COMMON POOL OF GENERIC ELECTIVES (GE) COURSES OFFERED BY THE DEPARTMENT

GENERIC ELECTIVE: Signal and image processing (INGE4A)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Signal and image processing (INGE4A)	04	03	-	01	Class XII passed with Mathematics/ Applied Mathematics/ Computer Science/Informatics Practices	Engineering Mathematics

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the fundamental concepts of signal and Image processing.
- To explore DFT for 1-D and 2-D signal and FFT for 1-D signal
- To apply processing techniques on 1-D and Image signals.
- To apply signal and image processing techniques for edge detection.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Apply the concept of DT Signal and DT Systems.
- Classify and analyze discrete time signals and systems
- Implements Digital Signal Transform techniques DFT and FFT.
- Use the enhancement techniques for digital Image Processing
- Differentiate between the advantages and disadvantages of different edge detection techniques
- Develop small projects of 1-D and 2-D Digital Signal Processing.

SYLLABUS OF GE-4

UNIT – 1 **(12 hours)**

Discrete Time Signals and Systems: Introduction, discrete time sequences, Examples of sequences – step, impulse, ramp, sine and exponential, properties of signals and sequences, interpolation and decimation, linear time invariant systems and their properties, stability, causality, system responses, convolution and correlation, sum, solutions of system using difference equations, ZIR, ZSR, natural and forced responses. Z-Transform.

UNIT – 2 **(11 hours)**

Discrete Fourier Transform: Introduction to DTFT and DFT, Relation between DFT and DTFT, IDFT, Properties of DFT without mathematical proof (Scaling and Linearity, Periodicity, Time Shift and Frequency Shift, Time Reversal, Convolution Property and Parsevals' Energy Theorem). DFT computation using DFT properties. Transfer function of DT System in frequency domain using DFT. Linear and Circular Convolution using DFT, Convolution of long sequences, Introduction to 2-D DFT.

UNIT – 3 **(11 hours)**

Fast Fourier Transform: Need of FFT, Radix-2 DIT-FFT algorithm, DIT-FFT Flow graph for N=4 and 8, Inverse FFT algorithm. Spectral Analysis using FFT. FIR and IIR filter.

Representation of Digital Image, Image File Formats, Fundamental steps in Digital Image Processing, Elements of visual perception, Image sensing and Acquisition, Image Sampling and Quantization, Imaging geometry.

UNIT – 4 **(11 hours)**

Image Enhancement:

Spatial Domain: Basic relationship between pixels- Basic Gray level Transformations Histogram Processing – Smoothing spatial filters- Sharpening spatial filters.

Frequency Domain: Smoothing frequency domain filters- sharpening frequency domain filters Homomorphic filtering, Image Compression and Image Segmentation

Practical component: **(30 hours)**

1. (a) Represent basic signals like:Unit Impulse, Ramp, Unit Step, Exponential.
   (b) To generate discrete sine and cosine signals with a given sampling frequency.
2. (a) To represent complex exponentials as a function of real and imaginary parts.
   (b) To determine impulse and step response of two vectors using MATLAB.
3. (a) To perform convolution between two vectors using MATLAB.
   (b) To perform cross correlation between two vectors using MATLAB.

4. To compute DFT and IDFT of a given sequence using MATLAB.
5. To perform linear convolution of two sequences using DFT using MATLAB.
6. (a) To determine z-transform from the given transfer function and its ROC using MATLAB.
   (b)To determine rational z-transform from the given poles and zeros using MATLAB.
7. To determine partial fraction expansion of rational z-transform using MATLAB
8. Implementation of Image negative, Gray level Slicing and Thresholding
9. Implementation of Contrast Stretching, Dynamic range compression & Bit plane Slicing
10. Implementation of Histogram Processing, Image smoothing/ Image sharpening

Essential/recommended readings

1. John G. Proakis, Dimitris and G.Manolakis, 'Digital Signal Processing: Principles, Algorithms, and Applications' 4th Edition 2007, Pearson Education.
2. A. Anand Kumar, 'Digital Signal Processing', PHI Learning Pvt. Ltd. 2013.
3. Rafel C. Gonzalez and Richard E. Woods, 'Digital Image Processing', Pearson Education Asia, 3rd Edition, 2009.
4. S. Sridhar, 'Digital Image Processing', Oxford University Press, Second Edition, 2012.

