Government of Karnataka
DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Programme	Electrical and Electronics Engineering	**Semester**	III
Course Code	20EE34P	**Type of Course**	Programme Core
Course Name	Analog and Digital Electronics	**Contact Hours**	8 hours/week 104 hours/semester
Teaching Scheme	L:T:P :: 3:1:4	**Credits**	6
CIE Marks	60	**SEE Marks**	40

1.Rationale:
Analog Electronic circuits are used to amplify, process and filter analog signals which are continuously variable, using amplifiers, Oscillators, switching circuits, operational amplifiers etc. Digital electronic circuits are usually made from large assemblies of logic gates. This digital logic circuitry is based on a binary system which has only two voltage levels, Low and High viz., Digital computers. Any intelligent electronic system is built by a combination of analog and digital circuits hence, it is imperative for any aspiring Technician to acquaint with the concepts of analog and digital electronics.

2. Course Outcomes/Skill Sets: *On successful completion of the course, the students will be able to*

CO-01	Identify the components of a given electronic circuit, list the uses and characteristics of the components and test the components to ensure they are in working condition.
CO-02	Use datasheets to list the alternative electronic components for a given electronic circuit ensuring the results/output remains the same.
CO-03	Build an electronic circuit for a given application and demonstrate its working either in real or a simulated environment.
CO-04	Test a given circuit for desired result/outcome, identify the problem and troubleshoot to obtain the desired result/output.

3. Course Content

Week	**CO**	**PO***	**Lecture (Knowledge Criteria)**	**Tutorial (Activity Criteria)**	**Practice (Performance Criteria)**
			3 hours/week	1 hour /week	4 hours/week (2 hours/batch twice in a week)
1	1	1,4	**ANALOG ELECTRONICS** 1.Passive components (Resistor, Inductors and capacitors): Introduction, symbols, units, types/classification, identification, selection and applications.	Refer Table 1	1a. Identify the different types of resistors. 1b. Measure the resistor values using colour code and verify the reading by measuring in the multimeter. 1c. Identify the power rating of carbon resistors by their size 1d. Identify different inductors and measure the values using LCR meter. 1e. Identify the different capacitors and measure capacitance of various capacitors using LCR meter.

			2.Semiconductors: Meaning, list semiconductor materials (Si, Ge,GaAs). -list characteristics of semiconductors. -Draw covalent bond diagram: Si, Ge, GaAs -Intrinsic Semiconductors-Two types of flow (free electrons & holes) Ref 7(1)		2a. Preparation of components, use of soldering iron and lead and flux. 2b. Standard Soldering practice to connect the components on base-board /PCB/assembly board (follow soldering standard).
			3.Doping a Semiconductor- Explain two types of Extrinsic Semiconductors (n-type and p-type). -concept of majority carrier and minority carriers. -Diode- formation, depletion region. Ref7(1)		
2	2,3	1,4	1. Diode-VI Characteristics, types, ratings and applications. Zener diode- reverse bias characteristics, voltage Regulation, shunt voltage regulator and their applications.	Refer Table 1	1a. Study and interpret data sheets of diodes and Zener diodes. 1b. Execute testing of given diode using multimeter and determine forward to reverse resistance ratio. 1c. Construct and test Zener based voltage regulator circuit.
			2.Bipolar Junction Transistors (BJT): Structure, Types, symbols, Construction, operation of (NPN/PNP) transistors. BJT Configurations, Transistor currents, alpha, beta and relationship between alpha and beta.		2a. Identify different transistors with respect to different package type, B-E-C pins, power, switching transistor, heat sinks etc b. Obtain output characteristics of BJT in CE configuration in physical mode. **OR** Simulate output characteristics of BJT in CE configuration **Ref.7(6)**
			3. CE input and output characteristics- cut off, saturation, and active regions. -Transistor biasing- definition, importance, list types. - Explain Voltage divider bias. Transistor as a switch in CE mode. -Stabilisation, thermal runaway, heat sink. **Ref.7(7).**		
3	1,3	1,4	1. FET- types. MOSFET- definition, types, symbols, N type enhancement mode- construction, working, MOSFET characteristics	Refer Table 1	1a. Identify terminals of a MOSFET and test. b. Obtain output characteristics of MOSFET in physical mode. **OR** Simulate output characteristics of MOSFET.
			2. MOSFET as switch, ratings.		2.Construct and test MOSFET application circuit (MOSFET as a switch)

