

**GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)****Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)**

Semester-IV

**Course Title: Diagnostic Medical Instrumentation**

(Course Code: 4340302)

<b>Diploma programme in which this course is offered</b>	<b>Semester in which offered</b>
Bio-Medical Engineering	4 <sup>th</sup> Semester

**1. RATIONALE**

Diagnostic medical instruments play a major role in the field of health care in providing information about the disease. This course will enable the students to understand functioning and constructional features of different diagnostic medical instruments used in biomedical engineering for sensing various parameters of human body. Biomedical engineers should be able to operate, calibrate and maintain this instruments/ equipment. And hence this course is a key course for biomedical engineers.

**2. COMPETENCY**

The course content should be taught and curriculum should be implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **Demonstrate and Operate different diagnostic medical instruments used for sensing various parameters of human body.**

**3. COURSE OUTCOMES (COs)**

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

- a) Identify various biomedical diagnostic instruments.
- b) Demonstrate and Operate different types of equipment used in diagnosis of cardiovascular disorders.
- c) Demonstrate and Operate different types of equipment used in diagnosis of neuromuscular disorders.
- d) Demonstrate and Operate different types of equipment used in diagnosis of respiratory system disorders.
- e) Illustrate various diagnostic techniques and instruments used for abnormalities of human eye and ear.

#### 4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
C	CA	ESE	CA	ESE	CA	ESE		
3	0	4	5	30	70	25	25	150

(\*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

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

#### 5. 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 at the ‘Precision Level’ of Dave’s Taxonomy related to ‘Psychomotor Domain’.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify and rearrange the various blocks of medical instrumentation system.	1	2
2	Demonstrate the working of ECG machine.	2	4
3	Identify various bipolar leads of ECG machine.	2	2
4	Listen and identify heart sounds using stethoscope.	2	2
5	Demonstrate the working of phonocardiograph.	2	2
6	Demonstrate the working of EMG machine/EMG simulator.	3	4
7	Identify various leads selector network of EEG based on 10-20 electrode placement method.	3	2
8	Demonstrate the working of EEG machine/EEG simulator.	3	4
9	Study of Lung volumes and capacities.	4	2
10	Identify various unipolar leads of ECG machine.	2	2
11	Measure heart rate using ECG simulator kit.	2	2
12	Measure respiration rate using respiration trainer kit.	4	2
13	Measure blood pressure using digital blood pressure meter.	2	2
14	Measure blood pressure using sphygmomanometer.	2	2
15	Measure SpO2 using pulse oximeter.	2	2
16	Demonstrate the working of ERG machine.	5	4
17	Demonstrate the working of EOG machine.	5	4
18	Demonstrate the working of spirometer.	4	4
19	Demonstrate the working of audiometer.	5	4
20	Study of E-waste management process of damaged diagnosis machine.	5	4
<b>Total</b>			<b>56</b>

**Note**

- i. 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.
- ii. 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 of experimental setup	20
2	Operate the equipment setup or circuit	20
3	Follow safe practices measures	10
4	Record observations correctly	20
5	Interpret the result and conclude	30
<b>Total</b>		<b>100</b>

**6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED**

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

Sr. No.	Equipment Name with Broad Specifications	PrOs. No.
1	ECG machine/ ECG trainer kit.	2,3,10,11
2	EMG simulator kit.	6
3	EEG simulator kit.	7,8
4	Phonocardiograph.	5
5	Pulse Oximeter (Measuring range for SPO <sub>2</sub> : 70-100% and SpO <sub>2</sub> measurement accuracy: 91%--100%, ±1%; 70%--89%, ±2%; ≤70%, unspecified.)	15
6	Spirometer.	18
7	Automatic Blood Pressure Monitor (Cuff Size - Fits Arm Circumference (22-32Cm), Power Adaptor, Batteries: 4 AAA Batteries, Memory: Last Reading)	13
8	Sphygmomanometer Mercury (Case: Aluminium, I.D. of glass tube: 2.2±0.1, Scale grading: 2mmHg, Cuff: 023 nylon/cotton cuff 51*14cm or 48*147cm, Measurement range: 0-300mmHg, Bladder: Rubber bladder with two tube, Measurement precision: ± 3mmHg, Bulb: Rubber bulb with both valves)	14
9	Stethoscope (Comprises a chest piece connected by a double tube to the headgear with earpieces that are placed into the users' ears, Double cup, with two diaphragms for dual-use (adult and paediatric auscultation) chest piece in zinc alloy, Adult diaphragm Ø: 45,5mm; paediatric diaphragm Ø: 31.5mm, Tube made of PVC and is crack resistant, Tube impervious to outside noises, guaranteeing full	4

