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FACULTY OF ENGINEERING & TECHNOLOGY

First Year Master of Engineering

Semester I

Course Code: 102430101

Course Title: Advanced Image Processing

Type of Course: Core Course I

Course Objectives: To provide insight into various signal transformation methods. To explore multivariate analysis and its applications. To provide the concepts of feature set, feature extraction techniques and classification techniques in detailed mathematical form

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Internal		External		Total
Lecture	Tutorial	Practical		Theory	J/V/P*	Theory	J/V/P*	
3	0	2	4	30 / 15	20 / 10	70 / 35	30 /15	150 / 75

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Wavelet transform: Short-Time Fourier Transform, Wavelet Transform, Restrictions on Mother Wavelets, Haar Wavelet and Multiresolution Analysis, Daubechies Wavelets, Other Standard Wavelets, Applications of Wavelet Transform	11
2	Multivariate analysis: Introduction, Background Mathematics – Variance, Covariance, Covariance Matrix, Eigenvectors and Eigenvalues, Principal Components Analysis (PCA): Solving PCA using Eigenvector Decomposition and General Solution using SVD, Independent Component Analysis (ICA), Cluster Analysis: Hierarchal Clustering and Partitional Clustering	11
3	Image representation and feature extraction: Run-Length Coding, Chain Codes, Polygonal Approximations, Signatures, Boundary Segments, Skeletons Feature Vectors and Vector Spaces, Binary Object Features, Fourier Descriptors, Shape Number and Hierarchical Features, Histogram-based (Statistical) Features, Texture Features, Hough Transform	15
4	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 Curves, Precision and Recall, Distance and Similarity Measures, Minimum Distance Classifier, k-Nearest Neighbors Classifier, Bayesian Classifier	15

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks						**R**: Remembering; **U**: Understanding; **A**: Application, **N**: Analyze; **E**: Evaluate; **C**: Create
R	**U**	**A**	**N**	**E**	**C**	
20	30	20	10	15	5	

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.

Reference Books:

1	Gonzalez, Woods and Eddins, "Digital Image Processing using MATLAB", McGraw Hill
2	Frank y. Shih, "Image Processing and Pattern Recognition", Wiley
3	J. H. Semmlow, "Biosignal and Biomedical Image Processing: MATLAB based Applications", Marcel Dekker
4	E. S. Gopi, "Algorithm Collections for Digital Signal Processing Applications Using MATLAB", Springer
5	Alfred Mertins, "Signal Analysis", Wiley
6	E. Gose, R. Johnsonbaugh and S. Jost, "Pattern Recognition and Image Analysis" Prentice-Hall India
7	A. C. Rencher, "Methods of Multivariate Analysis". Wiley

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	To understand about signal and its transformation	**30**
CO-2	To understand about the Multivariate system	**20**
CO-3	To understand about various feature extraction techniques	**25**
CO-4	To understand about various classification techniques	**25**

List of Practicals / Tutorials:

Laboratory work will be based on applications of the above syllabus with minimum 10 Experiments to be incorporated.

1	Write a program for implementation of wavelet tranform on the input data.
2	Construct STFT and CWT of signal $x(t)$ and discuss observations. $$x(t) = \begin{cases} 0, & 0 \le t \le 0.5 \\ \sin 2\pi 10t, & 0.5 \le t \le 1 \\ sin2\pi 40t, & 1 \le t \le 1.5 \\ 0, & 1.5 \le t \le 2 \end{cases}$$
3	A) Generate sin wave of 400 Hz with amplitude of 4 sampled 10 KHz, add noise to it. Compute 1st level decomposition. Plot original signal, level-1 approximation and detail coefficients. (Single level Analysis) B) Generate signal as per part (a). Carry out 4-level decomposition with "Db-8" family and reconstruct approximation at level 1, 2, 3 & 4. Plot all these signals. (Multi level analysis)

4	To write and execute program for wavelet transform on given image and perform inverse wavelet transform to reconstruct image.
5	Write a program to check the performance of PCA in blind source signal problem
6	To study and implement Medial Axis Transform
7	To study and implement Fourier descriptors using MATLAB.
8	Write a program to classify data using minimum distance classifier.
9	Write a program to classify data using k-nearest neighbour classifier.
10	Write a MATLAB function to obtain principal components and compress the given image.
11	Write a program for detection of the shape of an object using chain code.
12	Write a program for computing the Singular Value Decomposition (SVD) of the given input data.

Supplementary learning Material:	
1	NPTEL Video Lectures
2	www.scilab.org
3	MATLAB Signal and Image processing toolbox
4	www.python.org
5	http://fossee.in/

Curriculum Revision:	
Version:	**1**
Drafted on (Month-Year):	Apr-20
Last Reviewed on (Month-Year):	Jul-20
Next Review on (Month-Year):	Apr-22