GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Electrical
Subject Code: BE03009011
Subject Name: Analog and Digital Electronics

w. e. f. Academic Year:	2024-25
Semester:	3
Category of the Course:	Professional Core Course

Prerequisite:	Nil
Rationale:	Analog and Digital Electronics is a fundamental subject that shall give engineering students essential knowledge and skills related to designing, analyzing, and implementing electronic circuits. It bridges It bridges theoretical concepts with practical applications, crucial for careers related to electronics, automation, telecommunications, and embedded systems. Analog and Digital Electronics underpins modern technological advancements.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Comprehension of various types of analog and digital components – OPAMP, Combinational and sequential circuits, ADC and DAC, involved in the analog and digital systems	20
CO-2	Describe the functioning and selection of OP-AMP as per application.	20
CO-3	Design and testing of OP-AMP based circuits.	20
CO-4	Design and implement Combinational and Sequential logic circuits.	20
CO-5	Describe the process of Analog to Digital conversion and Digital to Analog Conversion.	20

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	TW/ SL	TH		ESE (E)	PA (M)	PA/ (I)	TW/ SL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

Content:

Sr. No.	Content	Total Hrs
1	**Differential, multi-stage and operational amplifiers** Power amplifier , Differential amplifier, Direct coupled multi-stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output Offset voltage, input bias current, input offset current, slew rate, gain band width product)	**8**
2	**Linear applications of op-amp** Idealized analysis of op-amp circuits. Inverting and non-inverting amplifier, differential amplifier, instrumentation amplifier, integrator and differentiator, active filter, voltage regulator, oscillators (Wein bridge and phase shift).	**6**
3	**Non linear applications of op-amp** Hysteretic Comparator, Zero Crossing Detector, Square-wave and triangular-wave generators. Precision rectifier, Peak detector.	**6**
4	**Combinational Digital Circuits** Standard representation for logic functions, simplification of logic functions using K- map and Boolean algebra, Don't care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, digital comparator, parity checker/generator, code converters, priority encoders, decoders/ drivers for display devices.	**8**
5	**Sequential circuits and systems** A 1-bit memory, the circuit properties of Bi-stable latch, the clocked SR flip flop, J- K, T and D types flip-flops, applications of flip-flops, shift registers, applications of shift registers, ring counter, sequence generator, ripple (Asynchronous) counters, synchronous counters, counters design using flip-flops, special counter IC's, asynchronous sequential counters, applications of counters.	**9**
6	**A/D and D/A Converters** Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter lCs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs	**8**
	TOTAL	**45**

Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
40	**40**	**10**	**10**	**00**	**00**

Legends:
R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. A.S.SedraandK.C.Smith,"MicroelectronicCircuits",NewYork,OxfordUniversityPress,1998.
2. J.V. Wait, L.P. Huelsman and G.A.Korn, "Introduction to Operational Amplifier theory and Applications", McGraw Hill U. S., 1992.
3. J. Millman and A.Grabel,"Microelectronics", McGraw Hill Education,1988.
4. P. Horowitz and W.Hill,"The Art of Electronics", Cambridge University Press,1989.
5. P. R. Gray, R. G. Meyer and S. Lewis, "Analysis and Design of Analog Integrated Circuits", John Wiley & Sons, 2001.
6. Ramakant A Gayakwad, Op-Amps and Linear Integrated Circuits, Prentice Hall of India
7. R.P. Jain, "Modern Digital Electronics", McGraw Hill Education, 2009.
8. M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016.
9. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India,2016

List of Experiments:

1. To Study the different parameters of op-amp.
2. To verify the working of Op-amp as an Inverting and a Non–inverting amplifier.
3. To verify the working of Op-amp as an Integrator and a Differentiator.
4. To verify the working of Op-amp as a comparator and Zero Crossing Detector.
5. To Study Phase shift and Wein's Bridge oscillator with amplitude stabilization using OPAMPs.
6. To Study Waveform generation–Square, triangular wave form generation using OPAMPs.
7. To verify working of half and full binary adder and Subtractor circuits.
8. To verify working of binary to gray and gray to binary converter circuit.

