Minor Courses:

Sr. No.	Course code	Courses Name	Sem	Hours per week			Credit	Examination Scheme					Total
				L	T	P		ISE	ESE	TW	PR	OR	
1.	ETMNR301	Analog Electronic Circuits	III	3	--	--	3	--	75*	--	--	--	75
2.	ETMNR302	Analog Electronic Circuits Lab	III	--	--	2	1	--	--	25	--	--	25
3.	ETMNR401	Integrated circuits	IV	3	--	--	3	--	75*	--	--	--	75
4.	ETMNR402	Integrated circuits Lab	IV	--	--	2	1	--	--	25	--	--	25
5.	ETMNR501	Microcontroller and Embedded Systems	V	3	--	--	3	--	75*	--	--	--	75
6.	ETMNR502	Microcontroller and Embedded Systems Lab	V	--	--	2	1	--	--	25	--	--	25
7.	ETMNR601	VLSI	VI	3	--	--	3	--	75*	--	--	--	75
8.	ETMNR602	VLSI Lab	VI	--	--	2	1	--	--	25	--	--	25
		Total		**12**		**8**	**16**	**--**	**300**	**100**	**--**	**--**	**400**

Second Year Electronics and Telecommunications (2022 Course)
Analog Electronic Circuits ETMNR301

Course Code:	ETMNR301	Credit	3
Contact Hours:	3 Hrs/week (L)	Type of Course:	Lecture
Examination Scheme	End-sem. Examination: 75 Marks		

Pre-requisites:

Basic knowledge of Semiconductor Physics and Basic Electronics Engineering.

Course assessment methods/tools:

Sr. No.	Course assessment methods/tools	External/ Internal	Marks
1.	End Semester Examination	External	75

Course Objectives	
1	To brief about Semiconductor devices JFET & MOSFET, its characteristics, parameters & applications.
2	To discuss MOSFET DC and AC Configurations and its analysis.
3	To introduce Concepts of feedbacks in amplifiers
4	To impart skills to evaluate the performance of voltage regulator

Course Outcomes: Students will be able to	
301.1	Compare the characteristics and parameters of JFET towards its applications.
301.2	Compare the characteristics and parameters of MOSFET towards its DC circuits.
301.3	Interpret, apply & evaluate MOSFET AC circuits.
301.4	Explain MOSFET amplifiers with and without feedback
301.5	Analyze the performance of voltage regulators towards its applications.

Topics covered:

UNIT I: Junction Field Effect Transistor (JFET) (6 hrs.)

Introduction to JFET, Types, Construction, Operation, Static Characteristics, Pinch off voltage, JFET Volt-Ampere characteristics, JFET Configurations (Common Source/Common Drain/Common Gate) and their Comparison. Self-Biasing circuit of JFET

UNIT II: Metal Oxide Semiconductor FET(MOSFET) & it's DC Analysis (6 hrs.)

MOSFET operation, Construction of n-channel E-MOSFET, E-MOSFET characteristics & parameters, non-ideal voltage current characteristics i.e. Finite output resistance, body effect, sub-threshold conduction, breakdown effects and temperature effects, MOSFET DC Analysis.

UNIT III: MOSFET AC circuit Analysis (6 hrs.)

MOSFET Common Source amplifier circuit, Load Line & Modes of operation, Small signal model of MOSFET and its parameters,Analysis of Common Source amplifier circuit. Frequency Response of CS Amplifier.

UNIT IV- Feedback amplifiers (6 hrs.)
Feedback Amplifiers: Four types of amplifiers. Feedback topologies. Effect of feedback on terminal characteristics of amplifiers. Examples of voltage series and Current series FET feedback amplifiers.

UNIT V- Voltage Regulator (6 hrs.)

Voltage Regulator: Block diagram of an adjustable three terminal positive and negative regulators (317,337), Typical connection diagram, Specifications of 317 and 337

Syllabus contents required for competitive exams (GATE, UPSC, MPSC etc.)(*if completeunit is applicable then write only "unit 1/2/.." or write the contents from that unit)*:**1. NA.**

Text Books:

1.Millman Halkias, "Integrated Electronics-Analog and Digital Circuits and Systems", Tata McGraw Hill, 2000.

