CALICUT UNIVERSITY – FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)

BSc PHYSICS HONOURS

Programme	**B.Sc. Physics Honours**				
Course Title	**SEMICONDUCTOR PHYSICS AND ELECTRONICS**				
Type of Course	**Minor (SET III: SEMICONDUCTOR PHYSICS)**				
Semester	**I**				
Academic Level	**100 – 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1.Basic understanding of physics and mathematics, including algebra and calculus. 2.Familiarity with fundamental concepts in electricity and magnetism.				
Course Summary	This course covers fundamental concepts in electronics, focusing on both theoretical understanding and practical applications. The syllabus includes topics such as atomic models, semiconductor physics, diode and transistor circuits, voltage stabilization, amplifiers, and digital electronics. The course aims to equip students with the necessary knowledge and skills to analyze, design, and troubleshoot electronic circuits.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Master the energy band structure of semiconductors, differentiate between intrinsic and extrinsic semiconductors, grasp majority and minority carrier concepts, and proficiently analyse pn junctions.	U	F	Instructor-created exams / Quiz
CO2	Analyse diode rectifiers and filtering circuits, understand transistor basics and various configurations and load line analyse	U & An	C	Practical Assignment / Observation of Practical Skills
CO3	Gain insight into voltage stabilisation using Zener diodes. Design and understand the working of CE amplifiers. Get introduced to operational amplifiers.	U, Ap & C	P	Seminar Presentation / Group Tutorial Work
CO4	Understand Boolean algebra basics, the functioning of OR, AND, NOT gates, and the fundamental theorems. Master truth tables, symbolic representation, universal gates, XOR gates and adder circuits.	U & Ap	C	Instructor-created exams / Home Assignments
CO6	Practical session will help in understanding the working of pn junction diode, transistors. Will comprehend the working of logic gates in digital electronics	Ap & C	M	One Minute Reflection Writing assignments

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

- Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks 70
I	**Semiconductor Physics**		**8**	**12**
	1	Bohr's atomic model and energy levels, Energy bands and classification of solids, silicon	2	
	2	Semiconductors and the influence of temperature	1	
	3	Intrinsic and extrinsic semiconductors, n type and p type, majority and minority carriers	2	
	4	pn junction and its properties	2	
	5	Biasing of junction	1	
		Sections 4.1 - 4.6 of chapter 4, sections 5.1 - 5.20 of chapter 5, Book 1		
II	**Analog Electronics**		**16**	**25**
	6	Diode as rectifiers- half wave and full wave- Efficiency and ripple factor calculations	6	
	7	Filter circuits	2	
	8	Introduction to transistor and its action	2	
	9	Transistor configurations- CE in detail (CB and CC as comparison with CE)	3	
	10	Load line analysis and operating point	2	
	11	Testing of transistor	1	
		Sections: 6.2,6.3, 6.6-6.21 (excluding 6.16) of chapter 6, sections 8.1-8.22, (Excluding 8.11) (Derivation of expression of Ic may be avoided in CE, CB and CC), 8.27 of chapter 8, Book 1		

III		**Voltage stabiliser and amplifier**	**13**	**21**
	12	Zener diode, voltage stabilisation, equivalent circuit of zener diode, zener diode as voltage stabilizer.	3	
	13	Faithful amplification, transistor biasing, inherent variations in transistor parameters, stabilization, voltage divider bias method	3	
	14	Designing of transistor biasing circuits, Mid - point biasing	1	
	15	CE amplifier – circuit, working, phase reversal, frequency response, voltage gain.	3	
	16	Operational amplifier: basic operation, inverting and noninverting modes, voltage follower.	2	
	17	Summing amplifier, applications of summing amplifiers	1	
		Sections: 6.24-6.28 of chapter 6, 9.1-9.5, 9.12, 9.14-9.15 of chapter 9, 10.1-10.5 of chapter 10, 11.3-11.4, of chapter 11, 25.15- 25.17, 25.22-25.24, 25.26, 25.27, 25.32 - 25.33 of chapter 25, Book 1		
IV		**Digital Electronic**	**8**	**12**
	18	Basic logic gates	3	
	19	Combination gates and XOR gates	1	
	20	Boolean Algebra and Boolean theorems	2	
	21	De Morgan's theorems	1	
	22	Electronic adder circuits	1	
		Sections: 26.11-26.17, 26.20-26.22, 26.32 of chapter 26, Book 1		
V		**PRACTICALS**	**30**	
		Conduct any 5 experiments from the given list and 1 additional experiment, decided by the teacher-in-charge, related to the content of the course. The 6th experiment may also be selected from the given list. Other experiments listed here may be used as demonstrations of the concepts taught in the course.		

