St. Thomas College of Engineering & Technology
Vellilode, Sivapuram PO. Mattanur. Kannur District, Kerala
Approved by AICTE New Delhi, Govt. Of Kerala and Affiliated to APJ Abdul Kalam Technological University

COURSE HANDOUT

(B. Tech - Semester 3)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

COLLEGE VISION

To be an Institute of repute recognized for excellence in education, innovation, and social contribution.

COLLEGE MISSION

M1: Infrastructural Relevance - Develop, maintain and manage our campus for our stakeholders.
M2: Life-Long Learning - Encourage our stakeholders to participate in lifelong learning through industry and academic interactions.
M3: Social Connect - Organize socially relevant outreach programs for the benefit of humanity.

DEPARTMENT VISION

To produce professionally competent, ethically sound and socially responsible Electronics and Communication Engineers.

DEPARTMENT MISSION

M1: Provide excellent infrastructure and lab facilities for quality education.

M2: Promote industry-academic interactions to keep up with technological advancements.

M3: Develop interpersonal skills and social responsibility among students through project-based and team-based learning.

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

Graduates of B. Tech ECE program after graduation will:

PEO1: Exemplify technical competence in designing, analyzing, testing and fabricating electronic circuits.

PEO2: Acquire leadership qualities, rapport, communication skills in the organization and adapt to changing professional and societal needs.

PEO3: Work effectively as individuals and as team members in multidisciplinary projects

PROGRAM OUTCOMES (POS)

Engineering Graduates will be able to:

PO1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSO)

PSO1: Define, design, implement, model, and test electronic circuits and systems that perform signal processing functions.

PSO2: Segregate and select appropriate technologies for implementation of a modern communication system.

CONTENTS

COURSE INFORMATION SHEETS OF SEMESTER 3 COURSES

B

PCECT302

SOLID STATE DEVICES

COURSE INFORMATION SHEET

PROGRAMME: ECE (UG)	**DEGREE**: BTECH
COURSE: SOLID STATE DEVICES	**SEMESTER: S3** **L-T-P-CREDITS**: 3:1:0:4
COURSE CODE: PCECT302 **REGULATION**:2024	**COURSE TYPE**: CORE
COURSE AREA/DOMAIN: ELECTRONICS AND COMMUNICATION ENGINEEERING	**CONTACT HOURS**:5 PERIODS/WEEK + 1 REMEDIAL HOUR
CORRESPONDING LAB COURSE CODE (IF ANY): NIL	**LAB COURSE NAME**: NIL

SYLLABUS

MODULE	DETAILS	HOURS
I	.Review of Semiconductor physics: Equilibrium and steady state conditions, Concept of effective mass and Fermi level, Density of states & Effective density of states, Equilibrium concentration of electrons and holes. Excess carriers in semiconductors: Generation and recombination mechanisms of excess carriers, quasi-Fermi levels. Carrier transport in semiconductors: Drift, conductivity and mobility, variation of mobility with temperature and doping, Hall Effect. Diffusion, Einstein relations, Poisson equations, Continuity equations, Current flow equations, Diffusion length, Gradient of quasi-Fermi level.	13
II	PN junctions: Contact potential, Electrical Field, Potential and Charge distribution at the junction, Biasing and Energy band diagrams, Ideal diode equation. Bipolar junction transistor: Transistor action, Base width modulation, Current components in a BJT, Derivation of current components.	12

III	Metal Semiconductor contacts: Electron affinity and work function, Ohmic and Rectifying Contacts, current voltage characteristics. Ideal MOS capacitor: band diagrams at equilibrium, accumulation, depletion and inversion, surface potential, CV characteristics, effects of real surfaces, threshold voltage, body effect. MOSFET- Drain current equation of enhancement type MOSFET (derivation) - linear and saturation region, Drain characteristics, transfer characteristics.	11
IV	MOSFET scaling: Need for scaling, constant voltage scaling and constant field scaling. Sub- threshold conduction in MOS. Short channel effects in MOSFETs: Channel length modulation, Drain Induced Barrier Lowering, Velocity Saturation, Threshold Voltage Variations and Hot Carrier Effects. MESFET and FinFET: Structure, operation and advantages.	8
Total hours		**44**

TEXT BOOKS/REFERENCE BOOKS:

T/R	BOOK TITLE/AUTHORS/PUBLICATION
T1	Semiconductor device Fundamentals Robert Pierret Pearson Education 1/e, 1996
T2	Physics of Semiconductor Devices Michael shur Pearson Education 1/e, 2019
T3	Semiconductor Physics and Devices, 3ed, An Indian Adaptation S.M. Sze, M.K. Lee Wiley 3/e, 2021
R1	Semiconductor Physics and Devices Neamen McGraw Hill 4/e, 2017
R2	Physics of Semiconductor Devices Sze S.M John Wiley 3/e, 2015
R3	Semiconductor Devices: Physics and Technology Sze S.M John Wiley 3/e, 2016
R4	Operation and Modelling of the MOS Transistor Yannis Tsividis Oxford University Press 3/e,2010
R5	Semiconductor Physics and Devices, , Sze S.M., M.K. Lee, An Indian

	Adaptation 3ed, 2021
R6	Fundamentals of Semiconductor Devices, Achuthan, K N Bhat, McGraw Hill 1e,2015

COURSE PREREQUISITES:

COURSE CODE	COURSE NAME	DESCRIPTION	SEMESTER
GBPHT121	Physics of Electrical Science		S1/S2

COURSE OBJECTIVES:

1	This course explains the physical processes and working principles of semiconductor devices, while relating the device performance to material parameters and design criteria.