			3. List applications of MOSFET, Differentiate between BJT and MOSFET		
4	3,4	1,4	1. Rectifiers- half wave, centre tapped FWR, efficiency, ripple factor, PIV. Filters- definition, necessity, C and PI filters.	Refer Table 1	1a. Identify the different types of fixed +ve and –ve regulator ICs and the different current ratings (78/79 series) 1b. Build +5V 1A DC Power Supply. **OR** Build +12V 1A DC Power Supply **Ref.7(8,9,10)**
			2. Regulated power supply- block diagram and applications. Regulator- working of 7805, mention operating voltages of 7809, 7812, 7905, 7912 Op-amp regulator, 723 regulators (Transistorized & IC based).		2a. Identify different heat sinks for IC based regulators b. Identify the parts, trace the connection and test the DC regulated power supply with safety. c. Troubleshoot and service a DC regulated power supply.
			3. Testing and Troubleshooting of Regulated Power Supply. **Ref.7(11,12)**		
5	1,3	1,4	1. Working of LED, IR LEDs, Photodiode, photo transistor and their characteristics and applications. Opto-couplers, circuits with Opto-Isolators. LASER diodes-characteristics and applications.	Refer Table 1	1a. Identify the different types of LEDs and IR LEDs. 1b. Identify optocoupler input/output terminals and measure the quantum of isolation between the terminals 1c. Construct a circuit to switch lamp load using phototransistor
			2.Amplifier- faithful amplification, classification based on configuration, power, and frequency		2. Construct and test a common emitter amplifier with and without bypass capacitors. **Ref.7(13)**
			3. Transistor CE amplifier with biasing, Working of Push pull amplifier.		
6	1,3	1,4	1. OPAMP– block diagram, operation, Characteristics, applications, µA 741 pin diagram.	Refer Table 1	1. Construct and test OP AMP as a Summer. Use an Analog IC tester to test the Analog ICs.
			2.OPAMP applications– inverting, differentiator. Integrator, summer, voltage follower, and comparator.		2. Construct and test Astable timer circuit using IC 555. Construct and test mono stable timer circuit using IC 555. **Ref.7(14)** Use an Analog IC tester to test the Analog ICs
			3. Timer– block diagram, pin diagram of IC 555, duty cycle, time-delay, Applications, A stable and Monostable multi-vibrators using IC 555.		
7	3	1,2	**DIGITAL ELECTRONICS** 1. Definitions- bit, nibble, byte, word, and parity bit. Number system- definition, types, radix, decimal, BCD, binary and hexadecimal.	Refer Table 1	1. Solve problems on number system

			2. Binary number system, Binary arithmetic: addition, subtraction, multiplication and division Complements: 1's, 2's.		2. Solve problems on conversion.
			3. Hexadecimal- addition, subtraction, Conversion- decimal to binary, decimal to hexadecimal		
8	3	1,2,4	1. Boolean variable, complement, Boolean function, expression, truth table. Boolean Algebra- rules and laws. **Ref.7(15)**	Refer Table 1	1. An electronic telephone exchange is being powered by a normal power supply. However, looking at the criticality of the exchange, a power backup generator is also installed, which can supply power in case of power failure. An alarm circuit is to be designed. There will be two LEDs (one green and the other red) on the front panel of the exchange, such that the green LED glows when power supply is available. In case of failure of power supply, the exchange draws its power from a generator, and in this case, the green LED goes OFF and the RED LED glows. In case, the generator also goes down, both green LED and red LED go OFF and a buzzer starts ringing indicating that there is a major failure. Design and implement this control circuit for both the LEDs and the buzzer.
			2.Logic gates NOT, AND, OR- definition, symbol, Boolean equation, truth table and working. Logic gates NAND, NOR, EX-OR- definition, symbol, Boolean equation, truth table and working. De Morgan's theorems- statement and equations		2. Akshay's Automated Cafeteria orders a machine to dispense coffee, tea, and milk. Design the machine so that it has a button (input line) for each choice and so that a customer can have at most one of the three choices. Diagram the circuit to ensure that the "at most one" condition is met. Implement the Circuit
			3. Karnaugh's map up to three variables- Simplification and drawing logic diagrams.		
9	1,3	1,4	1. COMBINATIONAL LOGIC CIRCUITS- Half adder- block diagram, logic diagram using AND and XOR, truth table and working.	Refer Table 1	1a. Construct Half Adder circuit using ICs and verify the truth table 1b. Construct Full adder with two Half adder circuits using ICs and verify the truth table. Use a digital IC tester to test the digital ICs
			2. Full adder- block diagram, logic diagram using AND, OR and XOR, truth table and working.		2. Construct a circuit to verify the truth table of 4:1 multiplexer using IC 74153 and 1:4 Demultiplexer using IC 74139. Use a digital IC tester to test the digital ICs
			3. Multiplexer and Demultiplexer, 4:1 MUX, 1: 4 DEMUX List real life applications of MUX and DEMUX		

