Appendix-75
Resolution - 44-9(3)
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B. Sc. Physical Science (Electronics) Semester 2

DISCIPLINE SPECIFIC CORE COURSE – DSC-5
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 DSC – 5	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	NIL

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 DSC – 5

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 andthe 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: **(7 Hours)**

Number system: Binary number, Decimal to Binary and Binary to Decimal conversion, BCD, Octal and Hexadecimal numbers.

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 binaryAdder/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).

Unit 5: **(4 Hours)**

Counters (4 bits): Asynchronous counter, Synchronous Counter, Decade Counter and RingCounter

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

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. Flyod, 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, TataMcGraw Hill Education.

3) Digital Electronics, S. K. Mandal, 2010, 1st edition, Tata McGraw Hill.