

Dr. Babasaheb Ambedkar Technological University, Lonere

**Dr. Babasaheb Ambedkar Technological University (Established as a University of
Technology in the State of Maharashtra)
(Under Maharashtra Act No. XXIX of 2014)
P.O. Lonere, Dist. Raigad, Pin 402 103, Maharashtra Telephone and Fax. 02140 - 275142
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**Structure and Detailed Syllabus for UG Degree
Minor in Electronics Engineering
in line with New Education Policy 2020
(Effective from Academic year 2025-26 for Affiliated Colleges Only)**

Bucket for Minor in Electronics Engineering

Offered by

Electronics and Computer Engineering / Electronics and Computer Science Engineering

Case I: B. Tech degree with Minor in Electronics Engineering (160-176 credits)

The Bachelor's Engineering Degree in chosen Engg./ Tech. Discipline with multidisciplinary minor (min.160-max.176 Credits) i.e. **"B. Tech in chosen Engg./ Tech. Discipline with Minor in Electronics Engineering"** (160-176 credits) enables students to take up four-six or required additional courses of 14 credits in the discipline other than **chosen Engg./ Tech. Discipline** distributed over semesters III to VIII.

Case II: Bachelor's Engineering Degree in chosen Engg./ Tech. Discipline with Double Minor (Multidisciplinary and Specialization Minor 180-194 credits)

The Bachelor's Engineering Degree in chosen Engg./ Tech. Discipline with Double Minor (Multidisciplinary and Specialization Minor, 180-194 credits), i.e. **"B. Tech in chosen Engg./ Tech. Discipline with minor in *other selected discipline in Engineering* (as MDM) with Specialization Minor in Electronics Engineering"** (180-194 credits) enables students to take up four-six additional courses of 14 credits in the discipline other than **chosen Engg./ Tech. Discipline** (for completion of multidisciplinary minor) and 18 to 20 extra credits in the **Electronics Engineering** distributed over semesters III to VIII. Here, the ***other selected discipline in Engineering* should be different from Specialization Minor i.e. Electronics Engineering**. This enables students to take up four-six or required additional courses of 18 to 20 credits in the discipline of **Electronics Engineering** distributed over semesters III to VIII, which are over and above the min.160-max.176 Credits. The decision regarding the mechanism of distribution of these 18-20 credits over semesters III to VIII, prescribed for the duration of four years will be taken by respective BoS. **Student must have CGPA equal to or greater than 7.5 at the end of second semester to go for this option.**

List of Courses for Minor in Electronics Engineering

Sr. No.	Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				Credit
				L	T	P	CA	MSE	ESE	Total	
1	SEM-III	25AF1844MD306	Analog and Digital Electronics	2	0	0	20	20	60	100	2
2	SEM-IV	25AF1844MD406	Microcontroller and Applications	2	0	0	20	20	60	100	2
3	SEM-V	25AF1844MD506	Embedded Systems	3	0	0	20	20	60	100	3
4	SEM-VI	25AF1844MD606	Internet of Things	3	0	0	20	20	60	100	3
5	SEM-VII	25AF1844MD706A	Edge AI and Intelligent Systems	2	0	0	20	20	60	100	2
		25AF1844MD706B	Industry 4.0								
6	SEM-VIII	25AF1844MD806	Industrial Automation and Control	2	0	0	20	20	60	100	2
										600	14

Course Objectives:

The objective of this course is to provide students with

1. Concepts of Semiconductor devices like BJT and MOSFET, its characteristics, parameters & applications
2. Knowledge of Operational amplifier, concept, parameters & applications
3. Boolean algebra, Karnaugh-Maps and its application to the design and characterization of combinational logic Circuits.
4. The principles of logic design and use of simple memory devices, flip-flops, and sequential circuits.

Course Outcomes:

After completing this course, students will be able to

CO1: Analyze the MOSFET based amplifiers with and without feedback.

CO2: Explore and deploy basic configurations of Op-amp and explain relevant parameters.