Suggestive readings

1. Sanjit K Mitra, 'Digital Signal Processing: A Computer Based Approach', TataMcGraw Hill, 3rd Edition.
2. S. Salivahanan, A. Vallavaraj, and C. Gnanapriya, 'Digital Signal Processing', Tata McGraw Hill Publication 1st Edition (2010).
3. S. Jayaraman, E. Esakkirajan and T. Veer Kumar, 'Digital Image Processing' TataMcGraw Hill Education Private Ltd, 2009.
4. Anil K. Jain, 'Fundamentals and Digital Image Processing', Prentice Hall of India Private Ltd, 3rd Edition.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE : Nuclear and Biomedical Instrumentation (INGE4B)

CREDIT DISTRIBUTION, ELIGIBILITY, AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Nuclear and Biomedical Instrumentation (INGE4B)	04	03	-	01	Class XII passed with Physics+ Mathematics/Applied Mathematics/ Biology + Chemistry	Chemistry & Analog Electronics

Learning Objectives

The Learning Objectives of this course are as follows:

- To gain the basic technical knowledge of biomedical instrumentation.
- To familiarize with various bioelectric signals and understand their source of generation.
- To understand the working principle and applications of medical imaging instruments and the modalities involved in each technique.
- To apprehend the essential operation of the nuclear medicine system.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Learn the technical vocabulary associated with basic instrumentation and design and fundamental signal analysis
- Develop a clear understanding of the various bioelectric signals produced by the body which could be obtained and analyzed using the basic implementation of Instrumentation
- Explain and compare the origin, instrumentation, and analysis of biological signals produced by the cardiovascular, respiratory, and nervous system

- Understand the basic difference between the working principle, instrumentation, and application of different medical imaging systems such as ultrasound, X-ray, and Computed tomography
- Infer the measurement principle and operating conditions of various detectors used in a nuclear medicine system

SYLLABUS OF GE-4

UNIT – 1 **(7 hours)**

Introduction to bioelectric potential, bio-amplifier, components of man Instrument system, design factors of biomedical instruments, types of biopotential electrodes.

UNIT – 2 **(14 hours)**

Measurement of Biopotentials: Cardiac vascular system, Origin of (Electrocardiography) ECG signals, Instruments of ECG, bipolar system lead system I, II, III, Einthoven's triangle, Augmented lead system, unipolar chest lead system, types of display.

The nervous system, Action potential of the brain, brain wave, Instrumentation Electroencephalography (EEG).

Measurement of Physiological Parameter: Respiratory system, Types of volume, types of measurements, Instrumentations of the respiratory system, pneumograph, principle & types of pneumograph, Spirometer.

UNIT – 3 **(14 hours)**

Medical Imaging System: Ultrasound, properties, beam width, its generation & detection, types of transducers, diagnostic application – A Scan, B Scan, and M Scan

Radiography: Conventional X-ray, properties, generation of X-ray, X-ray Computed Tomography (CT scanner), and Computer-aided tomography (CAT).

UNIT – 4 **(10 hours)**

Medicine System: Introduction to nuclear medicine system, safety aspects, Nuclear detectors, Gas filled detectors: Ionization, Proportional, and Geiger Muller (GM) Counter, Scintillation counter – principle, operating condition.

Practical component: **(30 hours)**

1. Characterization of biopotential amplifier for ECG signals.
2. Study on ECG simulator.
3. Recording of EEG.
4. Heart sound measurement using an electronic stethoscope.
5. Study of pulse rate monitor with alarm system.
6. Determination of pulmonary function.
7. Study on ultrasound transducers based on the medical systems.
8. Study of Respiration Rate monitor/ apnea monitor.
9. Study of conventional X-ray and CT film.

Essential/recommended readings

1. Cromwell L., Wiebell F. J., Pfeiffer EA, Biomedical Instrumentation and Measurements, Prentice Hall, 2nd edition, 2010.
2. Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, Fourth edition, Pearson Education, Inc, 4th edition, 2010.
3. Khandpur R.S., Handbook of Biomedical Instrumentation, Tata McGraw-Hill Publishing, India, 2nd edition, 2009.
4. Joseph D. Bronzino, The Biomedical Engineering Handbook, 4th Edition (2015), Volume 1, IEEE Press.

Suggestive readings

1. Richard Aston, Principles of Biomedical Instrumentation & Measurement, 1st edition, Merrill Publishing Company (1990).
2. Mandeep Singh, Introduction to Biomedical Instrumentation, 2nd Edition, PHI learning private limited (2014).

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.