

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM

Course Title: Medical Sensors and Measurement Techniques
(Code:3330304)

Diploma Programme in which this course is offered	Semester in which offered
Medical Sensors and Measurement Techniques	Third

1. RATIONALE

Biomedical sensors are the heart of most of the biomedical instrumentation and patient monitoring systems. The expectation of this course is that the students will develop their understanding of the most important biomedical sensors and 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:

- Maintain the attachments of biomedical equipment (Transducers).

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
5	0	2	7	70	30	20	30	

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** - Practical; **C** - Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

4. DETAILED COURSE CONTENT

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – 1 Introduction to Biomedical Instrumentation	1a. Explain the block diagram of 'man instrumentation system'. 1b. Define measurement, measurand and transducer. 1c. Enlist the problems encountered while measuring a living system and explain in brief	1.1 'Man-Instrumentation system': Components and their functions. 1.2 Measurement, measurand and transducer. 1.3 Problems encountered in measuring a living system: such as inaccessibility, variability, lack of knowledge, interaction among physiological systems, effect of transducer on measurement, artifacts, energy limitation
Unit – 2 Basic transduction principles	2a. Classify transducers. 2b. Describe principle of different active transducers 2c. Describe the working principles of passive transducers. 2d. Explain strain gauge transducer 2e. Describe principle of LVDT 2f. Give merits and demerits of LVDT.	2.1 Transducer and transduction principle: 2.1.1 active transducers: like magnetic induction, piezoelectric, thermoelectric, photoelectric 2.1.2 Passive Transducers: like resistive transduction, inductive transduction, capacitive transduction 2.2 Transducers for biomedical applications: 2.2.1 Force and pressure transducers: such as piezoelectric, strain gauge 2.2.2 Displacement transducers: Such as LVDT
Unit – 3 Biopotential Electrodes	3a. Enlist different bio potential signals generated in human body. 3b. Give principle of electrode-electrolyte interface 3c. Describe electrode circuit model with necessary diagram 3d. Describe microelectrodes, needle electrodes and skin surface electrodes. 3e. Describe the working principles of ECG, EMG and EEG electrodes with its diagram. 3f. Define half cell potential, action potential	3.1 Sources of bioelectric potentials 3.2 Electrode theory 3.3 Bio-potential electrodes :types of electrodes such as microelectrode, body surface electrodes and needle electrodes 3.4 Electrodes used for ECG, EEG and EMG measurement. 3.5 Electrode-electrolyte interface, half cell potential, Ag/AgCl electrode
Unit– 4 Transducers for cardiovascular measurement	4a. Describe characteristics of blood flow 4b. Enumerate different blood flow measurement techniques. 4c. Give principle of electromagnetic blood flow	4.1 Introduction to cardiovascular measurement and its importance 4.2 blood flow measurement: 4.2.1 characteristics of blood flow

Unit	Major Learning Outcomes	Topics and Sub-topics
	meter with necessary diagram. 4d. Describe principle of ultrasonic blood flow meter with necessary diagram. 4e. Describe microphone and how it is used to measure heart sounds.	4.2.1 Electromagnetic blood flow 4.2.2 Ultrasound blood flow meter 4.2.3 thermal convection 4.2.4 radiographic method 4.2.5 indicator/dye dilution method 4.3 heart sound measurement: 4.3.1 stethoscope 4.3.2 transducer used for heart sound measurement: such as microphone
Unit – 5 Transducers for Noninvasive diagnostic measurements	5a. Enumerate different temp transducers used for diagnostic measurements 5b. Describe working Principle of thermocouple. 5c. Describe principle of thermistor and its application for respiration rate measurement. 5d. Give principle of infrared thermometer 5e. Elucidate principle of ultrasonic transducers	5.1 Temperature measurement: types of temperature measurement 5.1.1 systemic body temperature: mercury thermometer, thermocouple, thermistor 5.1.2 skin temperature measurement: infrared thermometer 5.2 Ultrasonic measurement: properties of ultrasound, ultrasonic transducers 5.3 Transducers for respiration rate measurement

