectives: By the end of the course, students should be able to….

1. provide students with practical exposure to real-world instrumentation systems through field-based projects in industries, research laboratories, healthcare, environmental, or agricultural sectors.
2. enable students to identify, analyze, and solve practical problems using instrumentation principles, measurement techniques, and data acquisition systems.
3. develop skills in planning, executing, documenting, and presenting field projects using scientific and engineering methodologies.
4. enhance teamwork, communication, project management, and professional ethics while working in multidisciplinary environments.

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

1. identify and analyze real-life problems in the field and propose appropriate instrumentation-based solutions.
2. apply instrumentation techniques, measurement methods, and data analysis tools to execute field projects effectively.
3. demonstrate the ability to collect, interpret, and present experimental or field data using scientific and engineering practices.
4. exhibit professional ethics, teamwork, communication, and project management skills during field-based activities.

BISPFP-I: Field Project in Instrumentation Science

Credits: 02

The main purpose is to bridge the gap between theoretical knowledge and practical application. Students identify a real-world problem, collect data, design or select an instrumentation system, implement it, test its performance, and prepare a technical report.

Evaluation Pattern:40:60	
Total Marks: 50 M	
Internal Continuous Evaluation: (20 M) **Q.1 20 M**	**End Semester Examination: (30 M)** • **Q. -1 = 30M**

Bachelor of Science (B.Sc.) Part- III: Instrumentation Science

Semester VI

C.C. (Co-Curricular) (Credit 2)

Evaluation Pattern:40:60	
Total Marks: 50 M	
Internal Continuous Evaluation: (20 M) **Q.1 20 M**	**End Semester Examination: (30 M)** • **Q. -1 = 30M**