GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Biomedical Engineering (03)
SUBJECT NAME: BIOMEDICAL IMAGE PROCESSING
SUBJECT CODE: 2170308
B.E.VII SEMESTER

Type of course: Core

Prerequisite: Fourier transform, Digital signal processing

Rationale: The purpose of this course is to learn the fundamentals and various techniques of biomedical image processing and to develop the algorithms for image analysis and diagnosis in medical imaging.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	30	0	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning.

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Fundamentals of Digital image** Image formation, visual perception, CCD & CMOS Image sensor, Image sampling: Two dimensional Sampling theory, Nonrectangular grid and Hexagonal sampling, Optimal sampling, Image quantization, Non uniform Quantization, Image formats. Types of pixel Operations, Types of neighborhoods, adjacency, connectivity, boundaries, regions, 2D-convolution, Color models.	8	20
2	**Image Enhancement in Spatial and Frequency domain** Basic gray level transformations, histogram processing, Smoothing operations, Edge Detection-derivative based operation, filtering in frequency domain, 2D-DFT, Smoothing frequency domain filters, Sharpening frequency domain filters, Homomorphic filtering.	10	20
3	**Morphological Image Processing** Dilation and Erosion, Opening and Closing, Hit-or-Miss transformation, Boundary Extraction, Region filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening, Skeletons, Pruning.	8	15
4	**Image Segmentation** Detection of discontinuities, Point-line- edge detection, Linear and Circular Hough Transform, Basic Global and Adaptive Thresholding, Region Based segmentation, K-Means Clustering.	10	20

5	**Image Compression:** Fundamentals of Image compression models, Lossless compression: variable length coding, LZW coding, Arithmetic coding, Lossy compression: Wavelet and DCT coding, Predictive coding.	8	20
6	**Representation and Description** Image features, Feature extraction, Chain code, Moments	6	5
Total		50	

Books:

1. Digital Image Processing, Gonzalez and Woods- Pearson Education
2. Digital Image Processing, S. Sridhar – Oxford University Press.
3. Fundamentals of Digital Image Processing, A.K. Jain .P.H.I.
4. Digital Image Processing, William Pratt- John Wiley.
5. Feature Extraction and Image Processing, Mark S. Nixon and Alberto S. Aguado.
6. Digital Image Processing and Analysis, Chanda Majumder- Printice Hall India.
7. Medical image processing, Geoff Dougherty editor, springer.
8. Image processing, John G. Webster.

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	**U Level**	**A Level**	**N Level**	**E Level**
10%	**35%**	**30%**	**15%**	**10%**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate and above Levels (Revised Bloom's 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.

Course Outcome:

After learning the course the students should be able to:

1. Understand image fundamentals and acquisition techniques.
2. Develop algorithms of image improvement.
3. Develop algorithms for object localization.
4. Analyze Medical images for diagnosis.
5. To study various image descriptors and representation technique.
6. Develop algorithms of feature extraction for classification or verification applications.

List of Experiments: (Outlines)

1. To implement basic operations of image processing in MATLAB.
2. To implement Basic Image gray level transformations for medical images in spatial domain in MATLAB.
3. To implement piece-wise Linear Transformations functions for medical images in MATLAB.
4. To implement Image histogram processing for medical images in MATLAB.
5. To implement Image enhancement of medical images by using spatial filtering in MATLAB.

6. To implement Image enhancement of medical images in frequency domain in MATLAB.
7. To implement Image segmentation using thresholding and edge detection technique in MATLAB.
8. To implement Image segmentation by using K-means clustering in MATLAB.
9. To implement DCT Compression technique on medical image in MATLAB.
10. To implement Image compressions and feature extraction by using wavelet transform in MATLAB.

Design based Problems (DP)/Open Ended Problem:

To Develop or implement algorithms for Object recognition, Segmentation, Classification and Verification, Image Analysis to diagnosis diseases using medical images such as X-Ray, MRI, CT-scan etc…

Example: Tumors detection, Diagnosis of diabetic Retinopathy using fundus images, Breast cancer detection

Active Learning Assignments: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding of theory and practical work. The faculty will assign topics from which students can grasp knowledge about current scenario of the biomedical image processing. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.