GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS & COMMUNICATION (SIGNAL PROCESSING & COMMUNICATION) (41)
ADVANCE TOPICS IN SIGNAL AND IMAGE PROCESSING
SUBJECT CODE: 2744101
M.E. 4TH SEMESTER

Type of course: Major elective V**.**

Prerequisite: NA

Rationale: NA.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks		Practical Marks				
L	T	P	C	ESE (E)	PA (M)	ESE (V)		PA (I)		
						ESE	OEP	PA	RP	
3	0	2#	4	70	30	20	10	10	10	50

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Realization of digital Filters: Introduction, Block diagram representation, based structure for IIR systems, Direct form realization of IIR filters, Direct-Form I , Direct Form-II Realization, cascade and parallel form realization of IIR filters, Transposed structure, Feedback in IIR System, Ladder and Lattice structure, conversion between Lattice structure and direct form structure.	08	10
2	Theory and Design of FIR Filters: Stability, symmetric and asymmetric filters, Windowing Techniques, design of linear phase FIR filters, design of optimum Equi-Ripple linear phase FIR filters. Theory and Design of IIR Filters: Impulse Invariant method, Bi-linear transformation method, Butterworth filter approximation, chebyshev filter approximation, elliptical filters, Frequency transformation.	12	20
3	Multirate Digital Signal Processing: Applications, Advantages, sampling rate conversion methods, filter design and implementation for sampling rate alteration or conversion, sampling rate conversion by arbitrary factor.	12	30
4	Image Representation and Feature Extraction: Chain Codes, Polygonal Approximations, Signatures, Boundary segments, skeletons, Feature vector and Vector spaces, Binary object features, Fourier Descriptors, Shape Number and Hierarchical Features, Historgram-based (Statistical) Features, Texture features, Hough Transform.	08	20
5	Visual Pattern Recognition: Design and Implementation of a Visual Pattern Classifier, Patterns and Pattern Classes, Data Preprocessing, Training and Test Sets, Confusion Matrix, Hit Rates, False Alarm Rates, and ROC	08	20

	Curves, Precision and Recall, Distance and Similarity Measures, Minimum Distance Classifier, k-Nearest Neighbors Classifier, Bayesian Classifier		

Reference Books:

1. Digital Image Processing using MATLAB, Gonzalez, Woods and Eddins, McGraw Hill
2. Digital Signal Processing, John Proakis and Manolakis, John Proakis and Manolakis
3. Digital Signal Processing, Sanjay Sharma, Katson Books
4. Digital Signal Processing, Li Tan, Academic Press
5. Image Processing and Pattern Recognition. FRANK Y. SHIH, Wiley
6. Practical Image And Video Processing Using MATLAB, OGE MARQUES, Wiley
7. Digital Signal Processing, Shaila Apte, Wiley India

Course Outcome:

After learning the course the students should be able to explain about digital filters, FIR and IIR filters, Low pass FIR and High pass FIR filter responses and design, IIR Filter responses and design. The students should be able to change the sampling rate using multirate sampling frequency and should be able to do the analysis of multirate digital signals. The student should be able to develop a new algorithm for feature extraction of gray scale image or binary image. They can be able to develop Fourier Transform based boundary feature extraction of the objects. The students will learn the image classification methods and able to developed an algorithm for classification of test image based on the stored image database.

List of Experiments:

No	Title
1	1. Write a MATLAB function to design an IIR Filter. 2. Design a digital lowpass Butterworth filter with the following specifications: (a) 3 dB attenuation at the passband frequency of 1.5kHz. (b) 10dB stopband attenuation at the frequency of 3kHz. (c) Sampling Frequency of 8000Hz.
2	1. Write a MATLAB function to design an IIR Filter. 2. Design a first-order digital highpass Chebyshev filter with a cutoff frequency of 3kHz and 1dB ripple on passband using sampling frequency of 8000Hz.
3	1.Design a second order digital bandpass Butterworth filter with the following specifications: An upper cutoff frequency of 2.6kHz. A lower cutoff frequency of 2.4kHz. A sampling frequency of 8000Hz. 2. Design a digital bandstop butterworth filter with the following specifications: Center frequency of 2.5kHz. Passband width of 200Hz and ripple of 3dB Stopband width of 50Hz and attenuation of 10dB. Sampling frequency of 8000Hz.
4	1.Design a highpass FIR filter with the following specification: Stopband =0-1500Hz Passband = 2500-4000Hz Stopband Attenuation =40dB Passband ripple =0.1dB Sampling Rate=8000Hz 2.Design a bandpass FIR Filter with the following specification: Lower stopband=0-500Hz

	Passband=1600-2300Hz Upper Stopband=3500-4000Hz Stopband attenuation=50dB Passband Ripple=0.05dB Sampling rate=8000Hz
5	Design a linear phase lowpass FIR filter with 25 coefficients using the frequency sampling method. Let the cutoff frequency be 2000Hz and assume a sampling frequency of 8000Hz. Plot the frequency response.
6	1.Given a DSP upsampling system with the following specifications: Sampling rate=6000Hz Input audio frequency range=0-800Hz Passband ripple=0.02dB Stopband attenuation=50dB Upsample factor L=3 Determine the FIR filter length, cutoff frequency and window type if the window design method is used. 2. Write a MATLAB program for changing the sampling rate with a non-integer factor.
7	Generate a sinusoid with a 1000Hz for 0.05 sec using a sampling rate of 8kHz. Design an interpolator to change the sampling rate to 16kHz with following specifications: Signal frequency range : 0- 3600Hz Hamming window required for FIR filter design Write a MATLAB program to implement the upsampling scheme and plot the original signal and the downsampled signal versus the sample number, respectively.
8	To study and implement Medial Axis Transform for the given image.
9	To study and implement Fourier descriptors for the given image using MATLAB.
10	Write a program to classify data using minimum distance classifier.
11	Write a program to classify data using k-nearest neighbour classifier.

Design Engineering Problems/Open Ended Problems:

1. Design an algorithm for a Low pass and High pass IIR filter.
2. Design an algorithm for a Band pass and Band reject IIR filter.
3. Design an algorithm for a Low pass and High pass FIR filter.
4. Design an algorithm for a Band pass and Band reject FIR filter.
5. Design an algorithm for extracting the features of different objects present in an input image.
6. Design an algorithm for detecting the Fourier descriptors for the objects present in an input image.
7. Design an algorithm for Classifications of characters for OCR Application.
8. Design of an algorithm which classifies the round objects using Bayesian classifier.
9. Design an algorithm for extracting the boundary features of the given image.
10. Design an algorithm for performing the image retrieval operation using region based pixel properties.
11. Design an algorithm for classification of different shapes using signature vectors and minimum distance classifier.

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.