



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Instrumentation and Control Engineering

Subject Code : DI04017061

Subject Name : Biomedical Instrumentation

w. e. f. Academic Year:	2025-26
Semester:	4 th
Category of the Course:	Professional Elective - I

Prerequisite:	Students should have basic knowledge of human anatomy, physiology, and fundamental electrical and electronic principles. Understanding sensors, transducers, and measurement techniques is essential. Familiarity with circuit analysis, safety practices, and basic instrumentation helps in learning biomedical instruments and their applications in healthcare.
Rationale:	There is a growing use of biomedical instruments in health care every day. Today's hospitals use advanced, complex, and precise instruments. Biomedical Instrumentation is also a branch of instrumentation hence diploma instrumentation engineers should be familiar with biomedical instrumentation fundamentals and how various biomedical instruments work. Thus, this course aims to develop some basic skills in understanding, operating, and testing various biomedical instruments.

Course Outcome:

After Completion of the Course, the Student will be able to:

No	Course Outcomes	RBT Level
1	Describe various bio-signals and bio-potentials.	R/U/A
2	Operate and demonstrate the use of biomedical recorders used in hospitals.	R/U/A
3	Explain the construction and working of medical imaging equipment and demonstrate their operation.	R/U/A
4	Explain the construction and working of surgical and therapeutic instruments and operate them.	R/U/A
5	Explain the construction and working of medical laboratory instruments and operate them.	R/U/A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR		C	Theory		Tutorial / Practical	
			ESE (E)		PA(M)	PA(I)	ESE(V)	
3	0	2	4	70	30	20	30	150



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Course Content

Unit No.	Topics and Sub-topics	No. of Hrs.	% Weightage
1	Fundamentals of Medical Instruments	9	20
	1.1 Fundamentals of medical instrumentation. a. Sources of biomedical signals b. Generalized medical instrumentation block diagram. c. Medical transducers: Body temperature, Blood pressure, respiration rate 5.5 Classification of Medical instruments based on: a. Application – (diagnostic, therapeutic, Imaging, analytical) b. Physiological parameter and bio potential c. Biological system d. Different departments in the hospital		
2	Biomedical Recorders	10	20
	2.1 Cardiograph Machine: a. ECG block diagram b. Bipolar and unipolar leads c. Phono-cardiograph d. ECG electrodes 2.2 Electro- encephalograph (EEG). a. EEG block diagram b. EEG electrodes c. EEG readout device d. 10-20 electrode placement system. 2.3 Electro-myograph (EMG) machine. a. EMG block diagram b. EMG electrodes 2.4 Biofeedback Instrumentation		
3	Medical Imaging Equipment	8	20
	3.1 X-ray machine a. characteristics of x-ray b. generation of an X-ray 3.2 CT-Scan machine 3.3 Echo-cardiograph a. Properties of ultrasound b. Applications of Ultrasound 3.4 Magnetic Resonance Imaging (MRI) 3.5 Positron Emission Tomography (PET)		
4	Surgical & Therapeutic Instruments	10	25



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	4.1 Cardiac Pacemaker: <ul style="list-style-type: none"> a. Need for cardiac pacemaker b. Implantable Pacemakers 4.2 Electro-surgery machine (cautery machine) 4.3 Haemodialysis machine: <ul style="list-style-type: none"> a. Function of natural and artificial kidney b. Dialyzer: Hollow fibre dialyzer c. Haemodialysis machine 4.4 Electrotherapy: <ul style="list-style-type: none"> a. Current waveforms employed in electrotherapy b. Muscle stimulator machine 4.5 Ventilator machine <ul style="list-style-type: none"> a. Artificial ventilation b. Classification of ventilators. 4.6 Biomaterials for Medical Devices: <ul style="list-style-type: none"> a. Types of Biomaterials b. Biocompatibility c. Applications of biomaterials with examples 		
5	Medical Laboratory Instruments & Waste management	8	15
	5.1 Types of tests <ul style="list-style-type: none"> a. a Blood cell b. b Biochemistry 5.2 Blood Cell Counter <ul style="list-style-type: none"> a. Flow cytometry b. Coulter Counter 5.3 Basics of Oximetry <ul style="list-style-type: none"> a. In-vivo oximetry b. In-vitro oximetry c. Pulse oximetry 5.4 Auto Analyser 5.5 Bio-medical Waste <ul style="list-style-type: none"> a. Medical waste types b. Medical waste management 		
	Total	45 Hrs	100 %

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
30	50	20	-	-	-



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Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

