GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: BIO-MEDICAL DIGITAL SIGNAL PROCESSING
(COURSE CODE: 3360301)

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

1. RATIONALE

Signals emanating from some internal organs are very essential for diagnostic purpose. By acquiring, processing and analyzing the biomedical signals, we can understand biochemical and physiological activities of human body. The characteristic curves of biomedical signals depict the proper functionality of internal organs of human. So this course aims at understanding the process and techniques of digital signal processing to make captured biomedical signals understandable and useable.

2. COMPETENCY

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

i. **Process various biomedical signals using digital signal processing techniques.**

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. Compare various signals and systems.
ii. Test the signal conversions.
iii. Compare the digital filters over analog filters.
iv. Derive the various signal analysis methods.
v. Apply the data reduction techniques in biomedical field.

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 CONTENT DETAILS

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
Unit – I Classification of Signals and Systems	1a. Describe signal characteristics. 1b. Describe the types of signals. 1c. Explain singularity functions. 1d. Explain the different types of systems.	1.1 Concept of signals 1.2 Classification of signals 1.3 Singularity functions 1.4 Classification of systems 1.5 Representation of systems.
Unit– II Signal Conversions	2a. Justify the need for quantization. 2b. Explain with sketches analog to digital conversion of signal. 2c. Explain with sketches source coding method. 2d. Explain with sketches channel coding method.	2.1 Need of the quantization and its importance 2.2 Analog to digital conversion of signals 2.3 Source coding 2.4 Channel coding
Unit– III Concepts of Digital Filtering	3a. Describe the use of digital filters. 3b. Describe the advantages of digital filters over analog filters. 3c. Explain the function of different types of digital filters. 3d. Explain characteristics of FIR filter. 3e. Explain characteristics of IIR filter. 3f. Differentitate FIR and IIR filters. 3g. Explain with sketches adaptive filters.	3.1 Digital filters 3.2 Digital filters 3.3 FIR filter 3.4 IIR filter 3.5 Adaptive filters 3.6 Comparison of filters
Unit – IV Time Frequency Signal Analysis Methods	4a. Explain trigonometric Fourier series. 4b. Describe the characteristics of Fourier transform. 4c. Describe the correlation properties of Fourier transform. 4d. Describe the convolution properties of Fourier transform. 4e. Solve some examples based on correlation and convolution. 4f. Explain the technique of wavelet transform. 4g. Compare types of wavelet transform. 4h. Describe the applications of wavelet transform.	4.1 Trigonometric Fourier series 4.2 Fourier transform 4.3 Correlation 4.4 Convolution 4.5 Frequency domain analysis of ECG signal 4.6 Basic concept of wavelet 4.7 Wavelet transform 4.8 Applications of wavelet transform in biomedical instruments
Unit – V Data Reduction Techniques	5a. Explain the data reduction techniques. 5b. Describe the types of data reduction techniques in biomedical field. 5c. Describe the concept of redundancy. 5d. Explain the irrelevancy removal.	5.1 Data reduction techniques 5.2 Types of data reduction techniques 5.3 Redundancy 5.4 Irrelevancy removal

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	Classification of Signals and Systems	08	06	04	02	12
II	Signal Conversions	12	06	05	05	16
III	Concepts of Digital Filtering	12	04	06	04	14
IV	Time Frequency Signal Analysis Methods	14	05	06	05	16
V	Data Reduction Techniques	10	04	04	04	12
	Total	**56**	**25**	**25**	**20**	**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	Identify the nature of various biomedical signals.	02
2	I	Use open source software library for analysis of bio-signals.	02
3	I	Analyze bio-signals such as the electroencephalogram (EEG), electrocardiogram (ECG), electromyogram (EMG) using software.	02
4	II	Convert an analog signal to digital using A to D converter and back to analog using D to A converter and compare.	02
5	III	Write programs for Low Pass digital filter in Scilab/MATLAB.	02
6	III	Write programs for High Pass digital filter in Scilab/MATLAB.	02
7	III	Write programs for Band Pass digital filter in Scilab/MATLAB.	02
8	III	Write programs for Notch digital filter in Scilab/MATLAB.	02

S. No.	Unit No.	Practical Exercises (Outcomes in Psychomotor Domain)	Approx. Hours. Required
9	IV	Write Scilab/MATLAB programs for plotting of signals and images.	02
10	IV	Develop Scilab/MATLAB program showing image processing and de-noising of images.	02
11	V	Use of Scilab/MATLAB simulink, signal-processing toolbox	02
12	V	Deliver seminar on recent trends in bio-medical signal processing	06
Total			**28**

8. SUGGESTED STUDENT ACTIVITIES

Following is the list of proposed student activities like:

- Visit hospitals/multispecialty dispensaries and measure various parameters from the characteristic graphs of EEG, ECG, EMG.

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. Arranging hospital/multispecialty dispensary visit
iv. Arrange expert lectures.

10. SUGGESTED LEARNING RESOURCES

A) Books

S. No.	Title of Book	Author	Publication
1.	Digital Signal Processing	Salivahanan S. , Vallavaraj A., Gnanapriya C.	Tata McGraw-Hill, New Delhi, 2008
2.	Biomedical Signal Analysis	Rangayann Rangraj M.	IEEE Press, New York, 2002
3.	Biomedical Digital Signal Processing	Tompkins Willis J.	PHI Learning, New Delhi, 2001
4.	Biomedical Signal and Image Processing	Najarian Kayvan	CRC Press, 2009
5.	Digital Signal Processing	Proakis John G., Manolakis Dimitris G.	Pearson, New Delhi, 2007

B) Major Equipment/ Instruments with Broad Specifications

i. ECG trainer kit
ii. EEG trainer kit
iii. Multi-Para monitor
iv. EMG trainer kit
v. Scilab/MATLAB Software along with tool boxes like simulink, signal processing tool boxes, image processing tool boxes, etc.

C) Software/Learning Websites

i. www.dspguide.com
ii. www.dsp.rise.edu
iii. www.ocw.mit.edu
iv. http://biosig.sourceforge.net/

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. N.D.Makwana**, Lecturer, Dept of Biomedical engineering, G.P.Gandhinagar
- **Prof. B.C.Changela**, Lecturer, Dept of Biomedical engineering, A.V.P.T.I. Rajkot
- **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. S.S.Malkan**, Lecturer, Dept of Biomedical engineering, G.G.P.Ahmedabad

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