

SEMESTER-IV
DEPARTMENT OF INSTRUMENTATION
Category I

(B.Sc. Honours in Instrumentation)

DISCIPLINE SPECIFIC CORE COURSE – 10: Biomedical Instrumentation (INDSC4A)

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		
Biomedical Instrumentation (INDSC4A)	04	03	-	01	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry/ Computer Science/Informatics Practices	Sensors and Transducers

Learning Objectives

The Learning Objectives of this course are as follows:

- To identify and describe various biomedical signals.
- To describe the origin of biopotentials and explain the role of biopotential electrodes.
- To understand the synchronization between the physiological systems of the body.
- To understand the basic measurement principles behind biomedical instrumentation.
- To realize the working principle of numerous biomedical imaging techniques.
- To analyze the applications of biosensing in different domains of healthcare.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Analyze the origin of various bioelectric signals (ECG, EEG) and the method of recording using different types of electrodes.
- Develop basic knowledge about the Cardiovascular, respiratory and nervous systems.

- Develop an understanding of the measurement principles of medical instrumentation including measurement of respiratory function, cardiac variables, blood pressure as well as medical devices.
- Design various biomedical instruments with the help of respective transducers.

SYLLABUS OF DSC-10

Unit-1 (10 Hours)

Biopotentials, Bio amplifiers, and Bioelectrodes: Introduction to bio-electric potential, bio- amplifier, components of man Instrument system, types of biomedical systems, design factors and limitations of biomedical instruments, terms, and transducers to measure various physiological events, types of bio-potential electrodes (Body surface electrodes, Internal electrodes, Microelectrodes), electrolyte interface, electrode circuit model, impedance and polarization, Properties of electrodes

Unit-2 (13 Hours)

Cardiac vascular system & measurements: ECG: origin, Instrumentation, the bipolar system lead system I, II, III, Einthoven's triangle, Augmented lead system, unipolar chest lead system, types of display. Blood pressure measurements: direct, indirect. Pacemakers- Internal, External

Unit-3 (11 Hours)

Respiratory Measurement Systems: Types of volume, types of measurements, Instrumentation of respiratory system, principle & types of pneumograph, Spirometer, pneumotachometers, nitrogen washout technique

Unit-4 (11 Hours)

Nervous system: Action potential of the brain, brain wave, Instrumentation of Electroencephalography (EEG), electrodes used for recording EEG analysis. Conventional X-ray, properties, generation of X-ray, Thermal imaging system, working, IR detectors, applications.

Practical component: (30 hours)

1. Characterization of biopotential amplifier for ECG signals.
2. Study on ECG simulator.
3. Recording of EEG.
4. Measurement of blood pressure and measurement of heart sound using a stethoscope.
5. Study of pulse rate monitor with alarm system.
6. Determination of pulmonary function using a spirometer.
7. Measurement of respiration rate using thermistor /other electrodes.
8. Study of Respiration Rate monitor/ apnea monitor.

Essential/recommended readings

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

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.

DISCIPLINE SPECIFIC CORE COURSE – 11: Machine Learning (INDSC4B)

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		
Machine Learning (INDSC4B)	04	02	-	02	Class XII passed with Physics + Mathematics /Applied Mathematics + Chemistry/ Computer Science/Infor matics Practices	Understanding of Mathematics & programming language

Learning Objectives

The Learning Objectives of this course are as follows:

- Students have an understanding of issues and challenges of Machine Learning.
- Students should be able to select data, model selection, model complexity etc.
- Understanding of the strengths and weaknesses of many popular machine learning approaches.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Identify the characteristics of datasets and compare the trivial data and big data for various applications.
- Understand machine learning techniques and computing environments that are suitable for the applications under consideration .
- Solve problems associated with batch learning and online learning, and the big data characteristics such as high dimensionality, dynamically growing data and in particular scalability issues.
- Develop scaling up machine learning techniques and associated computing techniques and technologies for various applications.
- Implement various ways of selecting suitable model parameters for different machine learning techniques.
- Integrate machine learning libraries, and mathematical and statistical tools with modern