2.Donald Neaman, "Electronic Circuit Analysis and Design",3rd Edition, Tata McGraw Hill

3. David A.Bell,"ElectronicDevicesandCircuits",5thEdition, Oxford press

Reference Books:

1. R. L. Boylstad, L. Nashlesky, "Electronic Devices and circuitsTheory", 9thEdition, PrenticeHall of India, 2006.
2. Phillip E. Allen, Douglas R. Holberg, "CMOS Analog Circuit Design", Second Edition, Oxford.
3. K. R. Botkar, "Integrated Circuits", 5th Edition, Khanna Publication.

E- Books / E- Learning References:

1.NPTEL Course **"Analog Electronic Circuits"**
https://nptel.ac.in/courses/108/105/108105158/
2. NPTEL Course on **"Analog Circuits"**
https://nptel.ac.in/courses/108/101/108101094/

Second Year Electronics and Telecommunications (2022 Course)
Analog Electronic Circuits ETMNR302

Course Code:	ETMNR302	Credit	1
Contact Hours:	2 Hrs/week	Type of Course:	Practical
Examination Scheme	Term work 25 Marks		

Pre-requisites:
- Basic knowledge of Semiconductor Physics and Basic Electronics Engineering.

Course assessment methods/tools:

Sr. No.	Course assessment methods/tools	External/ Internal	Marks
1.	Term work	Internal	25

Course Objectives

1	To brief about Semiconductor devices JFET & MOSFET, its characteristics, parameters & applications.
2	To discuss MOSFET DC and AC Configurations and its analysis.
3	To introduce Concepts of feedback in amplifiers
4	To impart skills to evaluate the performance of voltage regulator

Course Outcomes: Students will be able to

302.1	Design and analyze analog electronic circuits.
302.2	Make use of the appropriate instrument for measurement
302.3	Implement and test the performance of the circuit.
302.4	Explain the working principle of different electronic circuits.

List of Experiments:

1.Design, build and test JFET/MOSFET voltage divider DC biasing circuit.

2.Build and test single-stage CS amplifier using MOSFET.

3.Simulate frequency response of single stage CS amplifier (use same circuit) and find the bandwidth.

4. Simulate current series feedback amplifier.

5. Design and implement an adjustable voltage regulator using three terminals voltage regulator

Second Year Electronics and Telecommunications (2022 Course)
Integrated Circuits ETMNR401

Course Code:	ETMNR401	Credit	3
Contact Hours:	3 Hrs/week (L)	Type of Course:	Lecture
Examination scheme	End-sem. Examination 75 Marks		

Pre-requisites:
　　　　Basic knowledge of Analog Electronic Circuits.

Course assessment methods/tools:

Sr. No.	Course assessment methods/tools	External/ Internal	Marks
1.	End Semester Examination	External	75

Course Objectives

1	To understand Op amp Fundamentals.
2	To know linear and nonlinear applications of operational amplifier ICs.
3	To understand Filters using op amp
4	To study and use different special purpose ICs

Course Outcomes: Students will be able to

401.1	Identify internal structure and characteristics of op-amp
401.2	Explain and analyze Linear applications of op-amp
401.3	Explain and analyze Non-linear applications of op-amp
401.4	Design active filters
401.5	Apply functionalities of Timer IC with their applications

Topics covered:

UNIT I: Op Amp Fundamentals (6 hrs.)
Block diagram of OP-AMP, Explanations of each block, Differential Amplifier configurations, Differential amplifier analysis, Need and types of level shifter, ideal parameters and practical parameters of OP-AMP and their comparison

UNIT II: Linear Applications of Op Amp(6 hrs.)
Inverting and Non-inverting amplifier, voltage follower, voltage scaling, difference amplifier, Ideal integrator, errors in ideal integrator, practical integrator, frequency response of practical integrator,Ideal differentiator, errors in ideal differentiator, practical differentiator, frequency response of practical differentiator

UNIT III: Non Linear Applications of OP amp(6 hrs.)
Comparator,Schmitt trigger (symmetrical), Square wave generator, triangular wave generator, Problems in basic rectifier, Need of precision rectifier, Half wave, Full wave precision rectifiers,

UNIT IV: Filterss (6 hrs.)
Design and frequency scaling of First order and second order Active LP, HP, BP and wide and narrow band BR Butterworth filters and notch filter. All pass filters

UNIT V: Special Purpose IC(6 hrs.)
The 555 Timer IC, Internal schematic, Astable and monostable modes of operation, Applications of IC 555

Text Books:
　　　　1.Ramakant A Gayakwad, "Op-Amps and Linear Integrated Circuits", PHI, 4th edition

2.D.Roy Choudhary, Shail Jain, "Linear Integrated Circuits", New Age Int.
press

Reference Books:

4. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", Tata McGraw Hill., Third Edition
5. G.B.Clayton, "Operational Amplifiers", International Edition.

