



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Subject Code: BE04020011

Subject Name: Analog and Digital Electronics

w.e.f.Academic Year:	2024-25
Semester:	4
Category of the Course:	Professional Core Course

<b>Prerequisite:</b>	Nil
<b>Rationale:</b>	This course aims to develop skills to test electronic circuits, that is vital for students in mechatronics while working in an industry. After studying this course, it is expected that student will develop an insight to identify, build and troubleshoot analog and digital electronic circuits at a wider scale in mechatronics based systems.

**Course Out comes:** At the end of the course, students will be able to:

Sr. No.	CO statement	Marks% weightage
CO-1	Summarize the role and working of amplifiers and operational amplifiers.	U25
CO-2	Make use of Op-Amps, such as amplifiers, filters, oscillators, and waveform generators for real-life electronic solutions.	A25
CO-3	Analyze fundamentals of digital logic, timer Ics, concepts of number systems, logic gates, and digital components for building digital circuits.	N25
CO-4	Interpret analog signals to digital signal conversion.	E-25

### Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
L	T	P	SL	Total no of hours per semester		Theory		Tutorial / Practical			
						ESE (E)	PA / CA (M)	PA/CA (I)	TW/SL (I)	ESE (V)	
45	0	30	45	120	4	70	30	20	30	50	200

\* **Problem Based Learning (PBL)** aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.

### Content:

Sr.No.	Content	Total Hrs
-	<b>Course Introduction</b>	<b>01</b>
1	<b>Differential amplifiers and Operational Amplifiers:</b> Introduction, Op-Amp basics, Block diagram representation of a typical op-amp Differential amplifier; power amplifier; direct coupled multi-stage amplifier, op-amp ICC circuits, types, designations, pin configurations and power supplies. Ideal op-amp, equivalent circuit, open loop op-amp configurations of differential, inverting and non-inverting amplifiers, Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product, op-amp feedback amplifier, differential amplifier with one, two and three op-amps.	<b>09</b>



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2	<b>Linear and Non-Linear Op-amp applications:</b> Inverting and non-inverting amplifier, instrumentation amplifier, integrator, active filter, P, PI and PID controllers and lead/lag compensator using an op-amp, Zero crossing detector, Schmitt trigger, Triangular & square wave generator, phase-shift oscillators, Wein bridge oscillator, summing scaling and averaging amplifiers, V to I and I to V converters, integrator, differentiator comparator.	08
3	<b>Timer Circuits and Signal Generators:</b> IC 555 and its functions, Astable, bistable and mono-stable circuits using IC 555, various applications of IC 555, IC 566 - VCO, IC 565 - PLL, IC - 9400 V/F and F/V - Pin Diagrams, functions, applications.	04
4	<b>Number system and Logic families:</b> Decimal, Binary, octal, and hexadecimal number systems, binary arithmetic. Number base conversion, Complements, Binary code. Logic families: Positive logic and Negative Logic, AND, OR, NOT, NAND, NOR, X-OR GATE, TTL, CMOS. Boolean Algebra: Introduction, Logic Operators, Postulates and theorems, properties - Product of Sums and Sum of Products - Karnaugh Map method, Converting Boolean expressions to Logic and Vice versa, NAND and NOR implementation - Don't-Care conditions, Introduction to Quine McCluskey's reduction method	08
5	<b>Combinational Logic Circuit:</b> Half and full Adder - Half and full Subtractor - Binary parallel adder - BCD Adder, Decimal adder - Magnitude comparator - Encoders & Decoders - Multiplexers - De-multiplexer.	04
6	<b>Flip Flops &amp; Design of Sequential Circuits:</b> S-R latch, edge triggered S-R flip flop, JK flip flop, D flip flop, T flip flop, Applications of flip-flops, shift registers, data transmission in shift register, serial in serial out, parallel in parallel out shift register, serial in parallel out, parallel in serial out shift register, asynchronous up/down counters, synchronous up/down counters.	05
7	<b>Analog to Digital and Digital to Analog Converters:</b> Analog to digital conversion, counter type ADC, tracking type ADC, successive approximation type ADC, flash type ADC Digital to analog conversion, R-2R ladder type DAC, weighted resistor type DAC, switched current source type DAC	05
8	<b>Memories and programmable logic devices:</b> Role of memory in computer system, memory types & terminology, types of ROM, sequential memories, programmable logic devices, and programmable logic array	03
<b>TOTAL</b>		<b>45</b>

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

Distribution of Theory Marks					
RLevel	ULevel	ALevel	NLevel	ELevel	CLevel
	25%	25%	25%	25%	