- technologies like hadoop distributed file system and mapreduce programming model
- Familiarize with Simple Linear Regression and Logistic Regression.
- Appreciate the various nuances of Multiple Regressions and Model Building.
- Identify and apply the Classification algorithms.
- Apply the Clustering algorithms for developing applications

SYLLABUS OF DSC-11

UNIT – 1

(8 hours)

Introduction to Machine Learning: varieties of machine learning, Supervised Learning, Unsupervised Learning, Reinforcement Learning. Dimensionality Reduction, Subset Selection, Shrinkage Methods, Principal Components Regression: Linear Classification, Logistic Regression, Linear Discriminant Analysis, Optimization, Classification-Separating Hyperplanes Classification.

UNIT – 2

(8 hours)

Learning input/output functions, sample application. Boolean functions and their classes, CNF, DNF, decision lists and Bias – Variance, Version spaces for learning, version graphs, learning search of a version space, candidate elimination methods.

UNIT – 3

(8 hours)

Artificial Neural Networks (Early models, Back Propagation, Initialization, Training & Validation) Parameter Estimation (Maximum Likelihood Estimation, Bayesian Parameter Estimation) Decision Trees: ID4, C4.5, CART, Evaluation Measures, Hypothesis Testing.

UNIT – 4

(6 hours)

Clustering, Gaussian Mixture Models, Spectral Clustering, Ensemble Methods Learning Theory, Graphical Models.

K-Nearest Neighbors: Computational geometry; Voronoi Diagrams; Delaunay Triangulations K-Nearest Neighbor algorithm; Wilson editing and triangulations. Aspects to consider while designing K-Nearest Neighbor, Support Vector Machines and its classifications. Linear learning machines and Kernel space, Making Kernels and working in feature space.

Practical component:

(60 hour)

Hardware requirement: i5 Processor, 8GB RAM, Internet Connection

Software Environment: IDE recommended PYCHARM (Recommended), JUPYTER, VISUAL STUDIO

1. Introduction to pandas and NumPy
2. Prediction based on different dataset: Vegetable Quality Prediction, Housing Price Prediction, Air Quality Prediction, Car Price Prediction

3. Prediction of diseases e.g. Liver Disease Prediction, Heart Disease Prediction, Crop disease.
4. Credit Default Prediction, Airline Passengers Prediction, Stock Price Prediction.
5. Bank Marketing, Media Content Problem, Online Retail Case Study
6. Energy Efficiency Analysis, Movie Sentiment Analysis, Car Evaluation
7. Program to demonstrate Simple Linear Regression
8. Program to demonstrate Logistic Regression using SCIKIT learn
9. Program to demonstrate Logistic Regression
10. Program to demonstrate k-Nearest Neighbor flowers classification
11. Program to demonstrate Decision Tree – ID3 Algorithm
12. Program to demonstrate Naïve- Bayes Classifier
13. Program to demonstrate Back-Propagation Algorithm
14. Program to demonstrate k-means clustering algorithm
15. Program to demonstrate K-Means Clustering Algorithm on Handwritten Dataset
16. Program to demonstrate K-Medoid clustering algorithm
17. Program to demonstrate DBSCAN clustering algorithm
18. Program to demonstrate SVM based classification
19. Program to demonstrate PCA on face recognition
20. Program to demonstrate PCA and LDA on Iris dataset
21. Mini Project works shall be given with a batch of four students considering different datasets such as digit dataset, face dataset, flower dataset and micro-array dataset.

Essential/recommended readings

1. Introduction to Machine learning, Nils J. Nilsson
2. Pattern Recognition and Machine Learning. Christopher Bishop. First Edition, Springer, 2006.
3. Pattern Classification. Richard Duda, Peter Hart and David Stock. Second Edition, Wiley-Interscience, 2000.
4. Machine Learning. Tom Mitchell. First Edition, McGraw-Hill, 1997.
5. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008.

