CURRICULUM AND SYLLABI
for
Minor Programme
(Applicable to 2022 admission onwards)

Department of Electronics and Communication Engineering
Sarabhai Complex
National Institute of Technology Goa
Kottamoll Plateau, Cuncolim, Salcete, South Goa, Goa- 403703, India
www.nitgoa.ac.in

Minor Specialization

in

Electronics and Communication Engineering

Offered by the

Department of Electronics and Communication Engineering

Scheme and Curriculum

Semester Offered	Course Code	Course Name	L	T	P	Credits
IV	EC250M	Analog Electronics	3	0	2	4
V	EC300M	Digital Electronics (for MCE and CVE Students)	3	0	2	4
V	EC301M	Semiconductor Devices (for CSE and EEE Students)	3	1	0	4
VI	EC350M	Fundamentals of Communication System	3	0	0	3
VII	EC400M	Sensor Technologies	3	0	0	3
VIII	EC450M	Practical Applications of Microcontrollers	3	0	2	4
Total Credits						18

Detailed Syllabi of Courses

Course Code	Course Name	L	T	P	Credits
EC250M	Analog Electronics	3	0	2	4

Course Objectives

1. Exploring the behaviour of the diodes and BJTs in analogue and digital environment.
2. Analysis of the various circuits using MOSFETs and study of the amplifiers.
3. Understand the high frequency model of the bipolar junction transistors (BJTs) for the different configurations.
4. Understanding and analysis of the different types of the feedback amplifiers.

Course Outcomes

CO1. Applying the device characteristics in different circuits and studying the related impact.

CO2. Acquire the basic understanding of the Field effect transistor (FET) and its small signal model, analyses the low frequency configurations of the amplifier using FET.

CO3. Understand the high frequency model of the BJTs & MOSFETs for the different configurations.

CO4. Exploration of the feedback concepts in different BJT and MOSFET amplifiers.

Relationship of Course Outcomes to Program Outcomes
H = High correlation; M = Medium correlation; L = Low correlation

POs→ COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	H	M	L	M	L	H	M	H	H
CO2	H	H	H	H	M	L	L	L	H	M	H	H
CO3	H	H	H	H	M	L	L	L	H	M	H	H
CO4	H	H	H	H	M	L	L	L	M	M	H	H

Syllabus

Module 1: Diode & Bipolar Transistors (12 hours)

Diode circuits: clipping, clamping and rectifiers.

Small and Large Signal Model, DC & Small Signal Analysis, Operating Point Analysis and Design: Simple Biasing and Resistive Divider Biasing, Ebers-Moll and Gummel-Poon Model, Common Emitter and Common Base Bipolar Amplifiers with Active Load, BJT Differential Pair

Module 2: MOSFETs (10 hours)
Small & Large Signal Model, Current Source, Current Mirror Circuits, MOS Differential Amplifiers, Differential and Common Mode Gain, CMRR, MOS Differential Amplifiers with Active Load-Qualitative & Quantitative Analysis.

Module 3: Frequency Response (10 hours)
Miller's Theorem, High Frequency Models of Transistors, Use of Miller's Theorem, Frequency Response of Followers, Cascode Stage and Differential Pairs. Voltage Amplifiers, Current Amplifiers.

Module 4: Feedback Amplifiers (10 hours)
Series-Shunt Feedback Amplifiers, Series-Series Feedback Amplifiers, Shunt-Shunt Feedback Amplifiers, Shunt Series Feedback Amplifiers, Loop Gain Stability.

List of Experiments (Any Five)

Experiment No. 1: Set-up and extract the input and output characteristics of the P-N junction diode.

Experiment No. 2: Realization of the different clipping and clamping circuits and observe the waveforms.

Experiment No. 3: To study input and output characteristics of a NPN Bipolar Junction Transistor (BJT) in Common-emitter configuration.

Experiment No. 4: To study transfer and output characteristics of an n-channel MOSFET in common-source configuration.

Experiment No. 5: Determine the Q-point stability of base bias.

Experiment No. 6: Construct the dc load line and plot the Q-point of voltage divider bias circuit.

Experiment No. 7: Study and simulate the frequency response of the common emitter amplifier.

