GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: VIRTUAL MEDICAL INSTRUMENTATION
(COURSE CODE:3360305)

Diploma Programmes in which this course is offered	Semester in which offered
Biomedical engineering	Sixth

1. RATIONALE

Virtual instrumentation combines mainstream commercial technologies, such as the PC, with flexible software and a wide variety of measurement hardware, so one can create user-defined systems that meet their exact application needs. Virtual instrumentation has led to a simpler way of looking at measurement systems. Instead of using several stand-alone instruments for multiple measurement types and performing rudimentary analysis by hand, biomedical engineer now can quickly and cost-effectively create a system equipped with analysis software and a single measurement device that has the capabilities of a multitude of biomedical instruments for human body measurements.

2. COMPETENCY

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

i. Maintain Virtual medical Instruments (computer based medical equipment) using diagnostic medical instruments such as PC, LabVIEW, and related hardware.

3. COURSE OUTCOMES (COs)

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

i. Explain virtual instrument concepts.
ii. Select proper data acquisition hardware.
iii. Configure data acquisition hardware in LabVIEW.
iv. Use LabVIEWand configure the related hardware like DAQ and transducers.
v. Create virtual instruments for practical works.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	150
4	0	2	06	70	30	20	30	

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

5. COURSE CONTAINT DETAILS

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
Unit – I Virtual Instrumentation (VI)	1a. Describe features of virtual Instrument. 1b. Explain with sketches the architecture of a Virtual Instrument. 1c. Describe the benefits of virtual instrumentation over conventional instrumentation. 1d. Explain the use of ELVIS. 1e. Justify the uses of programming languages for creating VIS.	1.1 Historical perspective of medical diagnostics instruments and development 1.2 Conventional instruments 1.3 Virtual instrument: Architecture, educational laboratory virtual instrumentation suite (ELVIS) and its virtual instruments 1.4 Graphical programming languages
Unit– II Data Acquisition (DAQ) Fundamentals	2a. Describe the advantages of PC based medical instruments. 2b. Justify the need of using DAQ with applications 2c. Explain with sketches the working principle of multi-channel analog DAQ system and the role of computers 2d. Explain with sketches the working principle PC-based data acquisition system. 2e. Distinguish between resolution and sampling. 2f. Differentiate between multiplexing and de-multiplexing. 2g. Describe different strategies for sampling of multi-channel analog inputs. 2h. Describe the steps of developing data acquisition system. 2i. Explain different software components in a DAQ. 2j. Describe the use of counter/ timers in DAQ and the DAQ card. 2k. Describe the use of universal DAQ card and the use of USB data acquisition.	2.1 PC-Based DAQ System: PC, transducers and signal conditioners, DAQ hardware 2.1 Data acquisition specifications: Analog input: sampling rate, multiplexing, resolution, relative accuracy, noise, Analog output, Triggers, Real-Time system integration, Digital I/O. Timing I/O, Software 2.2 Multichannel analog DAQ system 2.3 Set up for data acquisition universal DAQ card 2.4 Use of timer-counter and analog outputs on the universal DAQ card

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
Unit– III Application Development Software (LabVIEW)	3a. Describe the application of loops and charts with respect to LabVIEW applications for virtual instrumentation (VI) 3b. Describe the application of arrays and File I/O. 3c. Describe the mathematical operation available in LabVIEW. 3d. Describe the data flow programming. 3e. Explain the steps for configuring external instruments to PC in LabVIEW.	3.1 LabVIEW application development for virtual instrumentation (VI) 3.2 Creating a virtual instrument in LabVIEW 3.3 Dataflow programming concepts 3.4 Sub VIs and modular code creation 3.5 Arrays and File I/O 3.6 Textual Math Integration with LabVIEW 3.7 Interfacing external instruments to a PC.
Unit – IV Graphical Programming Environment in Virtual Instrumentation	4a. Differentiate graphs and charts. 4b. Describe the types of graphs and charts in LabVIEW. 4c. Describe the generation of a sine wave from array of values. 4d. Describe how four Express VIs that encompass the most common analysis can be used and the signal processing functions that LabVIEW offers. 4e. Explain Technical data management (TDM) data model with its applications. 4f. Explain the steps of simulating a DAQ device. 4g. Describe the applications of counters and digital I/O 4h. 4g. Develop a program to measure analog input and to generate analog output in LabView.	4.1 Data formulation 4.2 Wave form graph 4.3 Trigonometric waves 4.4 Wave form charts 4.5 Acquiring data and its graphical representation, File formats 4.6 Simulating a DAQ device 4.7 Using counter and digital I/O 4.8 Measuring Analog input 4.9 Generating analog output
Unit – V Analysis Tools and Medical Applications in Virtual Instrumentation	5a. Use Fourier transform some application for analysis. 5b. Use wavelet transform some application for analysis. 5c. Describe the windowing and filtering tools. 5d. Explain with sketches a VI based temperature monitor. 5e. Explain with sketches VI based cardiac monitor (ECG). 5f. Describe Bio bench applications. 5g. Explain with sketches a typical bio	5.1 Fourier transform and fast Fourier transform 5.2 Wavelet transform 5.3 Correlation (Windowing and filtering tools) applications in field 5.4 VI based temperature monitor 5.5 VI based cardiac monitor (ECG) 5.6 Bio bench-A virtual instrument application for

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
	medical application using bio-bench. 5h. Explain with sketches ECG signal processing and its importance using wavelet transform. 5i. Describe the use of Bio-Informatics and how labVIEW VIs can be used in biological tissues analysis.	data acquisition and analysis of physiological signals 5.7 ECG signal processing 5.8 Bio-Informatics and NI labVIEW technology in drug discovery process.