Suggested Practical Exercises

The following practical outcomes (PrOs) that are the sub-components of the COs. Some of the PrOs marked "*" are compulsory, as they are crucial for that particular CO. These PrOs need to be attained at least at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	CO	Approx. Hrs. required
1	Measure blood pressure using a sphygmomanometer.	1	2
2	Measure respiration rate using respiration rate-meter.	1	2
3	Measure body temperature using analog and digital thermometer.	1	2
4	Identify ECG, EMG and EEG electrodes.	2	2
5	Demonstrate the performance of the ECG machine.	2	4
6	Demonstrate the performance of the EEG machine.	2	4
7	Demonstrate the performance of the EMG machine.	2	4
8	Demonstrate the performance of an X-ray machine.	3	2
9	Demonstrate the performance of Computed Tomography (CT scan) Machine.	3	4
10	Identify the parts of the MRI Machine.	3	2
11	Identify the parts of the PET scanner Machine.	3	2
12	Demonstrate operation of cardiac pacemaker	4	2
13	Maintain different electrodes for Electro-surgery machine	4	2
14	Demonstrate various cutting modes of Electro-surgery machines.	4	4
15	Identify various parts of Haemodialysis machines.	4	2
16	Demonstrate operation Haemodialysis machine.	4	4
17	Demonstrate operation of Muscle Stimulators.	4	2
18	Demonstrate operation of Ventilator.	4	2
19	Demonstrate operation of Blood Cell Counter.	5	4
20	Demonstration of Flow Cytometry	5	4



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Sr. No.	Practical Outcomes (PrOs)	CO	Approx. Hrs. required
21	Measurement of Oxygen Saturation using In-Vivo Oximetry	5	2
22	Measurement of Oxygen Levels using In-Vitro Oximetry	5	2
23	Measurement of SpO ₂ using Pulse Oximeter	5	2
24	Identification of Medical Waste Types	5	2
25	Study of Biomedical Waste Management System	5	2

Note

- More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.
- The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency..

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare experimental setup	30
2	Operate the equipment setup or circuit	10
3	Follow safe practices measures	20
4	Record observations correctly	20
5	Interpret the result and conclude	20
Total		100

Major Equipment/ Instruments Required

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to the user in uniformity of practical's in all institutions across the state.

- Heart rate monitor cum ECG trainer
- 12 lead ECG simulator
- Respiration-rate monitor
- Electro-myograph trainer
- Phono-cardiograph trainer
- Blood pressure measurement trainer
- Sphygmomanometer



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- Bio-Electrodes for (ECG/EEG/EMG)
- Ultrasound probes
- Ultrasound machine trainer
- Electrocautery machine
- Muscle simulator
- cardiac pacemaker
- Ventilator
- Electronic/ electrical assorted tool kit
- Pulse Oximeter

Affective Domain Outcomes

The following *sample* Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

- a) Work as a leader/ team member.
- b) Follow safety practices while using biomedical instruments.

Suggested Student Activities

Other than the classroom and laboratory learning, the following are the suggested student-related co-curricular activities that can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform the following activities in groups and prepare reports of about 5 pages for each activity. They should also collect/ record physical evidence for their (student's) portfolio which may be useful for their placement interviews:

- a) Present a seminar on technical topics covered in the syllabus.
- b) Debate on merits and demerits of various biomedical instruments.
- c) Prepare a poster/ chart on anyone advanced topic related of course.
- d) Collect the extracurricular information related to the course from the internet and share it with other students.
- e) Institutes should arrange hospital visits for students.

Suggested Special Instructional Strategies (If Any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- a) Massive open online courses (*MOOCs*) may be used to teach various topics/ subtopics.
- b) Guide student(s) in undertaking micro-projects.
- d) About **20% of the topics/sub-topics** which are relatively simpler or descriptive in nature is to be given to the students for *self-learning*, but to be assessed using different assessment methods.



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Suggested Learning Resources

Sr. No.	Title of book	Author	Publication with place, year and ISBN
1	Handbook of biomedical instrumentation	R. S. Khandpur	Tata McGraw Hill, New Delhi
2	Introduction to biomedical equipment technology	Carr Joseph J., Brown J.M.	Pearson education, New Delhi
3	Medical instrumentation application & design	John G. Webster, Editor	John Wiley and Sons, New Delhi
4	Biomedical instrumentation measurements.	Lesli P Cromwell, Fred J. Weibell, Erich A. Pfeiffer	PHI Learning, New Delhi

Suggested Learning Websites

1. NPTEL – Biomedical Instrumentation <https://nptel.ac.in>
2. MIT Open Course Ware – Biomedical Engineering <https://ocw.mit.edu>
3. Khan Academy – Health & Medicine <https://www.khanacademy.org>
4. All About Circuits – Biomedical Applications <https://www.allaboutcircuits.com>
5. Electronics Tutorials – Sensors, Transducers <https://www.electronics-tutorials.ws>
6. WHO – Medical Waste Management Guidelines <https://www.who.int>
7. Government of India – Biomedical Waste Rules (MoEFCC) <https://moef.gov.in>
8. <http://phet.colorado.edu/en/simulations/category/biology>

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