10	1,3	1,4	1. Encoders and Decoders- definition, applications. Seven segment display- working	Refer Table 1	1. Construct a circuit to display 0-9 digits using standard Seven segment display with the help of decoder/ driver IC 7446/ or 7447. Use a digital IC tester to test the digital ICs.
			2. FLIP-FLOPS: S-R flip-flops, Clocked RS flip flop- block diagram, truth table, logic diagram.		2a. Identify different Flip-Flop (ICs) by the number printed on them 2b. Verify the truth tables of Flip-Flop ICs (RS, D, T, JK, MSJK) by connecting switches and LEDs.
			3. D flip- flop, JK flip-flop and T Flip-flop and Master JK flip-flop - block diagram, truth table, logic diagram.		
11	1,3	1,4	1. Shift Registers- definition, types and applications. Four-bit SISO using D Flip flops- block diagram, truth table and operation		1. Construct and test a four-bit SIPO register.
			2.Four-bit SIPO, PISO and PIPO shift registers using D flip flops- block diagram, truth table and operation.		2.Construct and test four-bit PIPO register.
			3.Counters- definition, modulus concept, timing diagram, types and applications		
12	3,4	1,4	1.Four-bit binary asynchronous counter- block diagram using JK flip flops, truth table, timing diagram and working		1. construct and test 4-bit Asynchronous binary up /down counter (IC **74LS193)**
			2. Four-bit decade asynchronous counter- block diagram using JK flip flops, truth table, timing diagram and working.		2. Rig up and test the truth table of Decade Asynchronous Counter (IC 74LS90)
			3.Three-bit synchronous up counter- block diagram, truth table, timing diagram and working.		
13	1,3	1,4	1.Digital to Analog converters: Binary weighted Resistor, DAC- block diagram and operation.		1.Construct and test (Binary weighted Resistor) Digital to Analog converter circuit.
			2. D/A converter specifications: resolution, accuracy and conversion speed. -Selection criteria for DAC		2.Construct and test the Analog to Digital converter circuit. **Ref.7(16,17)**
			3. Analog to Digital converters: Successive Approximation ADC- block diagram and operation. -Selection criteria for ADC		
Total in hours			**39**	**13**	**52**

***PO= Program Outcome as listed and defined in year 1 curriculum and CO-PO mapping with strength (Low/Medium/High) has to be mapped by the course coordinator. (Above only suggestive).**

Table 1: Suggestive Activities for Tutorials: (The List is only shared as an Example and not inclusive of all possible activities of the course. Student and Faculty are encouraged to choose activities that are relevant to the topic and on the availability of such resources at their institution)

Sl No.	Week	Activity
1	1	I 1. Explain types of inductors, construction, specifications, applications and energy storage concepts. 2. Explain types of capacitors, construction, specifications and applications. Dielectric constant. 3. Explain Capacitor behaviour with AC and DC. Concept of Time constant of a RC circuit. II. 1. Draw the atomic structure of Si, Ge, Ga and As. 2. Draw the energy level diagrams for Insulators, Conductors and Semiconductors, and list values of energy gap for Ge,Si and GaAs. 3. Draw the covalent-bond diagram for n-type and p-type material. 4. Explain the effect of donor impurities on energy band structure. 5. List the commercial applications of Ge,Si and GaAs.
2	2	I. Study datasheets of diode 1N4001-1N4007, select a diode which has peak repetitive voltage (VRRM) of 100V, RMS Reverse Voltage of 70V, Average rectified current of 1 Amp and can withstand temperature of 150 degrees Celsius. Demonstrate the appropriate method of mounting the diode or its alternatives. II. Study given Handy **Mobile Phone Charger** Circuit**,** identify components required, test the components for working condition, build circuit in a bread board and test the circuit for desired output, if desired output is not obtained, troubleshoot to obtain desired result. Demonstrate the working of a circuit in the class. III. Demonstrate troubleshooting of simple DC circuit using any simulation software.
3	3	Study given basic **LED Emergency Light** with day light sensing Circuit**,** identify components required, test the components for working condition, build circuit in a bread board and test the circuit for desired output, if desired output is not obtained, troubleshoot to obtain desired result. Demonstrate the working of a circuit in the class. Demonstrate troubleshooting of **LED Emergency Light** circuit using any simulation software.
4	4	1.Build a (0 –30) V variable output regulated power supply using IC LM317 circuit. test the circuit for desired output and demonstrate the working of circuits in the class. 2. Demonstrate the output voltage of different IC 723 metal/ plastic type and IC 78540 regulators by varying the input voltage with fixed load.
5	5	Demonstrate the operation of **Automatic Fence Lighting** Circuit with Alarm.
6	6	I. 1. Explain the criteria for selecting an appropriate Operational Amplifier for a given application. 2. Demonstrate working of OP-AMP based Peak detector 3. Demonstrate working of OP-AMP precision rectifier. List commercially available OP-AMP precision rectifiers and their applications. II. Build **Adjustable Dual Timer** Circuit using 555 Timer IC and demonstrate the working of circuit in the class.
7	7	1. Explain applications of 1s and 2s complement. 2. Explain applications of hexadecimal number system 3. Explain advantages of hexadecimal number system 4. Explain applications of BCD number system

