

## Category II

(Physical Science Courses (with Electronics) for Undergraduate Programme of study with Physics and Electronics discipline as Core Disciplines)

### DISCIPLINE SPECIFIC CORE COURSE (PHYSICS DSC - 3): ELECTRICITY AND MAGNETISM

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Electricity and Magnetism Physics DSC 3	4	2	0	2	Class XII pass	----

#### LEARNING OBJECTIVES

This course reviews the concepts of electricity and magnetism learnt at school from a more advanced perspective and goes on to build new concepts. The course covers static and dynamic electric and magnetic fields, and the principles of electromagnetic induction. It also includes analysis of electrical circuits and introduction of network theorems. The students will be able to apply the concepts learnt to several real world problems.

#### LEARNING OUTCOMES

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

- Understand Gauss' law, Coulomb's law for the electric field, and apply them to systems of point charges as well as line, surface, and volume distributions of charges. Also to use the knowledge to solve some simple problems
- Express electric current and capacitance in terms of electric field and electric potential.
- Calculate the force experienced by a moving charge in a magnetic field
- Determine the magnetic force generated by a current carrying conductor
- Have brief idea of magnetic materials, understand the concept of electromagnetic induction, solve problems using Faraday's and Lenz's laws

In the laboratory course, students will be able to measure resistance (high and low), voltage, current, self and mutual inductance, capacitor, strength of magnetic field and its variation, study different electric circuits.

## SYLLABUS OF PHYSICS DSC – 3

### THEORY COMPONENT

#### **Unit 1: (10 Hours)**

Electrostatics: Electric field, electric flux, Gauss' theorem in electrostatics, applications of Gauss' theorem (linear, plane and spherical charge distribution), line integral of electric field, electric potential due to a point charge, electric potential and electric field of a dipole and charged disc, capacitance due to parallel plates and spherical condenser. Electrostatic energy of system of charge (charged sphere), dielectric medium, dielectric polarization, displacement vector, Gauss' theorem in dielectrics, parallel plate capacitor filled with dielectric.

#### **Unit 2: (8 Hours)**

Magnetostatics: Magnetic force between current elements and definition of magnetic field  $\mathbf{B}$ , Biot-Savart's law and its applications (current carrying straight conductor, current carrying circular coil, current carrying solenoid), divergence and curl of magnetic field, Ampere's circuital law, magnetic properties of materials (magnetic intensity, magnetic induction, permeability, magnetic susceptibility), brief introduction of dia-, para- and ferro magnetic materials

#### **Unit 3: (7 Hours)**

Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self-inductance of single coil, mutual inductance of two coils, energy stored in magnetic field. Maxwell's equations and equation of continuity of current, displacement current

#### **Unit 4: (5 Hours)**

DC Circuits: Review of Kirchhoff's Voltage and Current Laws, Thevenin theorem, Norton theorem, Superposition theorem, Maximum Power Transfer theorem.

#### **References:**

##### **Essential Readings:**

- 1) Fundamentals of Electricity and Magnetism, Arthur F. Kip, 2nd Edn. 1981, McGraw-Hill.
- 2) Electricity and Magnetism, J. H. Fewkes and J. Yarwood, Vol. I, 1991, Oxford Univ. Press
- 3) Electricity and Magnetism, D. C. Tayal, 1988, Himalaya Publishing House.
- 4) Fundamentals of Electromagnetics, M. A. W. Miah, 1982, Tata McGraw Hill
- 5) Introduction to Electrodynamics, D. J. Griffiths, 3rd Edn, 1998, Benjamin Cummings.

##### **Additional Readings:**

- 1) Electricity and Magnetism, Berkeley Physics Course, Edward M. Purcell, 1986, McGraw-Hill Education.
- 2) Problems and Solutions in Electromagnetics, Ajoy Ghatak, K Thyagarajan and Ravi Varshney

- 3) University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- 4) Schaum's Outline of Electric Circuits, J. Edminister and M. Nahvi, 3rd Edn., 1995, McGraw Hill.

### **PRACTICAL COMPONENT – 60 Hours**

The teacher is expected to give basic idea and working of various instruments and circuits related to different experiments. Students should also be given knowledge of recording and analyzing experimental data.

Every student should perform at least 06 experiments from the following list of experiments.