Text/Reference Books

1. Behzad Razavi, "Fundamentals of Microelectronics", John Wiley & Sons .2008.
2. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder's College Publishing, 1991.
3. B.G. Streetman and S. K. Banerjee, Solid State Electronic Devices, Prentice Hall of India, New Delhi, 1995.
4. T. C. Carusone, D. Johns, and K. Martin, Analog Integrated Circuit Design, 2nd edition. Wiley-India, 2013.
5. P. R. Gray, P. J. Hurst, S. H. Lewis, and R. G. Meyer, Analysis and Design of Analog Integrated Circuits, 5th edition. Wiley-India, 2009.
6. R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory, 11th edition. Pearson, 2013.
7. D. A. Neamen, Electronic Circuits: Analysis and Design, 3rd edition. Tata McGraw-Hill, 2008.

Course Code	Course Name	L	T	P	Credits
EC300M	**Digital Electronics (*for MCE and CVE Students*)**	**3**	**0**	**2**	**4**

Course Prerequisites: Basic Electrical Science

Course Objectives

1. To understand the working of digital systems. Various hardware components of the Digital logics/computer shall be studied in greater depth.

Course Outcomes

CO1: Apply Boolean algebra and Karnaugh maps to simplify digital logic circuits.

CO2: Design and implement fundamental combinational circuits like adders, subtractors, comparators, decoders, encoders, multiplexers, and de-multiplexers.

CO3: Analyze the behavior of various flip-flops (SR, D, JK, and T) and design sequential circuits like counters, shift registers, and sequence detectors.

CO4: Model digital systems using state machines represented by state diagrams and tables, and perform state minimization for efficient design.

CO5: Understand the principles of logic families (e.g., ECL, CMOS) and use hardware description languages (Verilog/VHDL) for digital system modeling.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

POs→ COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	L	-	L	-	-	-	-	-	-	L
CO2	H	H	M	-	L	-	-	-	-	-	-	L
CO3	H	H	H	-	L	-	-	-	-	-	-	L
CO4	M	L	H	-	L	-	-	-	-	M	-	L
CO5	M	L	M	-	M	-	-	-	-	M	L	M

Syllabus

Module 1: Minimization of Boolean function (06 hours)

Number systems and binary codes, error detecting & correcting codes, Boolean algebra and Logic Gates, simplification of logic functions using Karnaugh map, Quine McCaskey method.

Module 2: Combinational Logic Design (08 hours)

Implementation of combinational logic functions, binary adder- subtractor, parallel adder, BCD adder, binary multiplier, magnitude comparator, decoders, BCD to 7-segment decoder driver, encoders, priority encoders, code converters, parity generator/checker, multiplexers & de-multiplexers, implementation of logical functions using multiplexers.

Module 3: Sequential Logic Design (12 hours)
Sequential circuits, latches and flip-flops: SR-latch, D-latch, D flip-flop, JK flip-flop, T flip- flop, timing hazards and races, edge-triggered flip-flops, register, shift register, universal shift register; application of shift register: ring counter, Johnson counter, sequence generator and detector, up- and down counter, asynchronous ripple counter, synchronous counters, counter design using flip flops, counter design with asynchronous reset or preset, applications of counters.

Module 4: State Machine (08 hours)
Canonical model of a state machine, types of state machines, state diagram, state table, state assignment, Moore and Mealy model, state minimization.

Module 5: Logic families (08 hours)
ECL, CMOS. Memories: read only and read/write memories, Hardware modeling using Verilog/VHDL; Laboratory exercises and assignments to supplement the course.

Text/Reference Books

1. M. Morris Mano, Michael D. Ciletti, "Digital Design: With an Introduction to Verilog HDL", 5th Edition, Pearson Education India, 2013.
2. Stephen Brown, ZvonkoVranesic, "Fundamentals of Digital Logic with VHDL Design", 3rd Edition, McGraw Hill Education, 2017.
3. Ronald J. Tocci, "Digital Systems", 10th Edition, Pearson, 2009.
4. Vahid, "Digital Design, with RTL Design, VHDL, and Verilog", 2nd Edition, John Wiley and Sons Publishers, 2010.
5. S. Palnitkar, " Verilog HDL: A Guide to Digital Design and Synthesis", 2nd Edition, Pearson Education, 2004

List of Experiments

Experiment No.1: Implementing and realization of Boolean expressions using logic gates and universal gates.

Experiment No.2: Study of the 7483 chip and implementing half/full adder & half/full subtractors using logic gates.

Experiment No.3: Realization and verification of the truth table of the JK flip-flop, D flip-flop and T flip-flop.

Experiment No.3: Implementation of the 3-bit sequential counter.

Experiment No.4: Write and implement the VHDL code of half adder using behavioral, dataflow and structural modelling.

