

As Per NEP 2020

University of Mumbai



Syllabus for Minor Vertical 2

Faculty of Engineering

Board of Studies in Biomedical Engineering

Second Year Programme in Minor (Biomedical Engineering)

Semester	IV	
Title of Paper (Theory)	Sem.	Total Credits 4
I) Diagnostic and Monitoring Instruments	IV	3
Title of Paper (Lab)		Credits
II) Diagnostic and Monitoring Instruments Lab	IV	1
From the Academic Year		2025-26

Sem. - IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2054211	Diagnostic and Monitoring Instruments	3	--	-	3	-	-	3

Course Code	Course Name	Theory							Total
		Internal Assessment (IAT)			End Sem Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	IAT-I + IAT-II (Total)					
2054211	Diagnostic and Monitoring Instruments	20	20	40	60	2			100

Rationale:

Biomedical Instruments are used to measure, monitor, record, evaluate and treat biological systems and are essential for medical treatments. Hence, to learn and study the various diagnostic and monitoring, analytical instruments, point care devices are very important. Students will learn the fundamentals of instrumentation, principles of operation, calibration and maintenance. They also develop skills in circuit design and laboratory skills.

Course Objectives:

1. To understand the basic principles and working of Diagnostic Instruments
2. To develop skills enabling Biomedical Engineers to serve the health care industry
3. To develop core competency and skill in the field of Biomedical Engineering, to design and develop new health care systems.

Course Outcomes: Learner will be able to

1. Demonstrate the building blocks of Instrumentation
2. Explain the Origin of bio potentials and their measurement techniques.
3. Describe the basic principle and working of Patient Monitoring Systems
4. Explain basic principle and working of Pulmonary Function Analyzer, Various Respiration measurement techniques
5. Explain the principles of various analytical instruments and different types of Blood cell Counters used in hospital and laboratories
6. Demonstrate the basic principle and working of Foetal and Neonatal Monitoring System.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	Building blocks of Instrumentation	Amplifiers, Differential, Instrumentation and Isolation Amplifier Rectifiers, Differentiator, Integrator Low pass, High Pass, Band Pass & Band Reject Filters	08	CO1

		Peak detector		
II	Origin of bio potentials and measurement techniques	Basic principle, working and technical specifications of ECG, EMG and EEG machines, LEAD configurations, 10-20 electrode system, measuring techniques for EOG, ERG and Phonocardiography	08	CO2
III	Patient Monitoring Systems	Basic principle and working of Patient Monitoring Systems: Measurement of Heart rate, Pulse rate, Blood pressure, Temperature and Respiration rate, Apnea detector. Heart rate variability measurement.	08	CO3
IV	Respiration measurement & Pulmonary Function Analyser	Basic principle and working of Pulmonary Function Analyzer Respiration measurement technique: Lung volume and capacities, Spirometry, Nitrogen washout, Helium dilution.	07	CO4
V	Analytical Instruments and Blood Cell Counters	Basic principle, working and technical specifications of Analytical Instruments 1. Colorimeter 2. Spectrophotometer 3. Principles of Chromatography 4. Principles of Electrophoresis apparatus 5. ELISA concepts (direct and indirect), Reader & Washer. Basic principle, working and technical specifications of Blood cell counter	07	CO5
VI	Foetal and Neonatal Monitoring System	Basic principle and working of Foetal and Neonatal Monitoring System Cardiotocograph, methods of monitoring of foetal heart rate, monitoring of labour activity, incubator and infant warmer, non-stress test monitoring.	07	CO6

Text books:

1. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Biomedical Instrumentation and measurements: Leslie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer. (PHI Pub)

Reference Books:

1. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)
2. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub)
3. Various Instruments Manuals.
4. Various Internet Websites.

Online References:

Sr. No.	Swayam Course: Biomedical Instrumentation and sensors
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Assessment:

Internal Assessment (IA) for 20 marks each:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of the syllabus content must be covered in the IAT-I and the remaining 40% to 50% of the syllabus content must be covered in the IAT-II.

End Semester Theory Examination:

➤ **Question paper format**

- Question Paper will comprise a total of **six questions each carrying 15 marks Q.1** will be **compulsory** and should **cover the maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2054212	Diagnostic and Monitoring Instruments Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment (IAT)			End Sem. Exam			
		IAT-I	IAT-II	IAT-I +IAT-II (Total)				
2054212	Diagnostic and Monitoring Instruments Lab	--	--	--	--	25	25	50

Lab Objectives:

- 1.To demonstrate the application technique of diagnostic and monitoring Instruments.
- 2.To measure the physiological signals from Human Heart
- 3.To measure the Blood Pressure
- 4.To study the Lead system in ECG,EEG and EMG
- 5.To gain the knowledge of measurement of various physiological parameters of human body.
- 6.To understand the basic principles and working of patient monitoring system.
7. To implement the basic circuits used in diagnostic Instruments.