- 1) To use a multimeter for measuring resistances, a.c and d.c voltages, d.c. current, capacitance and for checking electrical fuses.
- 2) Ballistic Galvanometer:
  - e) Measurement of charge and current sensitivity
  - f) Measurement of critical damping resistance
  - g) Determine a high resistance by leakage method
  - h) Determine self-inductance of a coil by Rayleigh's Method.
- 3) To compare capacitances using de Sauty's bridge.
- 4) Measurement of field strength B and its variation in a Solenoid
- 5) To study the Characteristics of a Series RC Circuit.
- 6) To study a series LCR circuit and determine its resonant frequency and quality factor.
- 7) To study a parallel LCR circuit and determine its anti-resonant frequency and quality factor
- 8) To determine a low resistance by Carey Foster bridge.
- 9) To verify the Thevenin, superposition and maximum power transfer theorems
- 10) To verify Norton theorem

### **References (for Laboratory Work):**

- 1) Advanced Practical Physics for Students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
- 2) Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
- 3) A Textbook of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- 4) Practical Physics, G. L. Squires, 2015, 4th Edition, Cambridge University Press
- 5) Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

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

**DISCIPLINE SPECIFIC CORE COURSE (PHYSICS DSC - 4):  
LINEAR AND DIGITAL INTEGRATED CIRCUITS**

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Linear and Digital Integrated Circuits Physics DSC 4	4	2	0	2	Class XII pass	----

### LEARNING OBJECTIVES

This paper aims to provide the basic knowledge of linear and digital electronics. It discusses about the operational amplifier and its applications. Boolean algebra and combinational logic circuits are also discussed.

### LEARNING OUTCOMES

At the end of this course, students will be able to achieve the following learning outcomes.

- To understand Op-Amp basics and its various applications.
- To become familiar with logic gates and boolean algebra theorems.
- To understand the minimization techniques for designing a simplified logic circuit.
- To design a half adder, full adder, half-subtractor, and full-subtractor.
- To understand the working of data processing circuits, multiplexers, de-multiplexers, decoders and encoders.
- To become familiar with the working of flip-flop circuits, its working and applications.

### SYLLABUS OF PHYSICS DSC – 4

#### THEORY COMPONENT

#### **Unit 1: (8 Hours)**

Operational Amplifiers (Black box approach): Characteristics of an ideal and practical Operational Amplifier (IC 741), Open and closed loop configuration, CMRR, Slew Rate and the concept of Virtual Ground.

Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Summing and Difference Amplifier, (3) Differentiator, (4) Integrator, (5) Wein bridge oscillator, (6) Comparator, and (7) Active low pass and high pass Butter worth filter (1st order only).

**Unit 2: (6 Hours)**

Logic Gates and Boolean algebra: Truth Tables of OR, AND, NOT, NOR, NAND, XOR, XNOR, Basic postulates and fundamental theorems of Boolean algebra.

Combinational Logic Analysis and Design: Standard representation of logic functions (SOP), Minimization Techniques (Karnaugh map minimization up to 4 variables for SOP).

**Unit 3: (6 Hours)**

Arithmetic Circuits: Half and Full Adder, Half and Full Subtractor, 4-bit binary Adder/Subtractor

Data processing circuits: Multiplexers, De-multiplexers, Decoders, Encoders

**Unit 4: (5 Hours)**

Sequential Circuits: SR, D, and JK Flip-Flops. Race-around conditions in JK Flip-Flop. Master-slave JK Flip-Flop.

Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel in-Parallel-out Shift Registers (only up to 4 bits). Ring Counter.

**Unit 5: (5 Hours)**

Counters (4 bits): Asynchronous counter, Synchronous Counter.

D-A and A-D Conversion: 4 bit binary weighted and R-2R D-A converters, A-D conversion characteristics, successive approximation ADC.

**References:****Essential Readings:**

- 1) Op-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
- 2) Operational Amplifiers and Linear ICs, David A. Bell, 3rd Edition, 2011, Oxford University Press.
- 3) Digital Principles and Applications, A. P. Malvino, D. P. Leach and Saha, 8th Ed., 2018, Tata McGraw
- 4) Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill
- 5) Digital Fundamentals, Thomas L. Floyd, Pearson Education Asia (1994).
- 6) Digital Principles, R. L. Tokheim, Schaum's outline series, Tata McGraw- Hill (1994).

**PRACTICAL COMPONENT – 60 Hours**

Every student should perform at least 04 experiments each from section A, B and C

**Section A: Op-Amp. Circuits (Hardware design)**

- 1) To design an inverting and non-inverting amplifier using Op-amp (741,351) for dc voltage of given gain.
- 2) To design inverting and non-inverting amplifier using Op-amp (741,351) and study their frequency responses
- 3) To add two dc voltages using Op-Amp in inverting and non-inverting mode.
- 4) To design a precision Differential amplifier of given I/O specification using Op-amplifier.

- 5) To investigate the use of an op-amp as an Integrator.
- 6) To investigate the use of an op-amp as a Differentiator.
- 7) To design a Wien bridge oscillator for given frequency using an Op-Amplifier.
- 8) Design a Butter-worth Low Pass active Filter (1st order) and study frequency response.
- 9) Design a Butter-worth High Pass active Filter (1st order) and study frequency response.
- 10) Design a digital to analog converter (DAC) of given specifications.