		5. Explain limitations of BCD number system
8	8	**Two-Floor Elevator** Numerous functions must be performed by the circuitry of an elevator (open/close door, move up/down, light up/down indicator, and so on). This example focuses on one aspect of a two-floor elevator: deciding when to move to the other floor. 1. Draw the truth table for given logical conditions. 2. write the logical expression. 3. Draw the logical diagram. 4. Implement the circuit. 5. Test the circuit for all possible input conditions.
9	9	I. A committee of three Individuals decides issues for an organization. Each individual votes YES or NO for each proposal that arises. A proposal is passed if it receives at least two YES votes. Design a circuit that determines whether a proposal is passed. 1. Draw the truth table for given logical conditions. 2. Prepare K-map and deduce simplified logical expression 3. Draw the logical diagram 4. Implement the circuit. 5. Test the circuit for all possible input conditions II. **Production line control** Rods of varying length travel on conveyor belt ● Mechanical arm pushes rod within (+/- 5%) to one side ● Second arm pushes rods too long to other side ● rods that are too short stay on belt ● 3 light barriers (light source photocell) as sensors Design combinational circuit to activate arms. (Inputs are three sensors and outputs are two arm control signals)
10	10	Study **8-to-3 Bit Priority Encoder (74LS148).** 1.Explain how it can be used in magnetic positional control as used on ships navigation or for robotic arm positioning etc 2. Draw truth table for above application 3. Draw block diagram and logic diagram
11	11	1.Study the latest technological changes in this course and present the impact of these changes on industry. 2. Demonstrate basic Traffic light signal circuit using counters
12	12	Study the latest technological changes in this course and present the impact of these changes on industry.
13	13	Study the latest technological changes in this course and present the impact of these changes on industry.

4. CIE and SEE Assessment Methodologies

Sl. No	**Assessment**	**Test Week**	**Duration** In minutes	**Max marks**	**Conversion**
1.	CIE-1 Written Test	5	80	30	Average of three tests 30
2.	CIE-2 Written Test	9	80	30	
3	CIE-3 Written Test	13	80	30	
4.	CIE-4 Skill Test-Practice	6	180	100	

5	CIE-5 Skill Test-Practice	12	180	100	Average of two skill test reduced to 20
6	CIE-6 Portfolio continuous evaluation of Tutorial sessions through Rubrics	1-13		10	10
Total CIE Marks					60
Semester End Examination (Practice)			180	100	40
Total Marks					**100**

5. Format for CIE written Test

Course Name	**Analog and Digital Electronics**	Test	I/II/III	Sem	III/IV
Course Code	**20EE32P**	Duration	80 Min	Marks	30

Note: Answer any one full question from each section. Each full question carries 10 marks.

Section	Assessment Questions	Cognitive Levels	Course Outcome	Marks
I	1			
	2			
II	3			
	4			
III	5			
	6			

Note for the Course coordinator: Each question may have one, two or three subdivisions. Optional questions in each section carry the same weightage of marks, Cognitive level and course outcomes.

6. Rubrics for Assessment of Activity (Qualitative Assessment)

Sl. No.	Dimension	Beginner	Intermediate	Good	Advanced	Expert	Students Score
		2	4	6	8	10	
1		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	8
2		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	6
3		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
4		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
	Average Marks= (8+6+2+2)/4=4.5						**5**

Note: Dimension and Descriptor shall be defined by the respective course coordinator as per the activities

7. Reference:

Sl. No.	Description
1	Electronic Devices and Circuits theory by Robert L. Boylestad Louis Nashelsky
2	Electronics Principles by Malvino, Mc. Graw Hill, Third edition. 2000.
3	Electronics Devices and Circuits by Allen Mottershead, PHI Learning Pvt. Ltd., First Edition

