

BT-106 PRINCIPLES OF BIOLOGICAL INSTRUMENTATION

Course details:

Course Title	Principles of Biological Instrumentation	Course Code	BT 106
Year	3	Course Group	Core
Teaching scheme in periods (L:T:P)	4:1:0	Credits	3
Type of Course	Lecture + Assignments	Total Contact periods	150
CIE	60 Marks	YEE	40 Marks

Pre-requisites:

This course requires the basic knowledge of Biology at Secondary School level.

Course Outcomes: (COs)

At the end of the course, the student will able to:

CO1	Learn the principles of electromagnetic radiation, spectrum and their application in instrumental analysis
CO2	Learn the principles Optics and their application in instrumental analysis
CO3	Learn the instruments based on principles of measurement of electrical signals in biological systems
CO4	Learn the instruments based on principles of separation
CO5	Learn the mechanical & hydrodynamic principles and their application in instrumental analysis
CO6	Learn the principle of signal Processing & Instrumentation Electronics in instrumental analysis

	Basic and Discipline Specific Knowledge	Problem Analysis	Design/Development of Solutions	Engineering Tools, Experimentation and Testing	Engineering Practices for Society, Sustainability and Environment	Project Management	Lifelong Learning	Linked PO
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	
CO1	3	2	-	-	-	-	2	1,2,7
CO2	3	-	1	1	1	-	2	1,3,4,5,7
CO3	3	-	-	1	1	-	2	1,4,5,7
CO4	3	-	-	1	-	-	2	1,4,7
CO5	3	-	-	1	1	-	2	1,4,5,7
CO6	3	-	1	1	1	-	2	1,3,4,5,7

CO-PO MAPPING

TIME SCHEDULE

S.No	Content	Periods
1	Unit 1	24
2	Unit 2	26
3	Unit 3	28
4	Unit 4	22
5	Unit 5	22
6	Unit 6	28

Course contents

Unit I

DURATION: 24

Introduction to Biological instruments and electromagnetic spectrum

Definition and importance of Biological Instrumentation, classification of biological instruments (basic & advanced)

Principle of Measurement Science-Basic Measurement terms, Units of measurement used in laboratories

Errors, precision, sensitivity and accuracy: Types of errors, methods of expressing accuracy and precision, confidence limits, sensitivity and detection limit for instruments

Calibration – Need and general methods of Calibration

Laboratory safety and maintenance of instruments

Introduction to Electromagnetic Spectrum.

Interaction of electromagnetic radiation with matter and transition between molecular energy levels. Types of molecular energies, classification of instrumental methods based on electromagnetic spectrum

Unit II

DURATION:26

Optical Principles

Principle of Microscopy-Simple and compound microscopes, Magnification and resolution for determination of image clarity.

Instruments based on principles of interaction of light with biological samples, Beer–Lambert Law, Colorimeter, UV–Visible spectrophotometer, Components of spectrophotometer.

Principle of Optical density (OD) measurement- Spectrofluorometer, Microplate reader, Principle of ELISA Reader (Microplate reader)

Unit III

DURATION: 28

Electrical & Electrochemical Principles

Instruments working on the principles of measurement of electrical signals in biological systems: working and principle of pH meter and Conductivity Meter.

Electrochemistry and Electrophoresis, applications of electrophoresis,

Classification of sensors, characteristics of sensors, Temperature sensors- Thermocouple and Thermistor.

Biosensors and classification, working principle of biosensors, types and applications of biosensors

Unit IV

DURATION: 22

Instruments based on principles of separation of substances based on physical and chemical properties: Filtration Unit, different types of filters

Chromatographic principles, Types of chromatography, Paper chromatography, TLC, Column chromatography

Unit V

DURATION: 22

Mechanical & hydrodynamic Principles:

Instruments based on principles of motion and force in biological systems-Centrifuge, Ultracentrifuge, Viscometer.

Principle of Fluid mechanics-Tensiometer.

Principles involved in downstream process, Types of instruments used in downstream process, Lyophilisers

Unit VI

DURATION: 28

Principle of Sterilization, Filtration as sterilization method, Automation and Control

Principle of Sterilization and Heat transfer, Methods of Sterilization- applications and limitations

Filtration as sterilization method –principles, types of Filtration methods, Applications of Membrane filters and Ultrafine-filtration units.

Principle of gravitational force –Sedimentation Tank.

Principle of Automation and Control- PCR machines, Automated analysers, Bioreactors

TEXT BOOKS

1. Biophysical Chemistry: Principles & Techniques by Upadhya & Upadhya, 4th Edition, Himalaya Publishing House, 2012.
2. Instrumental Methods of Chemical Analysis – Gurudeep R. Chatwal and Sham K. Anand, Himalaya Publishing House, ISBN.

REFERENCES

1. Hobert H. Willard, D. L. Merritt & J. R. J. A. Dean, Instrumental Methods of Analysis, CBS Publishers & Distributors.
2. Pranab Kumar Banerjee, Introduction to Biophysics, S. Chand Publications, 2008.
3. Principles & Techniques of Practical Biochemistry, 5th Edition, K. Wilson & J. Walker, Cambridge University Press, 2000.