### **Section B: Digital circuits (Hardware design)**

- 1) (a) To design a combinational logic system for a specified Truth Table.  
(b) To convert Boolean expression into logic circuit & design it using logic gate ICs.  
(c) To minimize a given logic circuit.
- 2) Half Adder and Full Adder.
- 3) Half Subtractor and Full Subtractor.
- 4) 4 bit binary adder and adder-subtractor using Full adder IC.
- 5) To design a seven segment decoder.
- 6) To build Flip-Flop (RS, D-type and JK) circuits using NAND gates.
- 7) To build JK Master-slave flip-flop using Flip-Flop ICs.
- 8) To build a Counter using D-type/JK Flip-Flop ICs and study timing diagram.
- 9) To make a Shift Register (serial-in and serial-out) using D-type/JK Flip-Flop ICs.

### **Section C: SPICE/MULTISIM simulations for electronic circuits and devices**

- 1) To verify the Thevenin and Norton Theorems.
- 2) Design and analyze the series and parallel LCR circuits.
- 3) Design the inverting and non-inverting amplifier using an Op-Amp of given gain.
- 4) Design and Verification of op-amp as integrator and differentiator.
- 5) Design the 1st order active low pass and high pass filters of given cutoff frequency.
- 6) Design a Wein's Bridge oscillator of given frequency.
- 7) Design clocked SR and JK Flip-Flop's using NAND Gates.
- 8) Design 4-bit asynchronous counter using Flip-Flop ICs.

### **References (For Laboratory Work):**

- 1) Fundamentals of Digital Circuits, Anand Kumar, 4th Edn, 2018, PHI Learning.
- 2) Digital Computer Electronics, A. P. Malvino, J.A. Brown, 3rd Edition, 2018, Tata McGraw Hill Education.
- 3) Digital Electronics, S. K. Mandal, 2010, 1st edition, Tata McGraw Hill.

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## **B.Sc. (Prog.) with Mathematics as Non-Major**

*Category-III*

### **DISCIPLINE SPECIFIC CORE COURSE – 2 (Discipline A-2): Elementary Linear Algebra**

#### **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		
Elementary Linear Algebra	4	3	1	0	Class XII pass with Mathematics	NIL

**Learning Objectives:** The objective of the course is:

- To introduce the concept of vectors in  $R^n$ .
- Understand the nature of solution of system of linear equations.
- To view the  $m \times n$  matrices as a linear function from  $R^n$  to  $R^m$  and vice versa.
- To introduce the concepts of linear independence and dependence, rank and linear transformations has been explained through matrices.

**Learning Outcomes:** This course will enable the students to:

- Visualize the space  $R^n$  in terms of vectors and the interrelation of vectors with matrices.
- Familiarize with concepts of bases, dimension and minimal spanning sets in vector spaces.
- Learn about linear transformation and its corresponding matrix.

## SYLLABUS OF DSC-2

### UNIT – I: Euclidean Space $R^n$ and Matrices (18 hours)

Fundamental operations with vectors in Euclidean space  $R^n$ , Linear combinations of vectors, Dot product and their properties, Cauchy-Schwarz inequality, Triangle inequality, Solving system of linear equations using Gaussian elimination, Application: Curve Fitting, Gauss-Jordan row reduction, Reduced row echelon form, Application: Solving several systems simultaneously, Equivalent systems, Rank and row space of a matrix, Eigenvalues, Eigenvectors, Eigenspace, Diagonalization, Characteristic polynomial of a matrix.

### UNIT – II: Introduction to Vector Spaces (12 hours)

Definition, Examples and some elementary properties of vector spaces, Subspaces, Span, Linear independence and linear dependence of vectors, Basis and dimension of a vector space, Maximal linearly independent sets, Minimal spanning sets.

### UNIT – III: Linear Transformations (15 hours)

Linear transformations: Definition, Examples and elementary properties, The matrix of a linear transformation, Kernel and range of a linear transformation, The dimension theorem, one-to-one and onto linear transformations, Invertible linear transformations, Isomorphic vector spaces.

#### Essential Reading

1. Andrilli, S., & Hecker, D. (2016). *Elementary Linear Algebra* (5th ed.). Elsevier India.

#### Suggestive Readings

- Lay, David C., Lay, Steven R., & McDonald, Judi J. (2016). *Linear Algebra and its Applications* (5th ed.). Pearson Education.
- Kolman, Bernard, & Hill, David R. (2001). *Introductory Linear Algebra with Applications* (7th ed.). Pearson Education, Delhi. First Indian Reprint 2003.