**R: Remembrance; U: Understanding; A: Application; N: Analyze; E: Evaluate; C: Create and**



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## 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	Boylestad R. L. and L. Nashelsky, Electronic Devices and Circuit Theory, 10/e, Pearson Education India, 2009.
2	Ramakant A Gayakwad, Op- Amps and Linear Integrated Circuits, Prentice Hall of India
3	Choudhury R., Linear Integrated Circuits, New Age International Publishers. 2008.
4	Malvino A. and D. J. Bates, Electronic Principles 7/e, Tata McGraw Hill, 2010.
5	M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016.
6	C.H.Roth and L.L.Kimney Fundamentals of Logic Design, 7/e, Cengage Learning, 2013
7	A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.
8	Floyd T.L, Digital Fundamentals, 10/e, Pearson Education, 2011
9	R.P. Jain, "Modern Digital electronics", Tata Mc-Graw Hill, Fourth Edition, 2010.
10	Zvi Kohavi, "Switching and Finite Automata Theory", Cambridge University Press.
11	Choudhury R., Linear Integrated Circuits, New Age International Publishers. 2008.

### List of Experiments:

1	Study the different parameter of op-amp.
2	Study of op-amp as inverting amplifier and non-inverting amplifier
3	OPAMP circuits –integrator, differentiator, and comparator.
4	OPAMP applications as waveform generator
5	Phase shift and Wein's Bridge oscillator with amplitude stabilization using OPAMPs.
6	Verification of function of Half/Full adder circuits.
7	Verification of function of Binary to Grey code conversion.
8	Verification of function of Latch and flip-flop.
9	Verification of Mux/Demux logic
10	Verification of Encoder/Decoder logic
11	Verification of Counter circuit like binary up/down counter, decimal counter, ring counter
12	Verification of Specification and Performance indices of D/A and A/D converters
13	Monostable multivibrators and noise sensitivity

### List of Open Source Software/learning website:

#### Supplementary learning Material:

1	<a href="https://www.analog.com/en/education/education-library/tutorials/analog-electronics.html">https://www.analog.com/en/education/education-library/tutorials/analog-electronics.html</a>
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2	<a href="https://www.allaboutcircuits.com/textbook/digital">https://www.allaboutcircuits.com/textbook/digital</a>
3	<a href="https://www.javatpoint.com/digital-electronics">https://www.javatpoint.com/digital-electronics</a>
4	NPTEL course on Analog Electronics Circuits by Prof. Pradip Mandal, IIT, Kharagpur. <a href="https://archive.nptel.ac.in/courses/108/105/108105158">https://archive.nptel.ac.in/courses/108/105/108105158</a>
5	NPTEL course on Digital Electronics Circuits by Prof. Goutam Saha, IIT, Kharagpur. <a href="https://archive.nptel.ac.in/courses/108/105/108105132">https://archive.nptel.ac.in/courses/108/105/108105132</a>

• **List of suggested activities for Problem Based Learning:**

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5hrs., Report preparation = 5hrs. Total = 10hrs.	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5hrs. Report preparation = 5hrs. Total = 10hrs.	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 4hrs. each. Total = 20hrs.	Based on the <b>correctness of</b> submitted assignment.
4.	Problem solving/Coding using C, C++, MATLAB, Python, SCILAB, modeling and Analysis software or any other software	5 small coding-based assignment of 2hrs. each. Total = 10hrs.	Based on the coding solution submitted.
5.	Self-learning online course	Minimum duration of the course should be 10hrs.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Identification and solution of Complex problem	Maximum 2 problems. Study of the problem and solution finding, Total = 10hrs.	Based on the depth of the solution submitted.
7	Videos on Industrial safety/Disaster Management aspects based on subject	Duration of video = 5hrs. Report preparation = 5hrs. Total = 10hrs.	Based on quiz/report submitted
8	Technical paper reading and summarization of research papers based on relevant subject	5 research papers = 20 hrs.	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 hrs.	Based on poster/chart preparation and presentation skills



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10	Working/non-working model on technical topics	Working = 12 hrs. Non- working = 8 hrs.	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/sustainability/any other issue	Duration = 15 hrs. for industrial exposure Problem identification and tentative solution = 10 hrs. Total = 20 hrs.	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = Min. 1 hr.per subject. Max. 3 hrs. per subject	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5hrs. Report preparation = 5hrs. Total = 10hrs.	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 hrs.	Depending on the complexity of the Application/Software
15.	Research paper publication	Duration = 10 hrs.	Based on submission of proof of publication
16.	Upgradation/Reverse engineering studies of existing equipment of the laboratory	Duration 10 hrs.	Based on the performance of the equipment
17.	Expert lecture/session	Duration 3 hrs. For attending the lecture/session– 2 hrs. and for report writing 1 hr.	Based on the proof of attendance and report submitted
18.	Annotated Video Explanation of Concept/Problem	10h (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
19.	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:

1. All the suggested activity should be related to the subject.
2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.
4. Subject teacher can add the relevant activities other than those listed above, with the consent of head of the department and DQAC.

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