Learning outcomes

Upon completion of this course the student will be able to

CO1

- 1.1 Define Biological instruments and their importance in biotechnology
- 1.2 Classify of biological instruments
- 1.3 Define the measurement terms, and Units of measurement used in laboratories
- 1.4 Define errors, precision, sensitivity and accuracy in biological instrumentation
- 1.5 List out the types of errors in biological instrumentation
- 1.5 Explain the methods of expressing accuracy and precision, confidence limits, sensitivity and detection limit for instruments
- 1.6 Explain calibration of biological instruments, its need and methods
- 1.6 Explain laboratory safety and maintenance of instruments
- 1.7 Define Electromagnetic Spectrum.
- 1.8 Describe the interaction of electromagnetic radiation with matter and transition between molecular energy levels.
- 1.9 Define the types of molecular energies
- 1.10. Classify biological instrumental methods based on electromagnetic spectrum

CO2

- 2.1 Define Optical Principles
- 2.2 Explain the principle of Microscopy and Simple, compound microscopes
- 2.3 Explain magnification and resolution for determination of image clarity
- 2.4 Define the principles of interaction of light with biological samples
- 2.5 Explain Beer–Lambert Law,
- 2.6 Explain the principle and working of Colorimeter,
- 2.7 Explain the principle and working of UV–Visible spectrophotometer
- 2.8 Define Optical density and its measurement
- 2.9 Explain the principle and working of Spectrofluorometer
- 2.10 Explain the principle and working of Microplate reader
- 2.11 Explain the principle and working of ELISA Reader (Microplate Reader)

CO3

- 3.1 Define electrical & electrochemical Principles
- 3.2 List the Instruments working on the principles of measurement of electrical signals
in biological systems:
- 3.3 Explain the principles and working and principle of pH meter
- 3.4 Explain the working and principle of Conductivity Meter
- 3.5 Define electrochemistry and electrophoresis
- 3.6 List out the applications of electrophoresis
- 3.7 Define and classify sensors and its characteristics
- 3.7 List out temperature sensors
- 3.8 Explain Thermocouple and Thermistor
- 3.9 Define Biosensors and their components
- 3.10. Explain the working principle of biosensors.
- 3.11 List out the types of biosensors and
- 3.12 List out the applications of biosensors

CO4

- 4.1 Define the principle of separation
- 4.2 List out Instruments working on the principles of separation
- 4.3 Define filtration
- 4.4 List out different types of filters
- 4.5 Define Chromatography and its principles
- 4.6 Explain the types of chromatography
- 4.5 Explain the working and principle involved in Paper chromatography,
- 4.6 Explain the working and principle involved in TLC
- 4.7 Explain the working and principle involved in column chromatography

CO5

- 5.1 Define the Mechanical & hydrodynamic Principles
- 5.2 List out the working of instruments based on principles of Motion and force in
biological systems:
- 5.3 Explain the working and principle involved in Centrifuge
- 5.4 Explain the working and principle involved in Ultracentrifuge

- 5.5 Explain the working, principle and applications involved in Viscometer
- 5.6 Define fluid mechanics
- 5.7 Explain the working and principle involved in Tensiometer
- 5.8 Define the Principles involved in Downstream processes
- 5.9 List out the instruments used in downstream process
- 5.10 Explain the working and principle involved in Lyophilisers

CO6

- 6.1 Define sterilisation and heat transfer
- 6.2 Explain the different methods of sterilization
- 6.3 Describe the applications and limitations of different sterilization techniques
- 6.4 Define filtration and types of filtration methods
- 6.5 Explain membrane filters, its applications
- 6.6 Explain Ultracentrifugation and its applications
- 6.7 Explain Sedimentation Tank and Centrifuge for size separation
- 6.8 Define Electrophoresis
- 6.9 Explain the principles of Electrophoresis of proteins and nucleic acids
- 6.10 Explain the types of electrophoretic techniques
- 6.11 Explain the principles of 1D gel Electrophoresis
- 6.12 Explain the principle of Automation and Control-- PCR machines
- 6.13 Explain the principle of Automated Analyzers
- 6.14 Explain the principle of Bioreactors

Course Content and Blue Print of Marks for MID Examinations & Semester End Examination (YEE)

MID-I Examination					
S. No	Unit	Questions to be set for MID Exam			Remarks
		R	U	A	
1	UNIT-1	1, 2	5(a) 5(b)	7(a) 7(b)	
2	UNIT-2	3, 4	6(a) 6(b)	8(a) 8(b)	
Total Questions		4	4	4	
MID-II Examination					
S. No	Unit	Questions to be set for MID Exam			Remarks
		R	U	A	
1	UNIT-3	1, 2	5(a) 5(b)	7(a) 7(b)	
2	UNIT-4	3, 4	6(a) 6(b)	8(a) 8(b)	
Total Questions		4	4	4	

Semester End Examination (YEE)