4	Electronics Principles and applications by Charles A Schuler and Roger L Tokhiem, Sixth Edition, Mc. Graw Hill, 2008. 2. 3.. 4.. 5.
5	Electronics Analog and Digital by I. J. Nagrath, PHI Learning Pvt. Ltd., 2013 Edition
6	Linear Integrated Circuits by Ramakant A. Gayakwad, PHI Learning Pvt. Ltd., Fourth Edition.
7	https://www.youtube.com/watch?v=nCqQhqLTmxw
8	https://bestengineeringprojects.com/automatic-cut-off-power-supply/
9	https://www.circuitstoday.com/5v-power-supply-using-7805
10	http://www.ide.iitkgp.ac.in/Pedagogy view/example.jsp?USER ID=70
11	https://bestengineeringprojects.com/noise-free-dual-polarity-12v-power-supply-circuit/
12	https://bestengineeringprojects.com/problem-and-troubleshooting-of-power-supply/
13	https://bestengineeringprojects.com/regulated-power-supply-troubleshooting/
14	http://ee.cet.ac.in/downloads/Notes/ECLab/04-CE%20Amplifier.pdf
15	https://bestengineeringprojects.com/adjustable-dual-timer-circuit-using-555-timer-ic/
16	https://www.iitg.ac.in/cseweb/vlab/Digital-System-Lab/experiments.php
17	https://www.ti.com/lit/ds/symlink/dac0808.pdf?ts=1613370064634&ref url=https%253A%252F%252Fwww.google.com%252F
18	https://www.mepits.com/project/336/diy-projects/diy-project-digital-thermometer
19	Work sheets digital 1. https://www.liveworksheets.com/un1107740kg 2. https://nohoacsl.weebly.com/uploads/1/1/2/2/112297219/ digital electronics worksheet.pdf
20	https://inst.eecs.berkeley.edu/~ee100/su07/handouts/EE100-MultiSim-Tutorial.pdf
21	http://eceweb1.rutgers.edu/~psannuti/ece223/Manual-for-multisim.pdf

8. 1 CIE-4 & 5 Skill Test Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions		10
2	Visually identify the passive /active components by Code number and demonstrate if the component is in working condition	1	05
3	Identify and explain the Data Sheets for the given Electronic Devices	2	05
4	Demonstrate the working condition of components (Diode, BJT, MOSFET, Zener diode, Phototransistor, OP Amp etc.,)	3	10

5	Identify the problem in a given circuit and demonstrate the troubleshooting method used to rectify that problem. (RPS, OP Amp circuit, 555Timer circuit)	4	20
6	Building and Demonstration of the working Circuit including; i. Draw the Circuit diagram using the right symbols 05 ii. Build the circuit as per the circuit diagram 10 iii. Demonstrate the working of the circuit. 20 iv. Document the necessary readings of the expected circuit outcomes. 05	3	40
7	Viva-voce		10
Total			100

8.2 SEE Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions		10
2	Building and Demonstration of the working Circuit including i.Draw the Circuit diagram using the right symbols 10 ii. Identify and explain the Data Sheets of the electronic Devices. 10 iii. Demonstrate the working condition of electronics devices 10 iv. Build the circuit as per the circuit diagram 15 v. Demonstrate the working of the circuit. 20 iv. Document the necessary readings of the expected circuit outcomes. 05	1,2,3	70
3	Viva-voce		20
	Total Marks		**100**

9. Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
1	DC Regulated power supply	(0-30V, 2A)	10
2	DC Regulated Dual power supply	(+/- 15V,2A)	10
3	DC Regulated Dual power supply	(+/- 5, 1A)	10
4	Cathode Ray Oscilloscope	Dual trace, 25 MHz.	10
5	Signal Generator / Function generator	(5V P-P, 200mA)	06
6	DC Voltmeter	(0-1V)	10
7	DC Voltmeter	(0-10V)	10
8	DC Voltmeter	(0-30V)	10
9	DC Ammeter	(0 -100mA)	05
10	DC Ammeter	(0 -10mA)	10
11	DC Ammeter	(0 -100mA)	10
12	Digital Multimeter-	31 /2" 06	06
13	Analog Multimeter		06
14	LCR meter		02
15	Decade resistance box	(4 Dial)	10
16	Decade capacitor box	(4 Dial)	10
17	Analog IC Trainer Kit		10
18	Digital Trainer kit		10
19	Digital IC Tester.		02
20.	Electronic Circuit Simulation Software (Multisim/Pspice/ LT spice/GNU-Octave/ MatLab-Simulink)		20