Lab Outcomes (LO):

The learner will be able to:

1. Understand the working of ECG machine by recording ECG.
2. Design and Implement Instrumentation amplifier to amplify low amplitude signals.
3. Demonstrate the measurement of Blood Pressure.
4. Demonstrate the measurement of lung volumes and capacities using Spirometer
5. Demonstrate the measurement of Blood glucose, Blood cells.
6. Provide a better understanding about foetal monitoring systems.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hrs	LO Mapping
0	Prerequisite	Basic knowledge in Diagnostic and Monitoring, Analytical Instruments.		
I	Building blocks of Instrumentation	Amplifiers, Differential, Instrumentation and Isolation Amplifier Rectifiers, Differentiator, Integrator Low pass , High Pass , Band Pass & Band Reject Filters Peak detector	08	CO1
II	Origin of bio potentials and measurement techniques	Basic principle, working and technical specifications of ECG, EMG and EEG machines, LEAD configurations, 10-20 electrode system, measuring techniques for EOG, ERG and Phonocardiography	08	CO2
III	Patient Monitoring Systems	Basic principle and working of Patient Monitoring Systems: Measurement of Heart rate, Pulse rate, Blood pressure, Temperature and Respiration rate, Apnea detector. Heart rate variability measurement.	08	CO3
IV	Respiration measurement & Pulmonary Function Analyser	Basic principle and working of Pulmonary Function Analyzer Respiration measurement technique: Lung volume and capacities, Spirometry, Nitrogen washout, Helium dilution.	07	CO4
V	Analytical Instruments and Blood Cell Counters	Basic principle, working and technical specifications of Analytical Instruments 1. Colorimeter 2. Spectrophotometer 3. Principles of Chromatography 4. Principles of Electrophoresis apparatus 5. ELISA concepts (direct and indirect), Reader & Washer. Basic principle, working and technical specifications of Blood cell counter	07	CO5
VI	Foetal and Neonatal Monitoring System	Basic principle and working of Foetal and Neonatal Monitoring System Cardiotocograph, methods of monitoring of foetal heart rate, monitoring of labour activity, incubator and infant warmer, non-stress test monitoring.	07	CO6

Text Books: a.a.

References: a.a.

Online Resources:

Sr. No.	Website Name
1.	Phillips , Meditronics

List of Experiments.

Week No	List of Experiments	Hrs
01	Design and Implementation of 5V,1Amp Regulated Power Supply	2
02	Design and Implementation of Low Pass Filter	2
03	Design and Implementation of High Pass Filter	2
04	Design and Implementation of Band Pass Filter	2
05	To study and demonstration of the ECG machine	2
06	To study and measurement of ECG using Tele-ECG	2
07	Selection of wavelength for colorimeter and spectrophotometer	2
08	To study and Demonstration of Baby incubator and infant warmer	2
09	Calculations of lung volumes and capacities using Spirometer	2
10	To study the Digital Blood Pressure measurement technique	2
11	To study and demonstration of Blood cell counters	2
12	Design of Instrumentation amplifier	2
13	To study and measurement of Blood Pressure Monitor	2
14	To study and demonstration of the EEG machine	2
15	Industry / hospital visit to be conducted.	2

Assessment:

Term Work: Term Work shall consist of at least 10 to 15 practicals based on the above list. Since the initial Python programs are small and straightforward, this allows for more practicals to be conducted, providing essential practice needed for mastering any programming language.

Internal Practical Exam: Conduct an internal practical exam after completing the first three modules of the Python course to assess and ensure the learner's understanding.

Term Work Marks: 25 Marks (Total marks) = 10 Marks (Experiment) + 10 Marks (Internal Practical Exam) + 5 Marks (Attendance)

Practical& Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Sd/-
Dr. Ghanshyam D Jindal
 BoS-Chairman-Biomedical Engineering
 Faculty of Technology

Sd/-
Dr. Deven Shah
 Associate Dean
 Faculty of Science & Technology

Sd/-
Prof. Shivram S. Garje
 Dean
 Faculty of Science & Technology