CO3: Apply the knowledge of number systems and Boolean algebra for simplification of logic equations.

CO4: Design and implement combinational logic circuits.

CO5: Design and implement Sequential logic circuits.

Unit-I: MOSFET Circuits and applications**06 Hours**

Types of MOSFETs, Construction, working, and characteristics. Common Source amplifier, CS/CD/CG Configurations, Common source amplifier, MOSFET as switch, MOSFET as resistor/diode. Concept of Feedback – Types of Negative Feedback amplifiers, Oscillators: Barkhausen Criterion, Wein Bridge & Phase shift oscillator.

Unit-II: Operational Amplifier**06 Hours**

Block diagram of Op-Amp, Op-amp characteristics (AC & DC), and Op-amp parameters. Inverting amplifier, non-inverting amplifier, Voltage follower, Summing amplifier, Differential amplifier, Comparator, Schmitt trigger, Square & triangular wave generator, Precision rectifiers.

Unit-III: Basics of Digital Electronics**06 Hours**

Number system & codes: Binary Number base conversion, Octal & hexadecimal numbers, complements, signed binary numbers, binary codes-BCD codes, gray codes, ASCII Character Code. Boolean algebra: Basic Theorems, Sum-of-Product, Product-of-Sum, up to 4 variable K-map. Don't care condition, Code convertors.

Unit-IV: Combinational Circuit Design**06 Hours**

NAND and NOR Implementation, Adders and Subtractors, look ahead carry, BCD Adder, Digital Comparator, Parity generators/checkers, Multiplexers, Encoders, De-multiplexers and Decoders and their use in combinational logic designs.

Unit-V: Sequential Circuit Design**08 Hours**

1 Bit Memory Cell, Clocked SR, JK, MS J-K flip flop, D and T flip-flops. Use of preset and clear terminals, Excitation Table for flip flops. Application of Flip- flops: Registers, Shift registers, Sequence Generators, ripple counters, up/down counters, synchronous counters, Basics of State Machines

Text Books:

1. Donald Neaman, “Electronic Circuits – Analysis and Design” Third edition, McGraw Hill. 2019.
2. R.P. Jain, Kishor Sarawadekar, “Modern Digital Electronics”, Fifth edition, McGraw Hill, 2022.

Reference Books:

1. Jacob Millman, Christos Halkias, Chetan Parekh “Integrated Electronics”, Second Edition, McGraw Hill, 2018
2. Ramakant Gayakwad, “Op Amps & Linear Integrated Circuits”, Pearson Education. Fourth Edition, 2015.
3. Anand Kumar, “Fundamentals of Digital Circuits”, Fourth Edition, Prentice Hall of India, 2016

Course Objectives:

The objective of this course is to provide students with

1. Comprehensive understanding of microcontroller architectures
2. Learn 8051 and STM32 platforms and programming using embedded c.
3. Explore internal structures, development environments, peripheral interfacing, and real-time programming techniques using industry-standard protocols
4. Develop working skills to use tools for application-based embedded system design.

Course Outcomes:

After completing this course, students will be able to:

CO1: Describe the architecture, features, and selection criteria of 8051 microcontrollers.

CO2: Implement interrupt programming for Timer/Counter, Serial communication and external and internal interrupts.

CO3: Interface various peripheral devices with 8051 microcontroller for real world applications.

CO4: Understand STM32 architecture and develop programs for STM32 microcontrollers

CO5: Interface and program the STM32 microcontroller with various peripherals and develop embedded C programming.

Unit-I: Introduction to 8051 Microcontroller**06 Hours**

Brief History, Classification of MCS-51family based on their features (8051, 8052, 8031, 8751, AT89C51), Pin configuration, Processor Architecture and Instruction Set: Registers of 8051, Inbuilt RAM, Register banks, stack, on-chip and external program code memory ROM, power reset and clocking circuits, I/O port structure, GPIO Programming using embedded C.

