GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: BIOMEDICAL ENGINEERING (03)
SUBJECT NAME: Introduction to Virtual Biomedical Instrumentation
SUBJECT CODE: 2170310
B.E. 7th SEMESTER

Type of course: Department Elective - I

Prerequisite: Human Anatomy & Physiology, Diagnostic Instrumentation, Digital Signal Processing

Rationale: This subject covers the use of general purpose instrumentation for biomedical applications. The design aspects of virtual instruments from general purpose instruments are highly in demand. This subject covers the design and implementation of various virtual instruments required in Biomedical engineering. The link between the virtual instrument and user is crucial to the development process of laboratory experiences and can offer students a learning continuum from their first year through graduation.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Introduction to Virtual Biomedical Instrumentation:** Introduction, history, Evolution, Virtual vs. Traditional Instruments, Advantages of VI, Role of Hardware and Software in Virtual Instrumentation.	4	10
2	**Virtual Instrument Architecture:** Sensor module, sensor interface, processing module, database interface, medical information system interface, presentation and control, functional integration; **Tools and Platforms:** hardware platforms and operating systems, programming language environments, graphical programming tools, Comparison of text-based and graphical programming.	6	15
3	**Introduction to Data Acquisition:** Analog Signal Transducers, Analog Signal Conditioning; Analog-to-Digital & Digital-to-Analog Conversion; Sampling, noise and filtering; Standard Hardware Interfaces.	10	20
4	**Introduction to Modular Programming:** Build a Vi Front Panel and Block Diagram, Repetition and Loops, Arrays, Clusters, Plotting Data, Structure, Strings and File I/O, 2D & 3D plots.	10	20
5	**Designing Virtual Biomedical Applications:** Electrocardiography (ECG), Electromyography (EMG), Air Flow and Lung Volume, Heart Rate variability analysis, Noninvasive Blood Pressure Measurement.	10	25
6	**Other Biomedical Applications of Virtual Instrumentation:** Examination and Diagnosis, Monitoring and Research, Training and Education, Biofeedback, Virtual Reality & 3D graphical modeling, Virtual Prototyping & Bio Manufacturing in Medical Applications	5	10
	Total -	45	100

Reference Books:

No.	Title of Books	Author	Publication
1	LabVIEW based advanced Instrumentation System	S. Sumathi, P. Surekha	Springer
2	Data Acquisition Techniques using PC	Howard Auserlitz	Academic Press
3	Virtual Instrumentation using LabVIEW	Jovitha Jerome	PHI Learning pvt. ltd.
4	Virtual Bio-Instrumentation	Jon B. Olansen, Eric Rosow	Prentice-Hall
5	PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control	Kevin James	Newnes
6	Virtual Prototyping & Bio Manufacturing in Medical Applications	Bopaya Bidanda, Paulo J. B´artolo	Springer

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	**U Level**	**A Level**	**N Level**	**E Level**
10%	**35%**	**30%**	**15%**	**10%**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate and above Levels (Revised Bloom's 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.

Course Outcome:

After completion of the course the student will be able to:

1. Understand the advanced applications of mathematical modelling for designing virtual instrument
2. Relate fundamental physiological properties with virtual biomedical instruments
3. Demonstrate advanced analysis capabilities that explore potential research topics
4. Demonstrate clinical utilization of virtual biomedical instrumentation
5. Categorise functions related to medical device development and tests.

List of Experiments:

Aim: Design and Develop virtual instrument for…

Sr. No.	Name of Practical	Planned Hours
1	**Introduction to Data Acquisition** – Introduces physiological data acquisition, analysis, and presentation acquisition unit, transducers, and software.	2
2	**Circuit Breadboard I** – Introduction to schematics and design of absolute value converter.	2
3	**Circuit Breadboard II** – Design of active filters and sine wave generators.	2
4	**Hand grip and Muscle Fatigue –** Record, graph, calculate, and compare hand grip muscle fatigue rates.	2
5	**Blood Pressure Measurement**– Introduces data collection process through recording of arterial blood pressure using the auscultatory technique.	2
6	**Heart Rate measurement and Analysis of HRV -** Monitor a person's heart rate before, during, and after a short period of vigorous activity (such as running on a treadmill).	2
7	**Nerve Conduction Simulation** – Simulation of charge acting along a nerve fiber and determine the nerve conduction velocity.	2
8	**Electrocardiology (ECG)** – Provides an introduction to the electrocardiograph and the	2

	recording of the heart's electrical signal.	
9	**Electromyography (EMG)** – Investigations of the physiological properties of skeletal muscle as well as performing signal processing analysis (i.e., FFT and RMS).	2
10	**Air Flow and Lung Volume** – Involves recording breathing rate and lung volume i.e. forced expiratory volume (FEV), forced vital capacity (FVC), and tidal volume (TV).	2
	Total Lab Hours	20

Design based Problems (DP)/Open Ended Problem:

1. Design an Automated Diagnostic Aid with voice /remote command
2. Design a virtual instrument for ventilator system
3. Design a virtual instrument for cardiac defibrillator
4. Design a virtual instrument for biometric security system
5. Design a modular Hospital Information Management system for patient data
6. Design a virtual system for remote robotic surgery

A student and faculty may choose any other such problem which includes the concept used in the course.

Active Learning Assignments: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding of theory and practical work. The faculty will assign topics from which students can grasp knowledge about current scenario of the virtual biomedical Instrumentation. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.