Suggestive readings

1. Christopher Bishop. Pattern Recognition and Machine Learning. 2e.
2. Tom M. Mitchell, "Machine Learning", McGraw-Hill, 2010
3. Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995.

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

DISCIPLINE SPECIFIC CORE COURSE – 12: Optical Instrumentation (INDSC4C)

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		
Optical Instrumentation (INDSC4C)	04	03	-	01	Class XII passed with Physics + Mathematics/ Applied Mathematics + Chemistry/ Computer Science/ Informatics Practices	Optics and Electronics

Course Learning Objectives

The Learning Objectives of this course are as follows:

- To understand concepts of light and optical effects
- To impart in-depth knowledge of opto-electronic devices and optical measurements
- To provide basic knowledge of interferometry and refractometers
- To introduce the concept of optical fiber-based sensing and measurements

Course Learning Outcomes

The Learning Outcomes of this course are as follows:

- Explain different light phenomenon, optical effects and their applications
- Design photo detector circuits using LED and Lasers as sources
- Understand the optical measurements using interferometers
- Analyze Fiber optic fundamentals and Measurements

SYLLABUS OF DSC-12

Unit-1

(12 hours)

Light as Source and optical effects: Concept of light, coherent and incoherent light sources, classification of different light phenomenon (interference, diffraction and polarization), Diffraction grating, Electro-optic effect, Acousto-optic effect and Magneto-optic effect.

Unit-2

(12 hours)

Opto–Electronic Devices: Light emitting diode (LED), Materials used to fabricate LEDs, Characteristics of LEDs, LED based optical communication, Lasers: Concept of laser (Spontaneous emission, stimulated emission and stimulated absorption), Ruby laser, He-Ne laser, semiconductor laser. Detectors: Photo diode, PIN diode, Photo-conductors, Solar cells.

Unit-3 (10 hours)

Interferometry for optical measurements: Michelson’s Interferometer and its application, Rayleigh’s interferometers, Abbe Refractometer, Fabry-Perot Interferometer, Holography: Concept of holography in brief (Recording and reconstruction).

Unit-4 (11 hours)

Optical Fiber for sensing and measurements: Step index and graded index fibers, Single and multi-mode fibers, Characteristics of optical fiber, Fiber losses, Fiber optic communication system, Dispersion measurement, Active and passive optical fiber sensors, Single mode fiber sensor, Fiber-optic refractive index sensor

Practical component: (30 hours)

1. To study characteristics of LED
2. To determine the slit width using He-Ne laser
3. To determine the wavelength of monochromatic source using Michelson interferometer.
4. Determine the numerical aperture and bending loss of optical fiber
5. To find the wavelength of a laser using transmission diffraction grating
6. To measure the intensity pattern of a single slit using He-Ne laser
7. To find the I-V characteristics of a solar cell
8. To measure the refractive index of the prism using a spectrometer.

Essential/recommended readings

1. Ajoy Ghatak, Optics, Tata McGraw Hill, New Delhi (2008)
2. S. O. Kasap, Optoelectronics and Photonics: Principles and Practices, Pearson Education (2009)
3. E. Hecht, Optics, Pearson Education Ltd. (2002)
4. Rajpal S. Sirohi, Wave Optics and its Application, 1st ed. (2001)
5. Pollock, Fundamentals of OPTOELECTRONICS, (1994)
6. Photonic Devices and Systems –by Robert G. Hunsperger, Taylor & Francis, 1994,
7. G. Hebbar, “Optical Fiber Communication”, Cengage

Suggestive reading

1. J. Wilson and J. F. B. Hawkes, Optoelectronics: An Introduction, Prentice H. India (1996)

2. Ghatak A.K. and Thyagarajan K., "Introduction to fiber optics," Cambridge Univ.Press. (1998)
3. 10. A. Yariv, Optical Electronics/C.B.S. College Publishing, New York, (1985)

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

DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES OFFERED BY THE DEPARTMENT