COURSE OUTCOMES:

After the completion of the course, the student will be able to

COs / CO-PO/PSO MAPPING. /BLOOM'S TAXONOMY LEVEL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
PCECT302.1	Apply Fermi-Dirac statistics to compare equilibrium carrier concentration.													
	3												2	
	APPLY													
PCECT302.2	State different carrier transport mechanisms in extrinsic semiconductors and obtain the current densities due to this transport.													
	3	2											3	
	APPLY													
PCECT302.3	Apply the concept of semiconductor physics to solve the current components in semiconductor devices.													
	3	2										2	3	
	APPLY													
PCECT302.4	Analyze the response of semiconductor devices for different biasing conditions													
	3	2	2									2	3	2

	APPLY													
PCECT302.5	Outline the effects of scaling in semiconductor devices.													
	3	2	2									2	2	3
	UNDERSTAND													
MAPPING AVERAGE	**3**	**2**	**2**									**2**	**2.6**	**2.5**

JUSTIFICATION FOR CO-PO/PSO MAPPING:

CO	PO/ PSO	MAPPING LEVEL	JUSTIFICATION
PCECT302.1	PO1	3	Requires application of mathematics and physics fundamentals, especially statistics.
	PSO1	2	Helps in understanding electronic device behavior essential for circuit modeling
PCECT302.2	PO1	3	Involves deep understanding of semiconductor physics.
	PO2	2	Needs interpretation and solving of engineering problems related to carrier motion.
	PSO1	3	Strongly supports modeling and analysis of electronic circuits using transport principles.
PCECT302.3	PO1	3	Uses scientific principles to analyze current components.
	PO2	2	Involves solving engineering device behavior problems.
	PO12	2	Understanding current components helps students learn on their own and keep up with new technologies, supporting life-long learning.
	PSO1	3	Direct application in analyzing and designing devices for signal processing.
PCECT302.4	PO1	3	Needs theoretical understanding of device behavior.
	PO2	2	Involves solving practical problems of biasing.
	PO3	2	Students apply engineering knowledge to analyze how semiconductor devices respond under

			different biasing conditions
	PO12	2	Encourages learning about modern circuit operation under various conditions.
	PSO1	3	Crucial for implementing and testing biased circuits.
	PSO2	2	Useful in communication circuit design involving different biasing levels.
PCECT302.5	PO1	3	Involves understanding of miniaturization and its impact.
	PO2	2	Requires analysis and comparison of scaled vs unscaled device behavior
	PO3	2	Students apply engineering knowledge to analyze and outline the effects of scaling in semiconductor devices.
	PO12	2	Encourages awareness of emerging trends and technologies.
	PSO1	2	Affects circuit performance and reliability.
	PSO2	3	Highly relevant for modern, high-speed, compact communication systems.

CORRELATION Levels: 3- Substantial (High) 2- Moderate (Medium) 1-Slight (Low)

GAPS IN THE SYLLABUS-TO MEET INDUSTRY/PROFESSION REQUIREMENTS

SL NO:	DESCRIPTION	PROPOSED ACTIONS	RELEVANCE WITH POS /PSOS
1	Lack of basic knowledge on how semiconductor devices are made	Conduct a session on IC fabrication process (intro level)	PO1, PO12, PSO2

CONTENT BEYOND THE SYLLABUS/ADVANCED TOPICS/DESIGN

SL NO:	DESCRIPTION	PROPOSED ACTIONS	RELEVANCE WITH POS /PSOS
1	Overview of how mobile chips (like in smartphones) work	Include a simple presentation or discussion	PO1, PO2, PSO1

WEB SOURCE REFERENCES:

SL NO:	DESCRIPTION
1	https://nptel.ac.in/courses/117106091
2	https://www.youtube.com/watch?v=kpP7cDcKrOE&t=1617s
3	https://www.youtube.com/watch?v=Kp-jS6NHsB8&list=PLF178600D851B098F

DELIVERY TECHNOLOGIES

CLASSROOM WITH BLACK BOARD/WHITE BOARD/SMART BOARD	▯	**ICT TOOLS**	▯
CLASSROOM WITH LCD PROJECTOR	▯	**ELECTRONIC CLASSROOM**	

INSTRUCTION METHODS

FACE TO FACE INSTRUCTION	Direct	▯	**FLIPPED CLASSROOM**	▯
	Project-based instruction		**BLENDED LEARNING**	
	Problem-based instruction		**ONLINE COURSES/MOOCs**	
	Technology enhanced learning	▯	**OTHERS (IF ANY)**	
	Experiential learning			
	Participative learning	▯		

CO ASSESSMENT TOOLS-DIRECT

ASSIGNMENTS	▯	**TUTORIALS**	▯	**SERIES EXAMINATIONS**	▯	**UNIVERSITY EXAM**	▯
LAB PRACTICES		**VIVA**		**INTERNAL LAB EXAM**		**REPORT/ DOCUMENT PREPARATION**	
PRESENTATION		**EVALUATION BY GUIDE**		**INTERIM EVALUATION**		**FINAL EVALUATION**	

CO ASSESSMENT TOOLS -INDIRECT

ASSESSMENT OF COURSE OUTCOMES (BY COURSE EXIT (END) SURVEY)	▯

ASSESSMENT ITEMS /CLASS SESSIONS/LAB/FIELD/TUTORIAL HOURS FOR EACH COURSE OUTCOMES

CO	ASSESSMENT ITEMS	CLASS SESSIONS	LAB/FIELD/TUTORIAL HOURS
PCECT302.1	S1,A1,T1,T2	7	-
PCECT302.2	S1,A1,T3	7	-
PCECT302.3	S2,A1,T4,T5	16	-
PCECT302.4	S2,A2,T6	16	-
PCECT302.5	S3,A3	10	-
		TOTAL HOURS OF INSTRUCTION	56

Prepared by **Approved by HOD**

Nithin C