Unit-II: Timer/Counter, Serial Port and Interrupts of 8051**06 Hours**

Basics of Timers & Counters, Timer Types and Modes of Operation, Interrupt vs Polling, Types of interrupts, Register used for interrupts initialization, External interrupts, Timer interrupts. Introduction to serial communication, RS232 standard, RS422 Standard, 1488 and 1489 standard, Max 232/233 Driver, Serial Communication Interrupts, [Timer/Counter, Serial Communication and Interrupt programming using embedded C].

Unit-III: I/O Port and Peripheral Interfacing with 8051**06 Hours**

LEDs, Relays and Opt-isolators interfacing, DC motor interfacing Stepper motor interfacing, and PWM using 8051. 7-Segment and LCD Interfacing, Analog to Digital converters (ADC) & Digital to Analog Converter (DAC) basics. ADC, DAC and Temperature Sensor interfacing.

Unit-IV: STM32 Architecture and Programming**08 Hours**

STM32 MCU family, ARM architecture, Difference between STM32F1, F4, L series, STM32F411: - Features, Functional Overview: - ARM Cortex-M with FPU core, Memory & Bus Architecture, Power Controller, Reset & Clock control, Direct Memory Access (DMA) controller, Interrupts, Timers and Watchdogs. ARM Thumb, Instruction Set. Language support (Assembly, C, C++ and Micro Python). Programming: - GPIO, Serial monitor, generate time delay using timer.

Unit-V: Interfacing Applications with STM32

06 Hours

Interfacing with STM32 and its programming: - LCD Interfacing, transfer and receive data from PC, read analog voltage and display on serial port, signal generator using DAC, IR sensor interfacing, control AC device using relay module with STM32, control servo motor angle using PWM.

Textbooks:

1. Mazidi, M. A., Mazidi, J. G., & McKinlay, R. D. (2006). The 8051 microcontroller and embedded systems: using Assembly and C (Vol. 626). Pearson/Prentice Hall.
2. Predko, M. (1999). Programming and customizing the 8051 microcontroller. McGraw-Hill, Inc.
3. Muhammad Ali Mazidi, STM32 ARM Programming, McGraw Hill.

Reference Books

1. Ayala, K. J. (2010). The 8051 Microcontroller and Embedded Systems: Using Assembly and C. Cengage Learning.
2. Ayala, K. J. (1995). The 8051 microcontroller. Penram, India.
3. Beginning STM32, William Grey, Apress

NPTEL Courses:

1. Microprocessors And Microcontrollers, IIT Kharagpur Prof. Santanu Chattopadhyay
<https://nptel.ac.in/courses/108105102>
2. Microcontrollers and Applications, IIT Kanpur by Dr. S. P. Das
<https://nptel.ac.in/courses/117104072>

Course Objectives:**The objective of this course is to:**

1. Understand the architecture, characteristics, design methodology, and applications of embedded systems.
2. Develop embedded applications using the ESP32 platform and its programming environment.
3. Implement embedded systems by interfacing sensors, actuators, displays, and communication peripherals.
4. Apply Embedded Linux concepts and Raspberry Pi programming for embedded application development.
5. Understand Real-Time Operating System (RTOS) concepts and develop multitasking embedded applications using FreeRTOS.

Course Outcomes:**After completing this course, students will be able to**

CO1: Explain the architecture, characteristics, design methodology, and applications of embedded systems.

CO2: Develop embedded applications using the ESP32 platform and embedded programming techniques.

CO3: Implement sensor, actuator, display, and communication interfaces using standard embedded communication protocols.

CO4: Apply Embedded Linux concepts and Raspberry Pi programming for embedded system development.

CO5: Develop real-time embedded applications using RTOS concepts, task scheduling, synchronization, and FreeRTOS.

