

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

**COURSE CURRICULUM
COURSE TITLE: BIOMEDICAL INSTRUMENTATION
(Code: 3341704)**

Diploma Programme in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	4 th semester

1. RATIONALE

The use of Biomedical instruments are increasing day by day in health care. Now days advanced, complex and precision biomedical instruments are being used in most of the hospitals. Diploma Instrumentation engineer are therefore also supposed to know about the biomedical instrumentation fundamentals, it is important as the students may get employment in hospitals where they will have to understand construction working application of different biomedical instruments. Hence this course has been designed to develop some of the basic skills in operation, test and maintenance of various biomedical instruments.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

- Operate and calibrate biomedical instruments.

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

- i. Operate biomedical instruments used in hospital
- ii. Calibrate biomedical instruments used in hospital
- iv. Test different biomedical instruments used in hospital
- v. Understands different bio signals / potentials

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
L	T	P		Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	0	4	7	70	30	40	60	200

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit ESE - End Semester Examination; PA - Progressive Assessment.

5. COURSE DETAILS

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I Fundamentals of Medical Instruments	1a. List the Sources of biomedical signals. 1b. Explain generation of bio-potential in human body. 1c. Draw and explain generalized block diagram of medical instrumentation system. 1e. Describe the features of the ECG/ EEG/ EMG/Defibrillator electrodes drawing schematic diagram. 1f. Explain the different types of medical transducers used in medical instruments for Body temperature, Blood pressure, and respiration rate. 1g. Explain the working of the indirect blood pressure measurement instrument (sphygmo-manometer). 1h. Classify medical instruments based on different principles with Application Viz - (diagnostic, therapeutic, Imaging, analytical) , Physiological parameter and bio-potential , Biological system , Different departments in the hospital.	1.1 Fundamentals of medical instrumentation. <ul style="list-style-type: none"> ▪ Sources of biomedical signals ▪ Generalized medical instrumentation block diagram. ▪ Medical electrodes - ECG, EEG, EMG , Defibrillator ▪ Medical transducers: Body temperature, Blood pressure, respiration rate 1.2 Classification of Medical instruments based on: <ul style="list-style-type: none"> • Application - (diagnostic, therapeutic, Imaging, analytical) • Physiological parameter and bio-potential • Biological system • Different departments in the hospital
Unit – II Biomedical Recorders	2a. Describe working principle of Electrocardiograph with a block diagram. 2b. Drawing a ECG waveform with labels describe relating cardiac activity of the heart. 2c. Explain bipolar and unipolar leads used for ECG measurements. 2d. Explain Einthoven's triangle. 2e. Explain working of phono-cardiograph. 2f. Describe 10-20 electrode placement method used for EEG. 2g. Explain working principle of Electro encephalograph. 2h. Draw block diagram and describe the working principle of EMG. 2i. Drawing block diagram explain bio- feedback instrumentation.	2.1 Electro-cardiograph (ECG) machine <ul style="list-style-type: none"> • ECG block diagram • Bipolar and unipolar leads • Phono-cardiograph 2.2 Electro-encephalograph (EEG). <ul style="list-style-type: none"> • 10-20 electrode placement system • EEG readout device 2.3 Electro-myograph (EMG) machine. 2.4 Bio-feedback Instrumentation

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – III Medical Imaging Equipments	3a. List and explain characteristics of x-ray. 3b. Explain generation of an X-ray. 3c. Describe working of an X-ray machine with block diagram. 3d. Describe working of a CT scan machine with block diagram. 3e. List properties of ultrasound and its applications in medical instrumentation. 3f. Draw block diagram and describe working of an ultrasonic foetal monitor. 3g. List the types of Transducers used in Ultrasonic foetal monitor. 3h. Describe working of an echo-encephalography machine with block diagram. 3i. Describe working of an echo-cardio graph machine with block diagram. 3j. Describe working of a colour Doppler ultrasound machine with block diagram.	3.1 X-ray machine. 3.2 CT-Scan machine. 3.3 Properties of ultrasound 3.3 Ultrasonic foetal monitors. 3.3 Echo-encephalography. 3.4 Echo-cardiograph. 3.5 Colour Doppler ultrasound machine.
Unit– IV Surgical & Therapeutic Instruments	4a. Describe working of an electro-surgery machine with block diagram and the safety precautions to be taken. 4b. Describe working of a Hemo-dialysis machine with block diagram. 4c. Describe working of a Muscle Stimulators machine with block diagram. 4d. Describe working of a Defibrillator Machine with block diagram and the safety precautions to be taken. 4e. Describe the electrodes of a Defibrillator Machine with diagram.	4.1 Electro-surgery machine (cautery) 4.2 Hemo-dialysis machine 4.3 Muscle stimulators 4.4 Defibrillator Machine
Unit – V Medical Laboratory Instruments	5a. List the pathological (clinical) test Instruments for medical diagnosis. 5b. Draw the block diagram and describe working of a blood cell counter with schematic diagram. 5c. Draw the block diagram and describe working of a bio-chemistry analyzer. 5d. Draw the block diagram and describe working of an auto analyzer. 5e. Draw the block diagram and describe working of a blood gas analyzer.	5.1 Types of test <ul style="list-style-type: none"> • Blood cell • Bio chemistry 5.2 Blood Cell Counter 5.3 Bio chemistry analyzer. 5.4 Auto analyzer. 5.5 Blood gas analyzer.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamentals of Medical Instruments	10	02	04	08	14
II	Biomedical Recorders	08	02	04	08	14
III	Medical imaging equipments	08	02	04	08	14
IV	Surgical & Therapeutic instruments	08	02	04	08	14
V	Medical Laboratory Instruments	08	02	04	08	14
Total		42	10	20	40	70