Course Code	Course Name	L	T	P	Credits
EC301M	Semiconductor Devices *(for CSE and EEE Students)*	3	1	0	4

Course Objectives

1. Understand the importance, types, and behaviors of different semiconductor materials.
2. Explore the properties and functions of p-n junction devices.
3. Develop a thorough understanding and comprehensive knowledge of transistors and their applications.

Course Outcomes

The student will be able to

CO1. Analyze the fundamental properties and behavior of semiconductor materials.

CO2. Understand the working of p-n junction devices and evaluate their usage in real world applications.

CO3. Analyze and design transistor circuits for a given application.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

POs→ / COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	H	M	L	M	L		M		H
CO2	H	H	H	H	H	L	L	L		M	L	H
CO3	H	H	H	H	H	M	L	L	L	M	L	H

Syllabus

Module 1: Introduction to Semiconductor Devices (14 hours)

Importance of semiconductor materials in electronics, basic semiconductor material types, intrinsic and extrinsic semiconductors, concept of charged carriers and its temperature dependence, Bond model, band model, charge carrier generation & recombination, minority current continuity equation.

Module 2: Introduction to p-n junction (14 hours)

Ideal band equation, diodes, forward & reverse biasing, built-in voltage, real & ideal VI characteristics & breakdown mechanism

Case study on p-n junction devices – Zener diodes, photovoltaic cells, LEDs, photodiodes, high frequency IMPATT diodes, Gunn diodes.

Module 3: Concept of Transistors (14 hours)

Unipolar & Bipolar transistors, construction, and operation of Bipolar Junction Transistors (BJT), concept of amplification, base transport factor, injection efficiency, VI characteristics, Ebers-Moll Model.

Module 4: Concept of Unipolar Junction Transistors (14 hours)

UJT, Field Effect Transistors (FET), Junction Field Effect Transistors (JFET), Insulated Gate Field Effect Transistors (IGFET), Construction and operation of Metal Oxide Silicon Field Effect Transistors (MOSFET), MOS Capacitance, modes of operation, MOSFET based amplifiers and uses.

Text/Reference Books

1. T. L. Floyd, "Electronic Devices," Prentice Hall, 9th Edition, 2012.
2. S. Salivahanan, N. Suresh Kumar, "Electronic Devices and Circuits", Tata Mc-Graw Hill, 3rd Edition
3. Bell, David A. "Electronic devices and circuits", Prentice-Hall of India, 1999.
4. R. L. Boylestad and L. Nashelsky, "Electronic Devices and Circuit Theory", 11th Edition, Pearson, 2013.
5. D. A. Neamen, "Electronic Circuits: Analysis and Design", 3rd Edition. Tata McGraw-Hill,2008.

Course Code	Course Name	L	T	P	Credits
EC350M	Fundamentals of Communication System	3	0	0	3

Course Objectives

1. Develop proficiency in analyzing continuous-time signals in both time and frequency domains.
2. Gain insight into the principles and properties of the sampling process for effective signal discretization.
3. Understanding fundamental communication modulation techniques, including Amplitude Modulation (AM) and Frequency Modulation (FM).
4. Apply theoretical knowledge to specific modulation techniques for practical skills in designing and analyzing real-world communication systems.

Course Outcomes

CO1. Understand and describe continuous-time signals using time and frequency analysis methods.

CO2. Apply knowledge of the sampling process to effectively convert continuous signals into discrete forms.

CO3. Exhibit proficiency in implementing and interpreting basic communication modulation techniques such as Amplitude Modulation (AM) and Frequency Modulation (FM).

CO4. Apply acquired skills to design and analyze practical communication systems using modulation techniques like Amplitude Modulation (AM), Frequency Modulation (FM), Pulse Amplitude Modulation (PAM), and Pulse Code Modulation (PCM).

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	L	L	L	M	M	L	H	H	L	M
CO2	H	M	L	L	M	L	L	L	M	H	L	L
CO3	L	M	M	L	M	H	M	M	L	M	H	L
CO4	L	H	L	H	L	M	M	H	M	M	L	L

Syllabus

Module 1: Review of Signals and Systems (08 hours)

Definition of signals and systems, Fourier series, Fourier transform, energy and power of signals in time domain and frequency domain, Power spectral density, Convolution, Parseval's theorem, Auto Correlation and Cross correlation.