DISCIPLINE SPECIFIC ELECTIVE: Linear Integrated Circuits (INDSE4A)

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		
Linear Integrated Circuits(INDSE4A)	04	03	-	01	Class XII passed with Physics + Mathematics/Applied Mathematics+ Chemistry / Computer Science/Informatics	Understanding of Analog electronics & Operational Amplifiers

Learning Objectives

The Learning Objectives of this course are as follows:

- Familiarity and designing of various non-linear circuits using op-amp
- Familiarity and designing of multivibrators using 555 timer.
- Use of op-amp in designing of D/A and A/D convertors.
- Familiarity with different Linear ICs like 380, 555, 565, 566, 78xx and 79xx.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Design and explain the working of log & anti-log amplifier, analog multiplier and precision rectifier using op-amp.
- Design and explain the working of D/A and A/D convertors using op-amp.
- Design and explain the working of different types of multivibrators using IC 555.
- Use the regulator ICs for regulation purposes.

SYLLABUS OF DSE-2

UNIT – 1 (12 hours)

Sample and hold circuits, logarithmic amplifiers, antilogarithmic amplifiers, analog multipliers, Precision rectifier circuit: Half wave rectifier, full wave rectifier, bridge rectifier, peak rectifier, clipper, clamping, and applications of precision rectifier circuits.

UNIT – 2 (12 hours)

D/A convertor: Binary weighted resistors, R/2R resistor. **A/D convertor:** Successive approximation.

Power Amplifiers: Monolithic power amplifier (IC 380), use of power boosters (IC 3329/03), application of power amplifiers

UNIT – 3 (12 hours)

Multivibrators (IC 555): Pin and block diagram, Astable and monostable multivibrator circuit, applications of astable and monostable multivibrators.

Phase locked loops (PLL): Block diagram, operating principle, phase detector types, monolithic phase locked loops (IC565). Application of PLL IC 565: Frequency multiplier and frequency shift keying. Voltage controlled oscillator (IC 566).

UNIT – 4 (9 hours)

Voltage Regulators IC: Fixed voltage regulator (IC 78xx and IC 79xx), adjustable voltage regulator (IC 317 and IC 337), switching regulator (IC 1723) and special regulator.

Practical component: (30 hours)

1. Designing of precision half wave rectifier circuit.
2. Designing of precision full wave rectifier circuit.
3. Designing of precision positive and negative clipper circuit.
4. Designing of precision positive and negative clamper circuit.
5. Designing of binary weighted D/A convertor OR R/2R resistor D/A convertor
6. Design an astable multivibrator using IC 555.
7. Design a monostable multivibrator using IC 555.
8. Design a voltage regulator circuit using voltage regulator IC.

Essential/recommended readings

1. Skoog & Lerry, Instrumental Methods of Analysis, Saunders College R. A. Gayakwad, Op-Amps and Linear IC's, Pearson Education 4th Edition, May 2015.

2. R. F. Coughlin and F. F. Driscoll, Operational amplifiers and Linear Integrated circuits, Pearson Education (2001).
3. J. Millman and C.C. Halkias, Integrated Electronics, Tata McGraw-Hill, (2001).
4. A.S. Sedra and K.C. Smith, Microelectronics Circuit, Oxford (2011).

Suggestive readings

1. A.P.Malvino, David J Bates, Electronic Principals, 7th Edition, Tata McGraw-Hil Education, (July 2017).

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

DISCIPLINE SPECIFIC ELECTIVE: Statistical Tools and Techniques (INDSE4B)

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		
Statistical Tools and Techniques (INDSE4B)	04	03	-	01	Class XII passed with Physics + Mathematics/Applied Mathematics/Biology+ Chemistry / Computer Science/Informatics	Class X Mathematics

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop the students' ability to deal with numerical and quantitative issues in industries.
- To enable the use of statistical, graphical, and algebraic techniques wherever relevant.
- To have a proper understanding of Statistical applications in different fields.
- To identify and discuss critically, the uses and limitations of statistical analysis.