9. To verify truth tables of RS, JK, D and T flip-flops.
10. To verify the working of 4 bit comparator.
11. To Design 8 to 3 Encoder and 3 to 8 line Decoder.
12. To Design 4 to 1 Multiplexer and 1 to 4 line De-multiplexer.
13. To verify the working of binary up/down counter.
14. To verify the working of Ring counter, Johnson counters.

Major Equipment:

- ✓ Trainer kits related to Analog and Digital electronics.
- ✓ Faculties may assign mini projects to students.

List of Open Source Software/learning website:

1. Courses available through NPTEL.
2. Sequel App developed by IIT-Bombay
3. VLABS
4. website: nptel.ac.in

- **Activities suggested under self-learning**

Sr. No.	Name of the activity	No. of hours	Evaluation Criteria
1	Interpretation of Datasheet of IC 741 and Analyze datasheets	Preparing report	Based on the understanding
2	Making of charts of various analog and digital Ics.	Preparing of Chart	Based on understanding
3	Differential Amplifier, Multistage Amplifier and Power stage Amplifier circuit simulation using MATLAB	Use of MATLAB for circuit simulation	Based on the understanding and applying of MATLAB
4	Simulation of all Linear application of op-amp	Use of MATLAB for circuit simulation	Based on the type of application and explanation
5	Simulation of all Non- linear application of op-amp	Use of MATLAB for circuit simulation	Based on the type of application and explanation
6	Build circuits on a breadboard: all linear and non linear application of Op-amp	Any two linear and non linear applications of Op-amp.	Based on the circuit explanation and results.

7	Practice debugging of circuits, identifying faults in circuits using multimeters and oscilloscopes	One circuit for each debugging and fault identifying exercise	Based on the Skill.
8	Mini project: Design and implementation of any application of op-amp	Undertake a small home-based or simulation-based project (10 h)	Based on the understanding, implementation and results.
9	Study and simulate logic gates: AND, OR, NOT, NAND, NOR, XOR using Matlab.	Duration of task = 2h Preparation of Report = 2h	Based on the understanding and applying of MATLAB for realisation.
10	Learn and realise Boolean algebra basics and laws	Duration of task = 2h Preparation of Report = 2h	Based on report submitted. Report should contain observations and truth table.
11	Mini Task: Design and realize a logic circuit using Matlab	Any two	Based on the understanding, implementation and results/ truth table.
12	Study combinational circuits: simplification of multiplexers, decoders circuits using Karnaugh maps. Mini Project: Create and simulate multiplexer and decoder circuit using Matlab.	One circuit for each decoder and multiplexer = 5h/each	Based on the understanding, implementation and results/ truth table.
13	Study of sequential circuits: simplification of flip-flops/ latch, shift register, counters	One circuit for each flip-flop, shift register and counter = 5h/each	Based on the understanding, implementation and results/ truth table.
14	Implement a logic-based application using Arduino (e.g., traffic light controller, seven segment display)	Any one Arduino based digital application = 20h	Based on the understanding, implementation and results.
15	Technical Video based learning related to the analog and Digital electronics	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.

16	Assignment writing on number system, memory basics, IC logic families.	1 assignment of 2h each. Total = 6h	Based on the assignment submitted.
17	Online Certification Courses (NPTEL / SWAYAM / Coursera / edX) In analog and Digital electronics	Complete one MOOC (Massive Open Online Course) from NPTEL/SWAYAM relevant to ADE-Electrical Engineering.	Certificate + a 1-page summary or review presentation of the course. Certificate of the course
18	Real world case studies based learning in ADE	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
19	Discussion on research paper based on ADE	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
20	Poster/chart/power point preparation on ADE	Duration = 6 h	Based on poster/chart preparation and presentation skills
21	Working/non-working model on technical topics of ADE	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
22	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
23	Group Discussion on emerging/trending technical topics based on ADE	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
24	Involvement in Student Chapter Activities (IEEE/ISTE/IEI)	Organizing student chapter activities/workshops (5h)+ Report /writing articles for the chapter newsletter(5h)	Based on short activity report and reflection
25	Industry Visit and Report Preparation	Attend an industry visit (e.g., to a substation, manufacturing unit, renewable energy plant) and prepare a detailed report.	Based on the report

Note:

- All the suggested activity should be related to the subject.
- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- Rubrics for the evaluation can be prepared by the faculty.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

****