GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3142408

Semester – IV
Subject Name: Analog and Digital Circuits

Type of course: Professional Core Course.

Prerequisite: Fundamental knowledge of basic electronics and circuit theory is essential.

Rationale: Analog and Digital Electronics is playing vital role in all engineering applications. The applications start from simple sensing circuit to IOT, automobiles, consumer products, military and space applications etc. Considering this, all engineers should have knowledge of Analog and Digital electronics. From Power Electronics Engineering point of view, interface circuits with Power Electronics, measurement of various parameters and implementation of protection circuits required understanding of basics related to Analog and Digital Electronics. This subject is intended to make students aware about all these concepts.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	1	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weight
1	**Introduction** Concept of basic circuits like amplifier, oscillator, linear power supply etc. Classification of amplifier considering feedback, power level etc., Basic electronics circuits as base for power electronics circuits like inverter, rectifier, power supply etc.	3	10
2	**Differential, multi-stage and operational amplifiers** Differential amplifier; power 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 bandwidth product etc.)	**8**	**20**
3	**Linear applications of op-amp** Idealized analysis of op-amp circuits, Inverting and non-inverting amplifier, differential amplifier, instrumentation amplifier, integrator, active filter, Current source, P, PI, PD and PID controllers, Lead /lag compensator, voltage regulator, Wein bridge and phase shift oscillators.	**8**	**20**
4	**Nonlinear applications of op-amp** Hysteretic Comparator, Zero Crossing Detector, Square-wave and triangular-wave Generators, Precision rectifier, peak detector etc.	**4**	**10**

5	**Combinational Digital Circuits** Standard representation for logic functions, K-map representation, simplification of logic functions using K-map, minimization of logical functions. Don't care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial/parallel adder, ALU, popular MSI chips, digital comparator, parity checker/generator, code converters, priority encoders, decoders/drivers for display devices, Q-M method of function realization	**8**	**20**
6	**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 and its applications, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple (Asynchronous) counters, synchronous counters, counters design using flip flops, special counter IC's, asynchronous sequential counters, applications of counters.	**8**	**20**
7	**A/D and D/A Converters** 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. Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, Specifications for D/A converters, examples of D/A converter ICs, sample and hold circuit.	**6**	**20**

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
35	**35**	**10**	**10**	**5**	**5**

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. Ramakant A Gayakwad, Op- Amps and Linear Integrated Circuits, Prentice Hall of India
2. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.
3. J. V. Wait, L. P. Huelsman and G. A. Korn, "Introduction to Operational Amplifier theory and applications", McGraw Hill U. S., 1992.
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. A. S. Sedra and K. C. Smith, "Microelectronic Circuits", New York, Oxford University Press,1998.
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. J. Millman and A. Grabel, "Microelectronics", McGraw Hill Education, 1988.

Course Outcomes:
After completion of this course, the students will be able to

Sr. No.	CO statement	Marks % weightage	Topics Mapped
CO-1	select OPAMP for implementation in practical applications.	25	2,3,4
CO-2	design and test OP-AMP based simple circuits.	25	3,4
CO-3	design and implement simple combinational and sequential logic circuits used in applications.	25	5,6
CO-4	select and use appropriate ADC and DAC for real world applications.	25	7

Suggested List of Experiments:

1. Study of types of amplifier
2. Study the different parameters of op-amp.
3. Frequency response of inverting amplifier and non-inverting amplifier.
4. Study of op-amp as inverting amplifier and non-inverting amplifier.
5. OPAMP circuits –integrator, differentiator, and comparator etc.
6. Phase shift and Wein's Bridge oscillator with amplitude stabilization using OPAMPs.
7. Waveform generation – Square, triangular and saw tooth wave form generation using OPAMPs.
8. Application of op-amp as low pass filter, high pass filter and band-pass filter.
9. Verification of function of Half/Full adder circuits.
10. Verification of function of Binary to Grey code conversion.
11. Verification of function of Latch and flip-flops.
12. Verification of counter circuit like binary up/down, decimal, ring, Johnson etc.

Major Equipment:

- Trainer kits related to Analog and Digital Electronics.
- Oscilloscope
- Multimeter
- Function generator
- Breadboard

List of Open Source Software/learning website:

1. http://ocw.mit.edu/
2. http://www.electrical-engineering-portal.com

3. Swayam- https://swayam.gov.in/
4. NPTEL- https://onlinecourses.nptel.ac.in/
5. Mooc- http://mooc.org/
6. Edx - https://www.edx.org/
7. Coursera- https://www.coursera.org/
8. Udacity - https://in.udacity.com/
9. Udemy - https://www.udemy.com/
10. Khan academy - https://www.khanacademy.org/
11. Skill share - https://www.skillshare.com/
12. Harvard University - https://online-learning.harvard.edu/
13. Ted - https://ed.ted.com/
14. Alison - https://alison.com/
15. Future learn - https://www.futurelearn.com/
16. Open Learn - http://www.open.edu/openlearn/
17. Future Learn - https://www.futurelearn.com/
18. Tuts Plus - https://tutsplus.com/
19. Open Culture - http://www.openculture.com/
20. KiCAD software with ngspice – www.kicad.com
21. http://www.fairchildsemi.com
22. http://www.ti.com/lsds/ti/analog/webench
23. https://www.circuitlab.com/editor/
24. http://www.datasheetcatalog.com/