Learning Outcomes

The Learning Outcomes of this course are as follows:

- Describe and discuss the key terminology, concepts tools, and techniques used in statistical analysis
- Understand the concept of probability and sampling distributions

- Perform different parametric and non-parametric tests for various statistical analysis.

SYLLABUS OF DSE-02

Descriptive statistics: Graphical and Tabular representation of data. Measures of Central Tendency, Measures of Dispersion, Measures of Skewness and Kurtosis.

Unit-1 (13 hours)

Correlation and Regression: Linear Regression and Correlation.

Unit-2 (12 hours)

Probability and Distributions: Introduction to probability, Experiment, sample space, event, probability, conditional probability, Baye's Theorem, Random Variables, Probability Distributions- Normal, Binomial, Poisson, Mathematical Expectation.

Unit-3 (10 hours)

Sampling and Sampling Distributions: Sampling distributions and Standard errors. One and two-sample estimation of means and proportions. One and two-sample tests of hypothesis- means, proportions and variances, t-test, Chi-square test.

Unit-4 (10 hours)

Nonparametric Statistics: Nonparametric tests, Sign test, Signed-Rank test, Rank-Sum test, Kruskal-Wallis test, Runs test.

Practical component: (30 hours)

1. Collection, tabulation, and statistical interpretation of data.
2. To study measures of central tendency- mean, median, mode.
3. To study measures of dispersion- range, standard deviation, variance.
4. To study the coefficient of variation.
5. To study measures of skewness.
6. To study the continuous and discrete distribution.
7. To study nonparametric tests.

Essential/recommended readings

1. Probability and Statistics for Engineers and Scientists by Walpole, Myers, Myers and Ye, 9th Edition, Pearson Education, 2012.
2. Mathematical Statistics and Applications by John E. Freund, 8th Edition, Prentice Hall, India, 2014.
3. Introduction to Statistical Quality Control by Montgomery, 8th Edition, John Wiley and Sons, 2019.

Suggested Books:

4. Principles of Biostatistics by M. Pagano and K. Gauvreau: Thompson learning (2nd edition); 2018.
5. Biostatistics: A Foundation for Analysis in the Health Sciences by W. W. Daniel and Chad L. Cross; John Wiley and Sons Inc (11th edition); 2018 .

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

DISCIPLINE SPECIFIC ELECTIVE: Virtual Instrumentation (INDSE4C)

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		
Virtual Instrumentation Techniques and Applications (INDSE4C)	04	02	-	02	Class XII passed with Physics + Mathematics/Applied Mathematics+ Chemistry / Computer Science/Informatics	Electronic Instruments & programming language

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the importance of Virtual Instrumentation and study its applications.
- To learn the basic programming concepts in LabVIEW.
- To understand the basics of data acquisition for designing a Virtual Instrument.
- To recognize the various building blocks of Virtual instrumentation and use them for PC-based Measurement.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the importance and applications of Virtual Instrumentation.
- Learn the basic programming concepts in LabVIEW.
- Recognize the components of Virtual instrumentation and use them for PC Based Measurement.

SYLLABUS OF DSE-02

Unit 1

(6 hours)

Introduction to Virtual Instrumentation: Historical perspective, advantages, Block diagram and Architecture of a Virtual Instrument, Data Flow Techniques, Graphical programming in the data flow, comparison with Conventional programming.

Unit 2

(10 hours)

LabVIEW Programming Environment: Basic operations, Controls/ Indicators, Auto indexing, Debugging, Timing issues (counters).

VI Programming Techniques: Modular programming: VIS and sub-VIS, loops, Arrays, Clusters, Graphs, Charts, Case & Sequence structures. Formula nodes, Local and Global variables, String & file input.

