Course code	Course Name	L-T-P-Credits	Year of Introduction
BM301	BIOMEDICAL SIGNALS & SYSTEMS	3-1-0-4	2016

Prerequisite : Nil

Course Objectives

- To familiarize various kinds of signals and their characteristics
- To introduce various systems
- To understand transform techniques
- To understand FFT algorithms.

Syllabus

Introduction to Biomedical signals - Continuous time and discrete time signal representation - Classification of signals - Continuous time and discrete time systems - LTI system – Convolution – Correlation - LTI described by differential and difference equations - Laplace transform – inverse Laplace transform – properties - analysis of LTI using Laplace transform - Sampling theorem. Z-transform - inverse Z-transform-properties of Z - transform-analysis of LTI using Z-transform. Fourier series and Fourier transform - discrete time Fourier series and Fourier transform - FFT algorithms.

Expected Outcome

After the completion of the course, students will be able to

i. Understand basic concepts of signals and systems.
ii. Get an idea on transforming signals and its advantage.
iii. Study various signal processing algorithms

Text Books:

1. Alan V Oppenheim, Alan S Willsky, Signals and Systems. Prentice Hall India, 2/e, 2010.
2. P. Ramesh Babu: Digital Signal Processing, Scitech Publications, India 2004.

Reference Books:

1.John G Proakis & Dimitris G Manolakis, Digital Signal processing-Principles, Algorithms and Applications, PHI
2.Sanjit K. Mithra, Digital Signal Processing, Tata McGraw Hill, 3rd ed.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to biomedical signals- ECG, EMG, EEG, , carotid pulse, - properties, characteristics of bio signals - challenges in processing - low amplitude low frequency signals.	3	15%
	Introduction to elementary signals - exponential and sinusoidal - unit step and impulse - mathematical representation.	3	
	Classification of signals - Energy and Power signals - Continuous time -periodic, even and odd signals.	3	
II	Continuous time & Discrete time systems - Basic system properties - Causality, stability, Time invariance, linearity.	4	15%
	Discrete time LTI –convolution – correlation - Properties of	3	

	LTI (problems).		
	LTI Systems described by differential and difference equations and calculation of impulse responses.	3	
FIRST INTERNAL EXAM			
III	Laplace transform - Region of convergence - The inverse Laplace transform - Properties of the Laplace transform.	5	**15%**
	Analysis and characterization of First-order and second-order LTI systems using the Laplace transform.	4	
IV	Sampling – Introduction - Representation of a continuous-time signal by its samples - the sampling theorem - Under sampling – effects - aliasing (problems).	4	**15%**
	Fourier Series and Transforms - The response of continuous-time LTI systems to complex exponentials.	2	
	Fourier series representation of Continuous time periodic signals - Convergence of Fourier series-properties.	3	
SECOND INTERNAL EXAM			
V	Continuous-time Fourier transform representation of Aperiodic signals – Fourier transform of periodic signals – Properties.	3	**20%**
	Fourier transform and Fourier series pairs.	1	
	discrete-time Fourier series - Properties - FFT algorithms - DIT and DIF.	5	
VI	The z-transform - The region of convergence - Properties of the z-transform - Inverse z-transform.	7	**20%**
	Analysis and characterization of LTI systems using z-transforms.	3	
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 Hours

There shall be three parts for the question paper.

Part A includes Modules 1 & 2 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part B includes Modules 3 & 4 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part C includes Modules 5 & 6 and shall have three questions of twenty marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Note: Each part shall have questions uniformly covering both the modules in it.