Core-II **Analog and Digital Electronics**

Course Outcomes

- After the completion of the course, one will be able to perform the following tasks:
- Be able to design amplifier circuits using BJT/FET/OP-Amp and observe the amplitude and frequency responses.
- Observe the effect of negative feedback on different parameters of an Amplifier and different types of negative feedback typologies.
- Observe the effect of positive feedback and able to design and working of different Oscillators using BJTS. Develop the skill to build, and troubleshoot Analog circuits.
- Binary systems, Boolean Function and their Minimization for Circuit Implementation
- Combination and Sequential Circuit Implementation
- Memory organization in Digital Systems

Unit-1

- Op-Amp: Differential Amplifier, Block diagram of Op-Amp, Characteristics of an Ideal and Practical Op-Amp, Open and closed loop configuration, Frequency Response, CMRR, Slew Rate and concept of Virtual Ground. Applications of op-amps: Concept of feedback, negative and positive feedback, advantages of negative feedback (Qualitative Study). Inverting and non- inverting amplifiers, Summing and Difference Amplifier, Differentiator, Integrator, Comparator and Zero-crossing detector. Filters: First and Second order active Low pass, High pass and Band pass Butterworth filters. Oscillators: Barkhausen criterion for sustained oscillations, Colpitt's oscillator and crystal oscillators using transistor, Phase Shift oscillator, Wien-bridge oscillator – (no derivation for each) 555 Timer: Introduction, Block diagram, Astable and Monostable multivibrator circuits. (Numerical Examples wherever applicable)

Unit-2

- Number System: Decimal, Binary, Octal and Hexadecimal number systems, base conversions. Representation of signed and unsigned numbers, Binary arithmetic; addition, subtraction by 1"s and 2"s complement method, BCD code (8421, 2421, Excess-3), Gray code, error checking and correction codes (Only parity check).
- Boolean Algebra: Constants, variables, operators, basic logic gates- AND, OR, NOT, Positive and negative logic, Boolean laws, Duality Theorem, De Morgan"s Theorem, simplification of Boolean expressions-SOP and POS. Derived logic gates (NAND, NOR, XOR & XNOR). Universal property of NOR and NAND gates. (Numerical examples wherever applicable).

Unit-3:

- Logic Families: Pulse characteristics, Logic Families-classification of digital ICs. Characteristics of logic families, circuit description of TTL NAND gate with totem pole and open collector. TTL IC terminology. CMOS NAND, Comparison of TTL and CMOS families. Combinational Logic Circuits: Minimisation techniques using K-

maps - SOP and POS, Minterm, Maxterm, SSOP, SPOS, Simplification of Boolean expressions, K-Map for 3 and 4 variables.

- Digital to Analog Converter: DAC with binary weighted resistor and R-2R resistor ladder network. Analog to Digital converter: Successive approximation method-performance characteristics.
- Design of Arithmetic Logic Circuits: Half Adder, Full Adder, Half Sub tractor, Full Sub tractor. 4-bit parallel binary adder, 2-bit and 4-bitmagnitude comparator. Encoder, decimal to BCD priority encoder. Decoder, 2:4 decoder using AND gates, 3:8 decoder using NAND gates, BCD to decimal decoder, BCD to 7- Segment decoder, Multiplexer - 4:1 and 8:1 multiplexer, Demultiplexer - 1:4 and 1:8 demultiplexer (logic diagram and truth table of each), Realization of Full adder and Full Sub tractor using Mux and Decoder.

Unit-4

- Sequential Logic Circuits: Flip-Flops - SR Latch, RS, D and JK Flip- Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. Master- Slave JK and T Flip-Flops. Applications of Flip-Flops in semiconductor memories, RAM, ROM and types.
- Registers and Counters: Types of 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), applications. Ring counter, Johnson counter applications. Asynchronous Counters: Logic diagram, Truth table and timing diagrams of 4bit ripple counter, modulo-n counters,4bit Up-Down counter, Synchronous Counter: 4-bit counter, Design of Mod 3, Mod 5 and decade Counters using K-maps.

Suggested References:

- ✓ *Robert L Boylestad, "Introductory circuit analysis", 5th edition., Universal Book 2003.*
- ✓ *Electronic Devices Conventional Current Version by Thomas L. Floyd, 10th edition, Pearson, 2018*
- ✓ *David A. Bell "Electronic Devices and Circuits", 5th Edition, Oxford Univesity Press, 2015*
- ✓ *OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edn., Prentice Hall., 2000*
- ✓ *Operational Amplifiers and Linear ICs, David A. Bell, 3rd Edition, Oxford University Press. 2011,*
- ✓ *R S Sedha, "A Text book of Applied Electronics", 7th edn., S Chand and Company Ltd., 2011*
- ✓ *Thomas L. Floyd, Digital Fundamentals, Pearson Education Asia, 1994*
- ✓ *Digital Principles and Applications, A.P. Malvino, D P Leach and Saha, 7th Edition, TMH, 2011.*
- ✓ *Fundamentals of Digital Circuits, Anand Kumar, 2ndEdn, PHI Learning Pvt. Ltd. 2009*
- ✓ *Digital Circuits and Systems, K R Venugopal and K Shyla, Tata McGraw Hill, 2011*
- ✓ *Digital Circuits and systems, Venugopal, Tata McGraw Hill. 2011*

- ✓ *Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, PHI Learning. 2001*
- ✓ *Digital Principles, Schaum"s Outline Series, R. L. Tokheim, TMH., 1994*
- ✓ *Digital Electronics, S.K. Mandal, 1st Edition, McGraw Hill., 2010.*

Practical:

1. Study of JFET/MOSFET characteristics – determination of parameters.
2. Study of single stage JFET amplifier. (frequency response and band width)
3. UJT characteristics and relaxation oscillator
4. SCR characteristics – determination of IH and firing voltage for different gate currents.
5. Design of inverting and non-inverting amplifier using Op-amp & study of frequency response.
6. Op-amp inverting and non-inverting adder, subtractor and averaging amplifier.
7. Study of the zero-crossing detector and comparator.
8. Design and study of differentiator and integrator using op-amp for different input waveforms.
9. 9 Design and study of Wien bridgeand RC phase shift oscillator using op-amp.
10. Design and study of first order high-pass and low-pass filters using op-amp. 11. Study of Colpitt"s and crystal oscillator using transistor.
11. Astablemultivibrator using IC - 555 timer.
12. Monostablemultivibrator using IC-555 timer.
13. Half Adder and Full Adder using (a) logic gates (b) using only NAND gates.
14. Half Subtractor and Full Subtractor(a) logic gates (b) using only NAND gates.
15. 4 bit parallel binary adder and Subtractor using IC7485.
16. Study of BCD to decimal decoder using IC7447
17. Study of the Encoders and priority encoders.
18. Study of Multiplexer and Demultiplexer using ICs.
19. Study of 2-bit and 4-bit magnitude comparators.
20. Study of Clocked RS, D and JK Flip-Flops using NAND gates.
21. Study of 4-bit asynchronous counter using JK Flip-Flop IC7476, modify to decade
22. Counter and study their timing diagrams.
23. Study of 4-bit Shift Register – SISO, modification to ring counter using IC 7495.