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

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Biomedical Instrumentation	10	6	6	-	12
II	Basic transduction principles	12	-	10	4	14
III	Biopotential Electrodes	12	2	12	4	18
IV	Transducers for cardiovascular measurement	12	2	12	4	18
V	Transducers for Noninvasive diagnostic measurements	10	-	8	-	8
	Total	56	10	48	12	70

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

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

6. SUGGESTED LIST OF EXERCISES/PRACTICAL/EXPERIMENTS

Sr. No.	Unit No.	Practical Exercises	Hrs. required
1	I	Identify and rearrange the various blocks of man-instrument system.	2
2	II	Measure body temperature using thermometer and thermocouple.	2
3	II	Use different types of resistive transducers.	2
4	II	Use different types of capacitive transducers.	2
5	II	Use different types of inductive transducers.	2
6	II	Use piezoelectric type transducer.	2
7	II	Measure oxygen saturation of the blood using photoelectric transducer	2
8	III	Use different types of ECG electrodes.	2
9	III	Use different types of EMG electrodes.	2
10	III	Use different types of EEG electrodes.	2
11	III	Use electrolyte jelly for measuring bio-potentials.	2
12	III	Calibrate the ECG machine.	2
13	IV	Identify the path used for catheterization method used for blood pressure measurement.	2
14	IV	Measure blood pressure using sphygmomanometer and stethoscope.	2
15	IV	Use stethoscope to listen heart sound.	2
16	IV	Use electromagnetic transducer for blood flow measurement.	2
17	IV	Use ultrasonic blood flow transducer.	2
18	V	Use different types of temperature transducers for measurement of body temperature.	2
19	V	Test the performance of thermocouple.	2
20	V	Test the performance of thermistor.	2
21	V	Test the performance of RTD.	2
22	V	Test the calibration of thermometer.	2
		TOTAL	44

7. SUGGESTED LIST OF STUDENT ACTIVITIES

- Student should collect the images of various Biomedical transducers(sensors) from internet and attach its photographs in file/journal.

8. SUGGESTED LEARNING ACTIVITIES

A. List of Books

Sr. No.	Title of Book	Author	Publication
1.	Biomedical Instrumentation and Measurements	Cromwell Leslie, Fred J. Weibell and Erich A. Pfeiffer	PHI Learning, New Delhi, 2010
2.	Medical Instrumentation Application and Design	Webster John G., Editor	WILEY India, 2011
3.	Biomedical transducers	Prof. Kashipara H. T.	Akshat , 2010

B. List of Major Equipment/ Instrument

- i. LVDT(Linear Variable Differential Transformer) Trainer Kit
- ii. Strain gauge with Unbalanced bridge Trainer Kit
- iii. Thermocouple Trainer Kit
- iv. RTD Trainer Kit
- v. Thermistor Trainer Kit
- vi. Piezoelectric Trainer Kit
- vii. Electromagnetic blood flow measurement Trainer Kit
- viii. Ultrasonic blood flow measurement Trainer Kit
- ix. Sphygmomanometer
- x. Stethoscope
- xi. All types of ECG electrodes
- xii. All types of EMG electrodes
- xiii. All types of EEG electrodes

C. List of Software/Learning Websites

www.efymag.com

www.electronicsforu.com

9. INSTRUCTIONAL STRATEGIES

- i. Lectures and demonstrations.
- ii. Practical exercises.
- iii. Hospital visit.

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

- **Prof. A.K.BULA** , Lecturer , Dept of Instrumentation engineering,
G. P. Gandhinagar
- **Prof. M.H.DAVE** , Lecturer, Dept of Biomedical engineering,
G. P. Gandhinagar
- **Prof. N.D.MAKWANA**, Lecturer, Dept of Biomedical engineering,
G. P. Gandhinagar
- **Prof. S.S.MALKAN** , Lecturer , Dept of Biomedical engineering,
G. G. P. Ahmedabad.

• **Co-ordinator and Faculty Members from NITTTR Bhopal**

- **Dr. S.K.Gupta**, Professor, NITTTR, Bhopal.