Unit-I: Fundamentals of Embedded Systems**08 Hours**

Introduction to Embedded Systems, Characteristics and Classification of Embedded Systems, Embedded System Architecture, Hardware Components: Microcontroller, Microprocessor, System-on-Chip (SoC), Embedded Software Components, Embedded System Design Flow, Design Metrics and Constraints, Applications of Embedded Systems

Unit-II: ESP32 and Embedded Development**08 Hours**

Introduction to ESP32: Functional Block Diagram, Features; SoC vs Modules vs Development Boards; ESP32 NodeMCU: Pin configuration, ESP32 Development Environment: Arduino IDE, PlatformIO (Overview), ESP32 GPIO Programming: Digital Input and Output, LED and Push Button Interfacing; PWM Controller: LED Dimming and Motor Control, Timers and Interrupts Programming, (Use of Embedded C programming)

Unit-III: ESP32 Embedded Interfacing**08 Hours**

ADC and DAC Concepts, Analog Sensor Interfacing: Potentiometer, LDR, Soil Moisture Sensor, LM35 Temperature Sensor, MQ Series Gas Sensors; Digital Sensor Interfacing: DHT11/22 Temperature and Humidity Sensor, HC-SR04 Distance Sensor, Actuator Interfacing: Relay, Buzzer, Solenoid Valve, Display Interfacing: LCD, Communication Protocols: UART, I²C, SPI Interface (Using ESP32 only)

Unit-IV: Raspberry Pi and Embedded Linux

08 Hours

Overview of Raspberry Pi: Introduction to Raspberry Pi, Comparison of various Rpi Models, Understanding SoC architecture and SoCs used in Raspberry Pi, Pin Description of Raspberry Pi, On-board components of Rpi. Introduction to Embedded Linux, Features of Embedded Linux, Raspberry Pi OS Installation and Configuration, Linux Commands: File viewing and editing, System information, Package management, configuration commands, network commands and python execution commands; GPIO Programming using Python: LED, Switch, DHT11/22, Ultrasonic Sensor Interfacing.

Unit-V: RTOS Programming and Applications

08 Hours

Introduction to FreeRTOS, FreeRTOS Kernel Architecture, FreeRTOS on ESP32; Task Creation and Management, Task Synchronization and Communication, Memory Management in RTOS, Interrupt Handling in RTOS, Real-Time Application Development using FreeRTOS, Case Studies: Real-time sensor monitoring and multitasking using ESP32.

Text Books:

1. Raj Kamal, Embedded Systems: Architecture, Programming and Design, McGraw Hill Education, ISBN-13: 978-9354602689, 3rd Edition.
2. Shibu K. V., Introduction to Embedded Systems, McGraw Hill Education, ISBN-13: 978-0070145894, 2nd Edition.
3. Simon Monk, Programming the Raspberry Pi: Getting Started with Python, McGraw-Hill Education, ISBN-13: 978-1259587405, 3rd Edition.

Reference Books:

1. Frank Vahid, Tony Givargis, Embedded System Design: A Unified Hardware/Software Introduction, Wiley India, ISBN-13: 978-8126523696, 2nd Edition.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide: Designing and Optimizing System Software, Morgan Kaufmann / Elsevier, ISBN-13: 978-1558608740, 1st Edition.
3. Richard Barry, Mastering the FreeRTOS Real Time Kernel, Real Time Engineers Ltd., Latest Edition.

NPTEL Courses:

1. NPTEL Course: Embedded System Design with ARM by Prof. Indranil Sengupta and Prof. Kamalika Datta, IIT Kharagpur. <https://nptel.ac.in/courses/106105193>
2. NPTEL Course: Introduction to Real Time Embedded Systems – Part I by Prof. Rajib Mall, Prof. Amit Patra and Prof. A. Routray, IIT Kharagpur. <https://nptel.ac.in/courses/108105057>
3. NPTEL Course: Operating System Fundamentals by Prof. Santanu Chattopadhyay, IIT Kharagpur. <https://nptel.ac.in/courses/106105214>

Course Objectives:**The objective of this course is to:**

1. Understand the fundamentals, architecture, and enabling technologies of the Internet of Things (IoT).
2. Learn IoT communication protocols, networking technologies, and device connectivity methods.
3. Explore cloud platforms, data acquisition, storage, and analytics for IoT applications.
4. Understand security, privacy, and device management techniques in IoT systems.
5. Design IoT-based solutions for smart home, industrial, agricultural, and healthcare applications.