Sr. No.	Equipment Name with Broad Specifications	PrOs. No.
	transmission of sound, good auditive quality, Tube diameter: outer diameter 10mm, inner diameter 4.8mm. Tube length 560mm, Sensitivity from 3.2dB to 26dB in a range from 50 to 1000Hz for cardiology, Sensitivity 8.1dB in a range from 600 Hz to 1,500Hz for pneumology, Arms: brass-steel with a flexible spring, Removable plastic earpiece, Latex-free.)	
10	Audiometer.	19
11	Respiration trainer kit.	12
12	EOG trainer kit	17
13	ERG trainer kit	16
14	Biomedical Instrumentation Trainer	ALL

## 7. 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 fulfil the development of this competency.

- a) Work as a leader/a team member.
- b) Follow safety practices while using electrical appliances.
- c) Practice environmental friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- i. 'Valuing Level' in 1<sup>st</sup> year
- ii. 'Organization Level' in 2<sup>nd</sup> year.
- iii. 'Characterization Level' in 3<sup>rd</sup> year.

## 8. UNDERPINNING THEORY

Only the major Underpinning Theory is formulated as higher level UOs of *Revised Bloom's taxonomy* in order development of the COs and competency is not missed out by the students and teachers. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
<b>Unit – I Introduction to Diagnostic Medical Instruments</b>	1a. Explain generalized block diagram of a medical instrumentation system. 1b. Classify medical instruments based on different applications. 1c. Enlist diagnostic medical instruments used in different departments.	1.1 Block diagram of medical instrumentation. 1.2 Classification of Medical instruments: Diagnostic, Therapeutic, Imaging, Critical Care, and Clinical Laboratory. 1.3 Diagnostic instruments of following medical departments: Cardiology, Neurology, Urology, Ophthalmology, Gynecology, Oncology, and Radiology.
<b>Unit – II Diagnostic Techniques for Cardiovascular System Disorders</b>	2a. Describe block diagram of ECG machine. 2b. Classify various ECG leads. 2c. Explain phonocardiograph (PCG). 2d. Define heart rate. Describe basic techniques used for heart rate measurement. 2e. Enlist different techniques used for BP measurements. 2f. Explain steps for blood pressure measurement using sphygmomanometer. 2g. Explain fingertip pulse oximeter used for SPO <sub>2</sub> measurement.	2.1 Electrocardiograph 2.1.1 ECG readout device: Block diagram, working principle. 2.1.2 Bipolar & unipolar leads 2.2 Phonocardiograph 2.3 Techniques of heart rate measurement. 2.3.1 Average heart rate meter 2.3.2 Instantaneous heart rate meter 2.4 Blood Pressure measurement 2.4.1 Direct method 2.4.2 Indirect method using Sphygmomanometer. 2.5 Oxygen Saturation measurement (Oximetry): 2.5.1 Fingertip Pulse oximeter.
<b>Unit-III Diagnostic Techniques for Neuromuscular System Disorders</b>	3a. Illustrate 10-20 electrode placement method used for EEG. 3b. Describe block diagram of EEG machine. 3c. Explain EMG readout device.	3.2 Electroencephalograph 3.2.1 10-20 electrode placement system 3.2.2 EEG readout device: Block diagram, working principle. 3.3 Electromyograph 3.3.1 EMG readout device: Block diagram, working principle.
<b>Unit – IV Diagnostic Techniques for Respiratory System Disorder</b>	4a. Define Spirogram and Spirometry. 4b. Describe various lung volumes & capacities. 4c. Explain working of basic spirometer. 4d. Define respiration rate. Describe Impedance Pneumography. 4e. Explain apnoea monitor.	4.1 Spirogram 4.2 Spirometry 4.3 Lung volumes and capacities (Respiratory volumes) 4.4 Basic Spirometer 4.5 Measurement of respiration rate: Impedance Pneumography. 4.6 Apnoea monitor