S. No	Unit	Questions to be set for YEE				Remarks	
		R		U	A		
1	UNIT-1	4	1		9(a)	13(a)	
2	UNIT-2						
3	UNIT-3		2		10(a)	14(a)	
4	UNIT4						
5	UNIT-5		3	5, 6	9(b)	13(b)	
					11(a)	15(a)	
		11(b)			15(b)		
6	UNIT- 6	7,8		10(b)	14(b)		
			12(a)	16(a)			
			12(b)	16(b)			
Total Questions		8		8	8		

Legend:	Remembering (R)	1 Mark
	Understanding (U)	3 Marks
	Application (A)	5 Marks

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DIPLOMA EXAMINATION (C 26)
MID 1 EXAMINATION

BT 106 Principles of Biological Instrumentation
Model Question paper

Duration: 1hour

Max. Marks: 20

PART-A

- Instructions:
1. Answer **ALL** questions.
 2. Each question carries **ONE** mark.

4 X 1 = 4

1. Define electromagnetic radiation.
2. What is meant by precision in measurements?
3. State Beer–Lambert law.
4. Name any one instrument based on fluorescence.

PART – B

Instructions:

1. Answer **ALL** questions.
2. Each question carries **THREE marks**.

2 X 3 = 6

5(a) Explain the types of molecular energy levels in biomolecules.

OR

5(b) Classify biological instruments based on the electromagnetic spectrum.

6(a) Describe systematic and random errors in biological measurements.

OR

6(b) Explain the principle and applications of a colorimeter.

PART-C

- Instructions:
1. Answer **ALL** questions.
 2. Each question carries **FIVE** marks.

2 X 5 = 10

7(a) Explain the need for calibration and importance in accuracy in the process

of calibration of biological instruments

OR

7(b) Describe electromagnetic spectrum with suitable diagram. Explain its role in analytical instrumentation.

8(a) Describe the principle, construction, and working of a UV–Visible spectrophotometer.

OR

8(b) Explain the principle, instrumentation, and applications of a microplate reader (ELISA reader).

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**DIPLOMA EXAMINATION (C 26)
MID 2 EXAMINATION**

**BT 106 Principles of Biological Instrumentation
Model Question paper**

Duration: 1hour

Max. Marks: 20

PART-A

- Instructions: 1. Answer **ALL** questions.
2. Each question carries **ONE** mark.

4 X 1 = 4

1. Define electrochemistry.
2. What is electrophoresis?
3. Define chromatography.
4. Name any one temperature sensor.

PART-B

- Instructions: 1. Answer **ALL** questions.
2. Each question carries **THREE** marks.

2 X 3 = 6

5(a) Explain the principle and working of a pH meter.

OR

5(b) Define sensors and list their important characteristics

6 (a) Describe the principle of electrophoresis and list its applications.

OR

6(b) Explain the principle of separation and list instruments based on separation techniques.

PART-C

- Instructions: 1. Answer **ALL** questions.
2. Each question carries **FIVE** marks.

2 X 5 = 10

7(a) Define biosensors. Explain the working, principle and application of biosensors

OR

7(b) Explain the construction and working of (i) Thermocouple (ii) Thermistor

8(a) Describe the principle, working, and applications of paper chromatography.

OR

8(b) Explain the principle, working, and applications of thin layer chromatography (TLC).

DIPLOMA EXAMINATION (C 26)
YEAR END EXAMINATION
BT 106 Principles of Biological Instrumentation
Model Question paper

Duration: 2 hours

Max. Marks: 40

PART – A

- Instructions: 1. Answer **ALL** questions.
 2. Each question carries **ONE** mark.

8 X 1 = 8

1. Define detection limit.
2. What is electrophoresis?
3. What is lyophilization?
4. Name any one type of filter.
5. Define centrifugation
6. Name any one downstream processing instrument
7. What is electrophoresis of proteins?
8. What is automation in biological instrumentation

PART – B

- Instructions: 1. Answer **ALL** questions.
 2. Each question carries **THREE** marks.

4X 3 = 12

9(a). Classify instrumental methods based on electromagnetic spectrum.

OR

9(b) Explain the principle of a tensiometer.

10(a). Explain the principle of paper chromatography.

OR

10.(b). Describe applications of membrane filters.

11(a). List instruments used in downstream processing

OR

11(b). Explain the principle of centrifugation.

12(a). Explain principles of electrophoresis.

OR

12(b). Describe the principle of PCR automation.

PART – C

Instructions: 1. Answer **ALL** questions.

2. Each question carries **FIVE** marks.

4 X 5 = 20

13(a). Explain molecular energy levels and their transitions with examples

OR

13(b). Explain the principle, construction, and working of a lyophilizer.

14(a). Explain biosensors—types, working principle, and applications.

OR

14(b). Explain different sterilization methods with applications and limitations

15(a). Describe ultracentrifuge—principle and applications.

OR

15(b) what is downstream process. List out the instruments used in used in downstream. Explain the application of Chromatography in downstream process.

16(a). Explain electrophoresis of proteins and nucleic acids.

OR

16(b). Explain the principle and applications of Bioreactors.

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