Unit 3

(10 hours)

Instrument Control: GPIB Communication, Instrument I/O Assistant, Virtual Instrument Software Architecture (VISA), Instrument Drivers, Serial Port Communication

Data Acquisition Basics: Signals Handling and Classification, Signal Conditioning, Analog Interfacing (I/O), Counters & Timers, Digital (I/O) - DAQ Hardware, DAQ Software Architecture, DAQ Assistant

Unit 4

(4 hours)

Developing applications on LabVIEW: Process control, Waveform generator, Motion control using a stepper motor.

Practical Components

(60 hours)

1. The length and breadth of a rectangle and the radius of a circle are inputs. Build a VI to calculate the area and perimeter of the rectangle and the area and circumference of the circle.
2. Convert a binary number to a decimal number.
3. Compute the equations $(X1 + 2)*3$ and $5 + X2*\log(X2)$ using functions, Expression node, and Express Formula for the given inputs X1 and X2.
4. Build a VI to find the factorial of a number.
5. Create a VI to find the sum of first n natural numbers using a While Loop with a feedback node.
6. Write a program in LabVIEW to read a positive number n and to generate the following number series using (a) a For Loop and (b) a While Loop
1, 22, 32, 42, ..., n²
0, 2, 4, 6, ..., n
7. Create a VI to compare the element of two clusters if the value of the corresponding element is the same switch on LED in the output cluster.
8. Build an array of cluster controls in which each cluster consists of a numeric control and a 1D numeric array (with 5 elements). This forms a database of marks of students. The numeric control indicates the roll number and the array indicates the test marks of five subjects. Build logic to modify the mark in a particular subject of a particular student. Input the roll number, the subject in which the mark is to be changed, and the new marks. Display the changed database on a separate array indicator.
9. Create a 1D numeric array that consists of ten elements and rotate it ten times. For each rotation display the equivalent binary number of the first array element in the

form of a Boolean array. Also, display the reversed Boolean array. Provide delay to view the rotation.

10. Create two 2D numeric arrays and add them. Change the number of rows and number of columns of each array and see the result.
11. Create a 1D array and find its reverse.
12. Build a VI to plot a circle in the XY graph using a For Loop.
13. Build a VI that generates a 1D array of random numbers and sort the ascending descending array and also find the max. and min. value array element.
14. Build a cluster control that consists of a seven-segment LED display, a switch, a string control, and numeric control. Split the cluster elements using the Unbundle function and alter the values of some of the cluster controls. Bundle them again and display them in a cluster indicator.
15. Using a for loop determines the number of odd numbers between a range of numbers entered by the user.
16. Write a for loop which takes the given values of μ from a numeric control labeled coefficient of kinetic friction. Calculate f'' from $\theta=0$ to 90 degree in 1-degree increment then display the resulting array f'' values on a waveform graph.
17. Create a VI to check whether the cluster elements are in range or not. Specify the upper and lower limits. Display the coerced output and a cluster of LEDs to indicate whether a particular cluster element is in the range or not.
18. Split an input string into two outputs with reference to a separating character. Find the length of the input string and reverse the string.
19. Write a program to solve $x^2+bx+c=0$.
20. Build a VI to generate two waveforms of different amplitude and frequency add the signal to find the resultant and plot it on the separate waveform graph.

Essential/recommended readings

1. John Essick , Hands-on Introduction to LabVIEW for Scientists and Engineers, 3rd Edition, 2015.
2. Gary Johnson, LABVIEW Graphical Programming, McGraw Hill, 4th Edition, 2006.
3. Lisa K. Wells and Jeffrey Travis, LABVIEW for Everyone, PHI, 3rd Edition, 2006.
4. James K, PC interfacing and data acquisition, 2002.
5. Skolkoff, Basic concepts of LABVIEW 4, PHI, 1998.

Suggested Books

1. Technical Manuals for DAS Modules of Advantech and National Instruments. L.T. Amy, Automation System for Control and Data Acquisition, ISA, 4th Edition, 1992.
2. S. Gupta, J.P. Gupta, PC Interfacing for Data Acquisition and Process Control, ISA, 2nd Edition, 2nd Edition, 1994.

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

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 Parseval's 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. Rafael 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).

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