<b>Unit – V Diagnostic Techniques for Special Senses Disorders</b>	5a. Enlist special senses. 5b. Classify different types of audiometers. 5c. Describe block diagram of ERG machine. 5d. Describe block diagram of EOG machine. 5e. Discuss the steps for E-waste manage of damaged diagnosis machine.	5.1 Introduction of special senses 5.2 Types of audiometers 5.2.1 Puretone 5.2.2 Speech 5.3 Electroretinograph: Block diagram, working principle 5.4 Electrooculograph: Block diagram, working principle. 5.5 E-waste management of damaged diagnosis machine.
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**Note:** The UOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.

## 9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A	Total Marks
1	Introduction To Diagnostic Medical Instruments	6	8	7	0	15
2	Diagnostic Techniques For Cardiovascular System Disorders	12	4	5	6	15
3	Diagnostic Techniques For Neuromuscular System Disorders	8	4	5	6	15
4	Diagnostic Techniques For Respiratory System Disorder	8	4	2	4	10
5	Diagnostic Techniques For Special Senses Disorders	8	6	4	5	15
<b>Total</b>		<b>42</b>	<b>26</b>	<b>23</b>	<b>21</b>	<b>70</b>

**Legends:** R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

**Note:** This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from above table.

## 10. SUGGESTED STUDENT ACTIVITIES

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

- Prepare specification of diagnostic medical equipment.
- Give seminar on various diagnostic medical instruments and their applications in medical field.
- Undertake a market survey of different diagnostic instruments.

## 11. 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/sub topics.
- b) Guide student(s) in undertaking micro-projects.
- c) '**L' in section No. 4** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
- 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.
- e) With respect to **section No.11**, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- f) Guide students on how to address issues on environment and sustainability.
- g) Guide students for using data manuals.

## 12. SUGGESTED MICRO-PROJECTS

**Only one micro-project** is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be **individually** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course. The student ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

- a) Build an amplifier for ECG/EMG/EEG signal measurement.
- b) Build a filter for ECG/EMG/EEG signal measurement.
- c) Build a simple digital thermometer.
- d) Prepare a chart on how to control noise pollution.
- e) Prepare a chart for E-waste management of damaged diagnosis machine.

### 13. 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
2	Biomedical Instrumentation and Measurements	Cromwell Leslie, Fred J. Weibell and Erich A. Pfeiffer	Prentice Hall India Learning Private Limited; 2nd edition or latest edition, ISBN-10: 8120306538
3	Medical Instrumentation Application and Design	Webster John G., Editor	Wiley; 4th edition or latest edition ISBN-10: 0471676004
4	Introduction to biomedical equipment technology	Carr Joseph J., Brown J.M	Pearson education Delhi

### 14. SOFTWARE/LEARNING WEBSITES

- <https://nptel.ac.in/>
- <https://swayam.gov.in/>
- [www.vlab.co.in](http://www.vlab.co.in)
- <https://www.electrical4u.com/electrical-engineering-articles/biomedical-instrumentation/>
- [www.efymag.com](http://www.efymag.com)

### 15. PO-COMPETENCY-CO MAPPING

Semester IV	Diagnostic Medical Instrumentation						
	Pos						
	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
<b>Competency</b>							
Demonstrate and Operate different diagnostic medical instruments used for sensing various parameters of human body.							
Identify various biomedical diagnostic instruments.	3	-	-	-	1	-	1
Demonstrate and Operate different types of equipment used in diagnosis of cardio vascular disorders.	3	2	2	3	2	1	2
Demonstrate and Operate different types of equipment used in diagnosis of neuromuscular disorders.	3	2	2	3	2	1	2



Demonstrate and Operate different types of equipment used in diagnosis of respiratory system disorders.	3	2	2	3	2	1	2
Illustrate various diagnostic techniques and instruments used for abnormalities of human eye and ear.	3	2	2	3	2	-	2

Legend: '3' for high, '2' for medium, '1' for low or '-' for the relevant correlation of each competency, CO, with PO/ PSO.

## 16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### GTU Resource Persons

Sr. No.	Name	Designation	Institute	Contact No.	Email
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