	Necessary theory of experiments can be given as Assignment/ Seminar.			
	1	**Study the V-I characteristics of diodes.** • Characteristics of Ge/Si diodes, and LEDs. • ExpEYES may be used. https://expeyes.in/experiments/electronics/diodeIV.html • Optional: Plot and fit the experimental data with the diode equation in GeoGebra or any other application and calculate the value of the ideality factor of the PN junction.		
	2	**Study the characteristics of Zener diode and construct a voltage regulator.** • Study the V-I characteristics of zener diode and hence determine the breakdown voltage. • https://expeyes.in/experiments/electronics/zenerIV.html • Construct a voltage regulator using a zener diode and determine the percentage of voltage regulation.		
	3	**Construction of the center tapped full wave rectifiers and regulated power supply.** • Construct a center tapped full wave rectifier without filter and with a filter. • Connections may be realized through soldering, to get an experience of soldering. • Measure the AC and DC voltages using a multimeter and calculate the ripple factor without and with a filter. • Observe the variation of the ripple factor with load resistance, when filter is used. • Optional: Construct 5V/12V regulated power supply using 78XX IC.		
	4	**Transistor input, output & transfer characteristics in CE configuration.**		

		• Draw the static characteristics of the transistor in common emitter configuration and calculate input/output resistance and the current gain. • ExpEYES may be used https://expeyes.in/experiments/electronics/npn.html		
	5	**Construction of CE transistor amplifier and the study of frequency response** • Design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias. • Study the frequency response and find the bandwidth.		
	6	**Operational Amplifier –inverting, non inverting amplifier and voltage follower.** • Design inverting and non inverting amplifiers of different voltage gain. • Measure and verify the gain using CRO/ExpEYES. • Construct a voltage follower and verify that the gain is unity.		
	7	**Operational Amplifier- adder, subtractor** • Design arithmetic circuits(adder and subtractor) using OP AMP, with two input voltages and measure the result using multimeter/CRO/ExpEYES.		
	8	**Construction of basic gates using diodes (AND, OR) & transistor (NOT)** • Realize the logic AND and OR gates using diodes and NOT gate using a transistor and verify the truth table. Logic output can be checked using a multimeter or LED.		
	9	**Construct Half adder using universal gates and study the operation.** • Implement half adder using NAND/NOR gates and verify the truth table for each input/output combination.		
	10	**Verification of De-Morgan's Theorems using basic gates.**		

		• Realize the either side of the De-Morgan's Theorems using gates from appropriate ICs and verify the truth table for each input/output combination.		
	11	**Acceleration of a Freely Falling Body** • Use the smartphone acoustic stopwatch to determine the duration of a free fall. • Measure the time of flight of a steel ball for different heights and plot a graph of distance vs. time squared (s vs. t^2). Determine g from the graph. • Experiment 2 of Book 2. • Phyphox app may be used. https://phyphox.org/experiment/free-fall-2/ **OR** • Use ExpEyes kit, electromagnet, and contact sensor to determine the duration of a free fall. https://expeyes.in/experiments/mechanics/tof.html		
	12	**Verification of the Relation of Angular Velocity and Centrifugal Acceleration** • Use the smartphone gyroscope and the accelerometer. • Attach the smartphone to some rotating arrangements and record the data from the gyroscope and accelerometer. • Plot angular velocity Vs acceleration and verify the relation. • Experiment 18 of Book 2. • Phyphox app may be used. https://phyphox.org/experiment/centrifugal-acceleration/		
	13	**Analysis of Bouncing Balls to Determine Gravitational Acceleration and Coefficient of Restitution.** • After doing the experiment, the student should be able to understand the concept of inelastic collision.		

		• Measure the time interval between successive bounces using a digital acoustic stopwatch and hence calculate g and coefficient of restitution • Experiment 12 of Book 2 • Phyphox app may be used. https://phyphox.org/experiment/inelastic-collision/		
	14	**Analysis of Air Resistance and Terminal Speed to Determine the Drag Coefficient.** • Record the motion of a light weight paper cup and analyse it with Tracker tool (https://physlets.org/tracker/). • Plot acceleration, velocity, and position with time. • Repeat the experiment with different mass (by simply stacking the paper cups) • Determine the Drag Coefficient • Experiment 27 of Book 2. • https://www.youtube.com/watch?v=iujzK3uH1Yc		
	15	**Projectile Motion: Energy Conservation** • Analyse the motion of the tossing ball/ projectile in the Tracker tool. • Plot time Vs the x-and y-components of velocity and acceleration. • Also plot the kinetic energy, potential energy (build data using define tool) and total energy. • https://www.youtube.com/watch?v=x0AWRLvgB28 • https://www.youtube.com/watch?v=i07HeUWo8xc		

Books and References:

1. V K Mehta and Rohit Mehta -Principles of electronics (Book 1)
2. Smartphones as Mobile Minilabs in Physics(Edn. 1) by Jochen Kuhn & Patrik Vogt, Springer, (Book 2)
3. https://phyphox.org/
4. https://physlets.org/tracker/
5. 3. Digital principles and applications - Leach and Malvino (Tata McGraw Hill)
6. Electronic Principles by Malvino - (Tata McGraw Hill)
7. Digital Computer Fundamentals (Thomas. C. Bartee)