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills (**outcomes in psychomotor and affective domain**) so that students are able to acquire the competencies/programme outcomes. Following is the list of practical/exercises for guidance.

*Note: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Approx Hrs.
1.	I	Identify ECG electrodes & Patient cable	2
2.	I	Identify EEG electrodes & Patient cable	2
3.	I	Identify EMG electrodes	2
4.	I	Measure blood pressure using sphygmomanometer.	2
5.	I	Measure respiration rate using respiration rate-meter.	2
6.	I	Measure body temperature using analog and digital thermometer.	2
7.	II	Identify various leads selector network of ECG machine	2
8.	II	Obtain Lead –I, II, III, aVr , aVl , V1 ... v6 type of ECG.	2
9.	II	Calibrate & maintain ECG machine.	2
10.	II	Obtain EEG of patient using EEG machine.	2
11.	II	Demonstrate the Performance of EMG.	2
12.	II	Demonstrate the performance of Electro surgery – cautery machine.	2
13.	II	Demonstrate the performance of EEG machine	2
14.	II	Demonstration of Phono-cardiograph machine.	2
15.	III	Have a handle on different controls of X-ray machine.	2
16.	III	Calibrate X-ray machine.	2
17.	III	Demonstration of CT-scan machine.	2
18.	III	Demonstration and operation of Ultra sonic machine along with transducer & patient cable.	2
19.	III	Identify ultra sound probes for sonography machine.	2
20.	IV	Maintain different electrodes for Electro-surgery machine (cautery).	2
21.	IV	Demonstrate various cutting modes of Electro-surgery machine. (cautery)	2
22.	IV	Identify parts of Hemo-dialysis machine.	2
23.	IV	Demonstrate operation of Muscle Stimulators.	2
24.	V	Demonstrate operation of Blood Cell Counter.	2
25.	V	Demonstrate operation of Bio chemistry analyzer.	2
26.	V	Demonstrate operation of Auto analyzer.	2
Total hours			52

8. SUGGESTED LIST OF STUDENT

ACTIVITIES Following is the list of proposed student activities like: i. Prepare presentation on relevant topics.
ii. Prepare chart/model on relevant topic.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

- i. Visits to Industries/ Hospital.
- ii. Use bio simulators in the class when teaching.
- iii. Video films/animation films on working of different types of bio-medical instruments.
- iv. Mini project.

10. SUGGESTED LEARNING**RESOURCES A) List of Books**

S. No.	Title of Book	Author	Publication
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.	Biomedical instrumentation measurements.	Lesli P Cromwell, Fred J. Weibell, Erich A. Pfeiffer	PHI Learning, New Delhi
4.	Medical instrumentation application & design	John G. Webster, Editor	John Wiley and Sons, New Delhi
5.	Medical Electronics	A. G. Patil	Excel Book, New Delhi

B) List of Major Equipment/ Instrument with Broad Specifications

- i. Heart rate monitor cum ECG trainer
- ii. 12 lead ECG simulator
- iii. Respiration-rate monitor
- iv. Electro-myograph trainer
- v. Phono-cardiograph trainer
- vi. Blood pressure measurement trainer
- vii. Sphygmomanometer
- viii. Bio-Electrodes for (ECG/EEG/EMG)
- ix. Ultra sound probes
- x. Ultrasound machine trainer
- xi. Electro cautery machine
- xii. Muscle simulator
- xiii. Electronic / electrical assorted tool kit

C) List of Software/Learning Websites

- i. <http://phet.colorado.edu/en/simulations/category/biology>

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE**Faculty Members from Polytechnics**

- **Prof. J.T.Patankar** H.O.D. (I/C) IC Engineering, Govt. Polytechnic, Ahmedabad.
- **Prof. A. K. Bula** Sr. lecturer IC Engineering, Govt. Polytechnic, Gandhinagar.
- **Prof. M. M. Shah** lecturer IC Engineering, AVPTI, Rajkot.
- **Prof. S. K. Raval** lecturer IC Engineering, Govt. Polytechnic, Ahmedabad.

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. (Mrs.) Susan S. Mathew**, Associate Professor, Department of Electrical and Electronics Engineering.
- **Prof. Joshua Earnest**, Professor, Department of Electrical and Electronics Engineering.