Semester-VI
ELECTRONIC SCIENCE

DEPARTMENT OF INSTRUMENTATION
Category I

(B.Sc. Honours in Instrumentation)

DISCIPLINE SPECIFIC CORE COURSE – 16: Analytical Instrumentation II (INDSC6A)

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		
Analytical Instrumentation II (INDSC6A)	04	03	-	01	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry/ Computer Science/Informatics Practices	Understanding of electronics and Chemistry till class XII

Learning Objectives

- To understand the perspective of different advanced analytical methods
- To understand the principle, instrumentation, and application of various electro analytical instruments
- To disseminate with principle and instrumentation of thermo analytical instruments along with their applications for analysing products of different origin
- To familiarize with detail principle, instrumentation, operation and applications of IR spectroscopy
- To differentiate between principle, instrumentation and operation of Atomic absorption and atomic emission spectroscopy.
- To understand the principle, instrumentation, and applications of Gas Chromatography (GC) and High-Performance Liquid Chromatography (HPLC)

Learning outcomes

At the end of this course, students will be able to

- Appreciate the potential of different analytical methods for resolving various scientific challenges.
- Describe the principle, instrumentation and application of electro analytical instruments.
- Understand the principle and instrumentation of thermo analytical instruments along with their applications for analyzing products of different origin.
- Understand the different terms, principle, instrumentation, operation, and applications of IR spectroscopy.
- Differentiate between principle, instrumentation and operation of atomic absorption spectroscopy and atomic emission spectroscopy.

SYLLABUS OF DSC-16

Unit-1 **(14 hours)**

Infrared Spectroscopy: Theory, diatomic molecule as a simple harmonic oscillator, instrumentation, sample handling techniques. Fourier Transform Infrared Spectroscopy (FTIR): instrumentation and advantages.

Atomic Spectroscopy: Principle, comparison of atomic and molecular spectroscopy, Atomic emission spectroscopy (AES): Flame photometer and its instrumentation, atomization process, types of flames- fuel/ oxidant combinations, instrumentation, Interferences and applications. Introduction to Atomic absorption spectroscopy (AAS).

Unit-2 **(10 hours)**

Electro analytical Methods of Analysis: Potentiometry: Introduction, reference electrode, indicator electrodes, ion-selective electrodes: glass electrode and liquid membrane electrode and their applications, potentiometric titrations.

Unit-3 **(12 hours)**

Gas Chromatography (GC): Principle, Carrier gasses, different types of injection systems, columns, stationary phases, and detectors. Isothermal mode, temperature-programming mode, applications.

Unit-4 **(9 hours)**

High Performance Liquid Chromatography (HPLC): mobile phase, isocratic and gradient elution, pumps, injection systems, columns, stationary phases, normal phase and reverse phase chromatography, detectors, and applications.

Practical component: **(30 hours)**

1. Determination of concentrations of sodium/calcium/lithium/potassium in sample using Flame Photometer.

2. Determination of concentration of sodium/calcium/lithium/potassium ions in sample by standard addition method using flame photometer
3. Spectrum interpretation using FTIR.
4. Qualitative/Quantitative analysis of samples using Gas chromatography.
5. Qualitative/Quantitative analysis of samples using High Performance Liquid Chromatography
6. Potentiometric titrations: (i) Strong acid with strong base (ii) weak acid with strong base and (iii) dibasic acid with strong base
7. Potentiometric titration of Mohr's salt with potassium dichromate
8. pH metric titrations of (i) strong acid and strong base (ii) weak acid and strong base

Essential/recommended readings

1. Skoog & Lerry, Instrumental Methods of Analysis, Saunders College Publications, New York, 4th edition, 1970.
2. H.H. Willard, L.L Merrit, J.A. Dean, F. A. Settle, Instrumental Methods of Analysis, CBS Publishers, 7th edition, 1988.
3. Skoog, Holler and Crouch, Principles of Instrumental Analysis, Cengage Learning, 6th edition, 2007
4. James W. Robinson, Eileen Skelly Frame, George M. Frame II, Undergraduate Instrumental Analysis, CRC Press, 7th edition, 2014
5. Vogel's Textbook of Qualitative Chemical Analysis, ELBS, 4th edition 1978.