Module 2: Amplitude Modulation (14 hours)

Amplitude Modulation (AM), Spectrum of AM, Envelope Detection, Power Efficiency, Double Sideband Suppressed Carrier (DSB-SC) Modulation, Costas Receiver, Single Sideband Modulation (SSB), Hilbert Transform, Demodulation of SSB, Visualization of various AM schemes in Simulink/MATLAB.

Module 3: Frequency Modulation (12 hours)

Angle Modulation, Frequency Modulation (FM), Phase Modulation (PM), Spectrum of FM signals, Carson's rule for FM Bandwidth, Narrowband FM Generation, Wideband FM Generation via Indirect Method, FM Demodulation, PLL, Visualization of various FM schemes in Simulink/MATLAB.

Module 4: Pulse Modulations and Noise (08 hours)

Pulse Modulation, Sampling process, Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM), Pulse Code Modulation (PCM).
SNR, Noise Figure and Figure of Merit, noise in transceivers.

Text/Reference Books

1. H. Taub, D. L. Schilling, and G. Saha, "Principles of Communication Systems", 4th Edition, McGraw

Hill Education, 2017.

2. B. P. Lathi, Z. Ding Modern, "Digital and Analog Communication Systems", Oxford University Press, 2010.
3. Alan V. Oppenheim, Alan S. Willsky, and S. Hamid Nawab, "Signals and Systems", 2^{nd} Edition, Prentice Hall of India, 2003.
4. S. Haykin, "Communication Systems", Wiley India Edition, 2009.
5. Wayne Tomasi, "Electronic Communications System: Fundamentals Through Advanced", Pearson Education, 5^{th} Edition, 2008.

Course Code	Course Name	L	T	P	Credits
EC400M	**Sensor Technologies**	**3**	**0**	**0**	**3**

Course Objectives

The primary objective of this course shall be to provide a introductory level understanding on the Physics, Fabrication and Principles of operation of a spectrum of sensor types, starting from traditional sensors to sensors at micro to nanoscale in dimensions and probing.

Course Outcomes

The student will be able to

CO1: To introduce different technologies associated with sensors.

CO2: To gain insight into almost the entire basic spectrum of sensor technologies from physics to fabrication and to associated circuits

CO3: To understand the physics, fabrication and technologies of typical sensors, and further microfabrication technologies associated with sensors at micro to nanoscale in dimensions and probing.

Relationship of Course Outcomes to Program Outcomes

H=High correlation; M=Medium correlation; L=Low correlation

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	H	M	L	M	L		M		H
CO2	H	H	H	H	H	L	L	L		M	L	H

CO3	H	H	H	H	H	M	L	L	L	M	L	H

Syllabus

Module 1: Basics of Sensors (10 Hours)

Introduction to Sensors, Transducers and Actuators. Materials for Sensors. Classification of sensors based on physics, devices, substrate, materials, dimensions and applications. Sensor Parameters: Accuracy, Precision, Calibration, Sensitivity, Selectivity, Threshold, Offset, Linearity, Non-Linearity, Hysteresis, Selectivity, Reproducibility, Dead Band, Resolution, Noise, Throughput, multiplexed sensing. Excitation, Dynamic Characteristics, Response and Recovery Time. Principles of Calibration and compensation techniques

Module 2: Physical Sensors and Transducers (10 Hours)

Types of sensors: active and passive sensors, Capacitive Sensors, Thermal Sensors, Optical Sensors, Fiber Bragg Grating based sensors. Chemical Sensors, Electro Chemical Sensors, Imaging sensors -CCD and CMOS. Transducer and classification: Primary & Secondary, active & passive transducers. Magnetic Sensors, Acoustic Sensors

Module 3: Micro Sensor Technologies (12 Hours)

Principles of microfabrication, Bottom up and Top-down approach for fabrication. Introduction to fabrication technologies, Deposition technologies, and characterization techniques.

Module 4: Emerging trends in Sensor Technology (10 Hours)

Introduction to world of wearable, Textiles and Clothing Wearable applications Personal Health, and Sports. Wearable Bio and Chemical Sensors and Challenges in Chemical Biochemical Sensing. Introduction to Microfluidics and sensing. Internet of Things (IoT) and Case Studies and Introduction to future trends.