Course Outcomes:**After completing this course, students will be able to:**

CO1: Explain IoT architecture, enabling technologies, and communication models.

CO2: Analyze IoT networking technologies and communication protocols for connected devices.

CO3: Apply cloud platforms and data analytics techniques for IoT applications.

CO4: Evaluate IoT security mechanisms and privacy-preserving techniques for secure deployment.

CO5: Design IoT solutions for real-world applications using appropriate hardware, networking, and cloud technologies.

Unit-I: IoT Fundamentals and Architecture**08 Hours**

Introduction to Internet of Things, Characteristics and Evolution of IoT, IoT Ecosystem and Applications, IoT Architecture: Perception Layer, Network Layer, Middleware Layer, Edge Layer Application Layer; IoT Enabling Technologies: Embedded Systems, Communication Networks, Cloud Computing, Big Data; IoT Communication Models: Device-to-Device (D2D), Device-to-Cloud (D2C), Device-to-Gateway (D2G), Back-End Data Sharing

Unit-II: IoT Communication and Networking**08 Hours**

IoT Communication Protocols: MQTT, CoAP, HTTP, AMQP, WebSockets, Protocol Comparison: Data Rate, Power Consumption, Communication Range; IP Addressing Basics, DNS and NAT Concepts, IPv6 and IPv6 for IoT; Wireless Technologies: Wi-Fi, Bluetooth Low Energy (BLE), ZigBee, LoRa; Network Topologies, Mesh Networking

Unit-III: IoT Cloud Platforms and Data Analytics**08 Hours**

IoT Data Formats: JSON, XML; REST APIs, Sensor Cloud, IoT Cloud Platforms: Firebase ThingSpeak, Blynk, AWS IoT, Microsoft Azure IoT, Google Cloud IoT, ThingsBoard, Data Acquisition and Storage, Data Visualization, IoT Dashboards, Cloud-Based Data Analytics, Trend Analysis and Threshold Alerts

Unit-IV: IoT Security and Device Management**08 Hours**

IoT Security Challenges, Authentication and Authorization, Data Encryption Techniques, Secure Boot, Firmware Over-the-Air (FOTA) Updates, Hardware Security Modules (HSMs), Access Control, Data Privacy in IoT, Zero Trust Security, Lightweight Cryptography, Device Monitoring and Management

Unit-V: IoT Applications and Emerging Trends

08 Hours

Smart Home Automation, Industrial Internet of Things (IIoT), Predictive Maintenance, Smart Agriculture using LoRa, Healthcare IoT, Smart City Applications, Wearable IoT Devices, Edge Computing in IoT, Green IoT and Energy-Efficient Design, Future Trends in IoT.

Text Books

1. Arshdeep Bahga, Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press, ISBN-13: 978-8173719547, 1st Edition.
2. Raj Kamal, Internet of Things: Architecture and Design Principles, McGraw Hill Education, ISBN-13: 978-9353164966, 2nd Edition.
3. Srinivasa K. G., Siddesh G. M., Hanumantha Raju R., Internet of Things, Cengage Learning, ISBN-13: 978-9353501877, 1st Edition.

Reference Books:

1. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, Wiley, ISBN-13: 978-1119994350, 2nd Edition.
2. Hakima Chaouchi, The Internet of Things: Connecting Objects, Wiley-ISTE, ISBN-13: 978-1848211407, 1st Edition.
3. Jeeva Jose, Internet of Things, Khanna Publishing House, ISBN-13: 978-9386173737, 1st Edition.

NPTEL / SWAYAM Courses

1. Introduction to Internet of Things by Prof. Sudip Misra, IIT Kharagpur <https://nptel.ac.in/courses/106105166>
2. Introduction to Industry 4.0 and Industrial Internet of Things by Prof. Sudip Misra, IIT Kharagpur <https://nptel.ac.in/courses/106105195>