Suggestive readings

1. W. Kemp, Organic Spectroscopy, ELBS, 3rd Edition, 1996.
2. R.S Khandpur, Handbook of Analytical Instruments, Tata McGraw-Hill, 3rd Edition 2006.
3. B.K Sharma, Instrumental Methods of Chemical Analysis, Krishna Prakashan Media, 1st Edition, 2011

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

DISCIPLINE SPECIFIC CORE COURSE – 17: Analog Devices and Circuits (INDSC6B)

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		
Analog Devices and Circuits (INDSC6B)	04	03	-	01	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry/ Computer Science/Informatics Practices	Semiconductor devices

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce different types of diodes like Tunnel diode, Varactor diode, Schottky diode, Photodiode etc.
- To explain construction and characteristics of JFETs, MOSFETs and UJT
- The student should be able to explain and calculate small signal parameters of MOSFET.
- To learn the basics of MOSFET Circuits.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Explain the operation of Tunnel diode, Varactor diode, Schottky diode, Photodiode etc.
- Reproduce the I-V characteristics of JFET, MOSFET and UJT.
- Analysis of the operation of MOS transistor
- Ability to understand the fundamentals of MOSFET circuits.

SYLLABUS OF DSC-17

UNIT – 1 **(8 hours)**

Special purpose electronic devices: Principal of operation and Characteristics of Tunnel Diode, Varactor Diode, Schottky Diode, Photo diode, Photoconductive cells, IR emitter, Liquid crystal displays, Solar cells, and Thermistor.

UNIT – 2 **(12 hour)**

Junction Field Effect Transistors (JFET): JFET, Construction, Idea of Channel Formation, Pinch-Off and Saturation Voltage, Current-Voltage Output Characteristics. FET Amplifiers: FET Common source Amplifier, Common Drain Amplifier, Generalized FET Amplifier, FET biasing.

UNIT – 3 **(13 hours)**

Metal Oxide Semiconductor Field Effect Transistor (MOSFET): Types of MOSFETs, Circuit symbols, Working and Characteristic curves of Depletion type MOSFET (both N channel and P Channel) and Enhancement type MOSFET (both N channel and P channel). Biasing of MOSFETs, Small Signal Parameters, Common Source amplifier circuit analysis.

UJT, Basic construction and working, Equivalent circuit, intrinsic Standoff Ratio, Characteristics, and Relaxation oscillator

UNIT – 4 **(12 hours)**

MOS Inverter: Introduction, Voltage Transfer Characteristic (VTC), Noise Immunity and Noise margins, Resistive-Load Inverter, CMOS Inverter, DC Characteristics of CMOS Inverter, Calculation of VIL, VIH, VOL, VOH and Vth, Design of CMOS Inverters, Supply Voltage Scaling in CMOS Inverters, Power, and Area considerations

Practical component: **(30 hours)**

1. To verify practically the response of various special purpose electronic devices.
2. To Study the I-V Characteristics of JFET.
3. To Study the I-V Characteristics of MOSFET
4. To obtain the frequency response of a MOSFET amplifier in common source configuration with given specifications.
5. To Study I-V Characteristics of the UJT.
6. NMOS inverter: (a)Transient analysis using Step input and Pulse input. (b) DC analysis (VTC).
7. CMOS inverter: (a)Transient analysis using Step input and Pulse input. (b) DC analysis (VTC).

Essential/recommended readings

1. R. L. Boylestad, L. Nashelsky, K. L. Kishore, Electronic Devices and Circuit Theory, Pearson Education (2006)
2. J. R. C. Jaegar and T. N. Blalock, Microelectronic Circuit Design, Tata McGraw Hill (2010)
3. Donald E. Neaman, “Electronic Circuit, Analysis and Design”, Tata McGraw Hill Publishing Company Limited, Second Edition, 2006.
4. J. Millman and C. C. Halkias, Integrated Electronics, Tata McGraw Hill (2001)
5. CMOS Digital Integrated circuits – Analysis and Design by Sung – Mo Kang, Yusuf Leblebici, TATA McGraw-Hill Pub. Company Ltd.