Text/Reference Books:

1. A.K. Sawhney, “Electrical and Electronic Measurements and Instrumentation”, Dhanpat Rai, 2015.
2. Alan S Morris, “Measurement and Instrumentation Principles”, 3rd Edition, Butterworth Hienemann, 2001.
3. David A. Bell, “Electronic Instrumentation and Measurements”, 2nd Edition, Oxford Press, 2007.
4. Madou, Fundamental of Microfabrication, 2nd Edition, CRC Press.
5. Raj Kamal Internet of Things: Architecture and Design Principles, 1st Edition, Mc Graw Hill Education Pvt. Ltd., 2017.
6. Sudip Misra, Anandarup Mukherjee, Arijit Roy, Introduction to IoT, Cambridge University Press, 2021.
7. T. Pradeep, NANO: The Essentials: Understanding Nanoscience and Nanotechnology, 1st Edition, Tata

McGraw-Hill, 2007.

8. Maity, Asit Baran, Optoelectronics and Optical Fiber Sensors, PHI Learning.

Course Code	Course Name	L	T	P	Credits
EC450M	**Practical Applications of Microcontrollers**	**3**	**0**	**2**	**4**

Course Objective

1. To provide insight and hands on experience of using microcontrollers for practical applications to solve engineering problems.

Course Outcomes:

CO1: Shall obtain knowledge on fundamentals of Embedded Systems

CO2: Shall be able to understand the process of Arduino Engineering and software.

CO3: Shall be able to practically demonstrate various automation, control and communication applications using Arduino systems

Relationship of Course Outcomes to Program Outcomes
H = High correlation; M = Medium correlation; L = Low correlation

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	L	-	L	-	-	-	-	-	-	L
CO2	H	H	M	-	L	-	-	-	-	-	-	L
CO3	H	H	H	-	L	-	-	-	-	-	-	L

Syllabus

Module 1: Introduction to Embedded systems (08 Hours)

Introduction, Embedded system Vs General purpose computing system, classification of embedded system, typical embedded system, core of embedded system, memory, Input and output devices. Introduction to family of microcontrollers.

Module 2: Hardware Platform (10 Hours)

Introduction, ATmega2560 microcontroller-Block diagram and pin description. Arduino Mega 256 board - Introduction and pin description. Simple Applications - Solar Tracker, 4-Digit 7-Segment LED Display, Tilt Sensor, Home Security Alarm System, Digital Thermometer, loT applications.

Module 3: Introduction to Arduino (10 Hours)

The Process of Arduino Engineering, Understanding Arduino software, Arduino IDE, Structuring Arduino Program using simple Primitive Types, using Floating-Point Numbers, Working with group Values, Using C Character Strings, Converting number to string, performing bitwise operations. Using Mathematical Operators: Arithmetic and Logical Operations, Raising a Number to a power, Square root of a number, Rounding floating-point-numbers Up and Down, Trigonometric Functions, Generating random Numbers, Shifting bits.

Module 4: I/O Application (14 Hours)

Simple digital and analog input using a switch, Reading a keypad. Input from sensors, Driving 7-segment display. Audio Output: Playing Tones, Playing a simple melody.

Communication Applications: Serial Communications, Controlling RGB light using a Blink M module, Adding External EEPROM memory, Communicating between two or more Arduino Boards.

Laboratory Component: Simple Projects

1. Demonstrate the application, to design a water level indicator system using LEDs
2. Demonstrate the application, to design a basic temperature controller to be switched ON and OFF with respect to a set point and to display the temperature on a LCD display.
3. Demonstrate the application, to control the distance of movement of a gate using a DC motor and a proximity sensor.
4. To design and demonstrate a vehicle parking counter, wherein it shall display the total number of vehicles being parked in a parking area and display the same.
5. Demonstrate the application, to design and development a automatic brightness correction through an LED with reference to ambience intensity of light.
6. Demonstrate the application, which will automatically open and close the toll gate when vehicles are identified.
7. Design and develop a fire alarm system for domestic applications.
8. Demonstrate the application, light intensity detection and sending message from one computer to another using ZigBee module.
9. Demonstrate the application, alerting the movement detection by sending message from one computer to another using RF433 MHz module.
10. Design and develop a vehicular/personnel movement detection by sending message from one computer to another through free space optical communication.

Text/Reference Books

1. Shibu K V, Introduction to Embedded Systems, 2nd Edition, Tata Mc Graw Hill Education Pvt. Ltd., 2017.
2. Arsath Natheem S, Handbook of Arduino: 100+ Arduino Projects learn by doing practical guides for beginners and inventors, Kindle Edition.
3. Arduino Cookbook, Michael Margolis, 1st Edition, O'Reilly Media Inc., 2011.

E-Resources

1. https://www.arduino.cc/en/Guide