# (BM-408) - Biomedical Imaging

## Course Outline:

**Theory:**

1. **Digital Image Fundamental**
    1. Image file formats
    2. Elements of Visual Perception
    3. Image Sampling and Quantization
    4. An Introduction to the Mathematical Tools Used in Digital Image Processing
2. **Intensity Transformations and Spatial Filtering**
    1. Basic Intensity Transformation Functions
    2. Histogram Processing
    3. Fundamentals of Spatial Filtering
    4. Smoothing Spatial Filters
    5. Sharpening Spatial Filters
3. **Filtering in the Frequency Domain**
    1. Review of Concept about Fourier in 1D
    2. Fourier Functions of Two Variable
    3. The Basics of Filtering in the Frequency Domain
    4. Image Smoothing Using Frequency Domain Filters
    5. Image Sharpening Using Frequency Domain Filters
4. **Image Restoration and Reconstruction**
    1. Noise Models
    2. Restoration in the Presence of Noise Only-Spatial Filtering
    3. Periodic Noise Reduction by Frequency Domain Filtering
    4. Inverse Filtering, Least Squares Filtering, GM filtering
    5. Image Reconstruction from Projections
5. **Image Segmentation**
    1. Point, Line, and Edge Detection
    2. Thresholding
    3. Region-Based Segmentation
    4. Segmentation Using Morphological Watersheds
    5. The Use of Motion in Segmentation
6. **Image Compression**
    1. Compression Standards
    2. Some Basic Compression Methods (Huffman Coding, Golomb Coding)
7. **X-ray Imaging**
    1. Physics of X-ray
    2. Imaging with X-ray
    3. Radiation dose
    4. Attenuation based X-ray Imaging
    5. X-ray Detection
    6. X-ray Image Quality
    7. Diagnostic Applications of X-ray Imaging
    8. Demonstration of X-rays Equipment
8. **Principles of Computed Tomography**
    1. Introduction to Computed Tomography and Scanners
9. Attenuation Tomography
10. Time of Flight Tomography
11. Reflection Tomography
12. Diffraction Tomography
13. Formulation of Attenuation Computed Tomography
14. Fourier Slice theorem

1. **Magnetic Resonance Imaging**
    1. Physical and physiological principle of Magnetic Resonance Imaging
    2. MR Imaging
    3. Formulation of MRI reconstruction
    4. Functional MRI, BOLD MRI,
    5. Applications of MRI and fMRI
2. **Ultrasound Imaging**
    1. Generation and detection of ultrasound waves
    2. Physical and physiological principles of Ultrasound
    3. Resolution of Ultrasound imaging
    4. Ultrasound Imaging Modalities
    5. Doppler Ultrasound Imaging
    6. Modes of ultrasound image representation
    7. Ultrasound Image Artifacts
3. **Positron Emission Tomography**
    1. Physical and physiological principles of PET
    2. PET Signal Acquisition
    3. PET Image formation
    4. Significance of PET
    5. Applications of PET

## List of Practicals:

1. MATLAB: Introduction to MATLAB and image processing toolbox
2. Digital Image Fundamentals: Sampling and quantization, bits per pixel & shades, spatial resolution & image size, Zooming & shrinking images
3. Basic Gray Level transformations: Image Negative, Log transform.
4. Application Of Gamma Correction to enhance image
5. Contrast stretching and thresholding
6. Introduction to image Histogram , Histogram sliding
7. Histogram equalization
8. Enhancement using arithmetic/logic operations
9. Smoothing spatial filters (Mean and Median filters)
10. Sharpening spatial filters (Laplace and Sobel)
11. Un-sharp masking and high-boost filtering Combining Spatial Enhancement methods
12. Review of Fourier transform and convolution theorem, 2D-FT, FT and frequency components of an image
13. Lowpass and Highpass Filters: Ideal filters, Butterworth filters, Gaussian filters. Filters comparison, Unsharp Masking
14. Dilation and erosion
15. Detection of discontinuities, Edge linking and boundary detection, Segmentation by thresholding
16. Object recognition, classification and image compression

## Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

## Suggested Assessment:

**Theory (100%)**

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)

- Midterm (30%)
- Final Term (50%)

**Laboratory (100%)**

- Labs
- Open-Ended Labs

## Recommended Text and Reference Books:


1. Bushberg J.T., The Essential Physics of Medical Imaging 3rd Ed.
2. Z. H. Cho, Foundations of Medical Imaging
3. Biomedical Imaging (Principles & Application Engg: Series).
4. Digital Image Processing for Medical Applications, Geoff Dougherty, Cambridge University Press 978-0-521-86085-7
5. Digital Image Processing for Medical Applications by Geoff Dougherty, Cambridge University Press.
6. Digital Image Processing by Gonzales, R. C., Prentice Hall, New Jersey.


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