Suggestive readings

1. D. L. Schilling and C. Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill (2002)
2. Michael Shur, “Physics of Semiconductor Devices,” Prentice Hall
3. Thomas L. Floyd, David M. Buchla, Electronics Fundamentals: Circuits, Devices & Applications, 8th Edition, Pearson education, 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 – 18: Control Systems (INDSC6C)

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		
Control Systems (INDSC6C)	04	03	-	01	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry/ Computer Science/Informatics Practices	Engineering Mathematics

Learning Objectives

The Learning Objectives of this course are as follows:

- To study how to interpret and apply block diagram representations of control systems and design PID controllers based on empirical tuning rules
- To help the students understand and practice feedback and feed-forward control architecture and discuss the importance of performance, robustness and stability in control system design
- To teach about how to solve the steady state and transient analysis of a system for standard inputs
- Introduce students how to compute stability of linear systems using the Routh array test and use this to generate control design constraints
- To teach students the use Evans root locus techniques in control design for real world systems

Learning outcomes

The Learning Outcomes of this course are as follows:

- Interpret and apply block diagram representations of control systems and design PID controllers based on empirical tuning rules
- Define and explain feedback and feed-forward control architecture and discuss the importance of performance, robustness and stability in control system design
- Solve the steady state and transient analysis of a system for standard inputs

- Compute stability of linear systems using the Routh array test and use this to generate control design constraints
- Use Evans root locus techniques in control design for real world systems
- Compute gain and phase margins from Bode diagrams and Nyquist plots and understand their implications in terms of robust stability

SYLLABUS OF DSC-18

UNIT – 1 **(11 hours)**

Introduction to Control System: Introduction of open loop and closed loop control systems, mathematical modelling of physical systems (Electrical, Mechanical), derivation of transfer function, Armature controlled and field controlled DC servomotors, block diagram representation & signal flow graph, reduction technique, Mason's Gain Formula, effect of feedback on control systems.

UNIT – 2 **(11 hours)**

Time Domain Analysis: Time domain performance criteria, transient response of first, second, steady state errors and static error constants, performance indices.

Concept of Stability: Asymptotic stability and conditional stability, Routh – Hurwitz criterion, relative stability analysis, Root Locus plots and their applications.

UNIT – 3 **(12 hours)**

Frequency Domain Analysis: Frequency Domain Analysis: Correlation between time and frequency response, Polar plots, frequency domain specifications, Logarithmic plots (Bode Plots), gain and phase margins, Nyquist stability criterion, relative stability using Nyquist criterion.

UNIT – 4 **(11 hours)**

State Space Analysis: Definitions of state, state variables, state space, representation of systems, Solution of time invariant, homogeneous state equation, state transition matrix and its properties.

Controllers and Compensation Techniques: Basic Control Actions: Proportional, Integral and Derivative controls, response with P, PI and PID Controllers, Basic concept of compensation, Lag, Lead and Lag-Lead networks.

Practical component: **(30 hours)**

1. To study characteristics of :
   a. Synchro transmitter receiver
   b) Synchro as an error detector
1. To study position control of DC motor
2. To study speed control of DC motor
3. To find characteristics of AC servo motor
4. To study time response of type 0,1 and 2 systems
5. To study frequency response of first and second order systems

6. To study time response characteristics of a second order system.
7. To study effect of damping factor on performance of second order system
8. To study frequency response of Lead and Lag networks.
9. Study of P, PI and PID controller.

Essential/recommended readings

1. J. Nagrath& M. Gopal, Control System Engineering, New Age International, 2021, 7th Edition.
2. K. Ogata, Modern Control Engineering, Prentice Hall of India, 2015, 5th Edition.
3. B. C. Kuo , "Automatic control system", Prentice Hall of India, 2010, 9th Edition.
4. B. S. Manke, Linear Control Systems, Khanna Publishers, Delhi, 7th Edition.

Suggestive readings

1. N.K Jain, Automatic Control System Engineering, DhanpatRai Publication, 2019, Standard Edition.
2. Veenadevi S V and Sujatha Hiremath, Control System, I K International Publishing House Pvt Ltd, 2022.

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