6. 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	Virtual Instrumentation (VI)	10	04	04	04	12
II	Data Acquisition (DAQ) Fundamentals	14	06	06	08	20
III	Application Development Software (LabVIEW)	08	00	06	04	10
IV	Graphical Programming Environment in VI	12	04	06	04	14
V	Analysis Tools and Medical Applications in VI	12	04	06	04	14
	Total	**56**	**18**	**28**	**24**	**70**

Legends: R = Remember**, U =** Understand**, A=** Apply and above Level (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 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 mainly 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. Hours Required
1	I	Install LabVIEW and driver software.	02
2	I	Use Educational Laboratory Virtual Instrumentation Suite (ELVIS).	04
3	I	Use a traditional CRO and virtual CRO using ELVIS.	04
4	II	Use data acquisition card (DAQ card).	02
5	III	Develop a program on addition and subtraction and to run it.	02
6	III	Create a simple subVI where the formula node to calculate A (slope) and B (intercept) in the equation Y=AX+B when you have two points(x1,y1) and (x2,y2).	02
7	III	Create a subVI that performs a linear scaling Y=AX+B.	02
8	III	Create a VI displaying two signals on a graph and to run it.	02
9	III	Build virtual instrument panels customizing a knob control and a waveform graph in LabVIEW.	02
10	III	Build a VI from a Blank VI.	
11	III	Add an express VI that simulates a signal.	02
12	III	Customize a user interface from the block diagram.	02
13	III	Configure a VI to run continuously until the user stops it.	02
14	III	Develop a VI program for displaying data using a table.	02
15	IV	Develop a VI program on analyzing and saving a signal.	02
16	IV	Develop a VI program on acquiring data and communicating with instruments.	02
17	IV	Develop a VI program on graphing data from a DAQ device.	02
18	IV	Develop a VI program on communicating with an instrument.	02
19	IV	Develop a VI program on controls and indicators.	02
20	V	Develop and run a program to measure temperature with a thermistor.	02
21	V	Develop and run a program to measure temperature using thermocouple.	02
22	V	Develop VI based temperature monitor.	02
23	V	Develop VI based instrumentation of an amplifier to acquire an ECG signal.	02
24	V	Prepare a VI program for any bio signal monitor using Bio bench.	02
25	V	Measure current, voltage ,capacitance, resistance and inductance using ELVIS.	02
Total			**50**

Note: Perform any of the practical exercises from above list for total of minimum 28 hours depending upon the availability of resources so that skills matching with the most of the outcomes of every unit are included

8. SUGGESTED STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

i. Visit the reputed hospital and reputed diagnostic center to study the virtual medical instrumentation.
ii. Explore internet and visit websites of reputed manufacturers of DAQ cards

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Arrange Seminars/Symposiums by giving topics to students (and ask them to explore the details from Internet.)
ii. Show animations/video films to explain the concepts
iii. Arrange visit to an advanced hospital and reputed diagnostic center to study the virtual medical instrumentation.
iii. Arrange expert lectures.

10. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Book	Author	Publication
1.	Virtual Bio-Instrumentation Biomedical, Clinical, and Healthcare Applications in LabVIEW	Olansen Jon B. and Rosow Eric	National instrument Virtual instrument series
2.	LabVIEWprogramming,data acquisition and analysis	Beyon Jeffery Y	National instrument Virtual instrument series
3.	PC Interfacing for Data Acquisition and Process Control	Gupta S.and Gupta J.P	Instrument society of America, 1994
4.	Learning with Lab-view	Bishop Robert H.	Prentice Hall
5.	Lab View for data acquisition	Brace Muhura	National instrument Virtual instrument series
6.	Sensor,transducer and labview	Paton Barry E.	Tata McGraw Hill, New Delhi 2012
7.	Handbook of Biomedical Instrumentation	Khandpur R.S.	Tata McGraw Hill

B) Major Equipment/ Instrument with Broad Specifications

i. DAQ cards
ii. Biomedical amplifiers
iii. NI ELVIS
iv. Temperature transducers
v. ECG electrodes.
vi. Blood pressure transducers
vii. Computers

C) Software/Learning Websites

i. NI LabVIEW9 or later version
ii. Driver softwares
iii. NI biobench
iv. www.ni.com
v. www.researchgate.net
vi. www.worldscientific.com

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. A.K.Bula**, Lecturer, Department of instrumentation and control Engineering, G.P.Gandhinagar
- **Prof. R. P. Merchant**, HOD, Department of instrumentation and control Engineering, G.P.Gandhinagar
- **Prof. N. D. Makwana,** Lecturer, Department of Bio-Medical Engineering, G.P.Gandhinagar

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. (Mrs.) Susan S. Mathew**, Associate Professor, Dept. of Electrical and Electronics Engineering.
- **Dr. Shashi Kant Gupta**, Professor and Coordinator for State of Gujarat