6. K. R. Botkar, "Integrated Circuits", 5th Edition, Khanna Publication.

E- Books / E- Learning References:

1.NPTEL Course **"Integrated Circuits"**
https://nptel.ac.in/courses/108108111

Second Year Electronics and Telecommunications (2022 Course)
Integrated Circuits Lab ETMNR402

Course Code:	ETMNR402	Credit	1
Contact Hours:	2 Hrs/week	Type of Course:	Practical
Examination Scheme	Term work 25 Marks		

Pre-requisites:
- Basic knowledge of Analog Electronic Circuits.

Course assessment methods/tools:

Sr. No.	Course assessment methods/tools	External/ Internal	Marks
1.	Term work	Internal	25

Course Objectives

1	To understand Op amp Fundamentals.
2	To know linear and nonlinear applications of operational amplifier ICs.
3	To understand Filters using op amp
4	To study and use special purpose IC

Course Outcomes: Students will be able to

402.1	Design and analyze analog electronic circuits.
402.2	Make use of the appropriate instrument for measurement
402.3	Implement and test the performance of the circuit.
402.4	Explain the working principle of different electronic circuits.

List of Experiments: (any 5)

1. Measurement of Op amp DC Parameters

2. Measurement of Op amp AC Parameters

3. Simulate op-amp based Integrator

4. Design, build and test Symmetrical Schmitt Trigger circuit

5. Simulate Precision rectifiers.

6. Simulate Square wave and Triangular Wave generator

7.Simulate Active filter circuits

8. Design, build and test Astable /Monostable multivibrator using IC 555

Third Year Electronics and Telecommunications (2022 Course)
Microcontroller & Embedded System (ETMNR501)

Course Code:	ETMNR501	Credit	3
Contact Hours:	3 Hrs/week	Type of Course:	Lecture
Examination Scheme	End Semester Examination 75 Marks		

Pre-requisites:

1**.** Basic Electronics Engineering
2. Basics of C Language

Course assessment methods/tools:

Sr. No.	Course assessment methods/tools	External/ Internal	Marks
1.	End Semester Examination	External	75

Course Objectives: During the course study students will be able to

1	To explain the hardware and software design for Embedded Systems
2	To describe the practical aspects of Microcontrollers in industry

Course Outcomes: On completion of the course, Students will be able to

501.1	Describe the fundamentals of microcontroller and programming.
501.2	Interface various electronic components with microcontrollers
501.3	Explain the features of PIC 18F XXXX
501.4	Describe the programming details in peripheral support
501.5	Develop interfacing models according to applications

Topics covered:

UNIT I: Introduction to Microcontroller Architecture   (6 hrs.)

Difference between microprocessor and microcontroller Introduction to the Microcontroller classification, Comparison of PIC with ARM, Comparison of PIC family, Criteria for Choosing Microcontroller, features, PIC18FXX architecture with generalized block diagram.

UNIT II: Introduction to Embedded Systems   (6 hrs.)

Overview of Embedded System Architecture, Application areas, Categories of embedded systems, specialties of embedded systems. Recent trends in embedded systems. Brief introduction to embedded microcontroller cores CISC, RISC, ARM, DSP and SoC. Introduction to ARM processors and its versions, ARM7, ARM9 & ARM11 features, advantages & suitability in embedded application

UNIT III: PIC 18FXXX Microcontroller   (8 hrs.)

MCU, Program and Data memory organization, Bank selection using Bank Select Register, Pinout diagram. Reset operations, Watchdog Timers, Configuration registers and oscillator options (CONFIG), Power down modes, Brief summary of Peripheral support, Overview of instruction set

UNIT IV- Peripheral Support in PIC 18FXXXX   (6 hrs.)

Timers and its Programming (mode 0 &1), Interrupt Structure of PIC18F with SFR, PORTB change Interrupts, use of timers with interrupts, CCP modes: Capture, Compare and PWM generation, DC Motor speed control with CCP, Block diagram of in-built ADC with Control registers, Sensor interfacing using ADC: All programs in embedded C.

UNIT V- Real Word Interfacing With PIC 18FXXXX   (6Hrs)

Port structure with programming, Interfacing of LED, LCD and Keyboard, Motion Detectors, DAC for generation of waveform, Design of PIC test Board and debugging, Home protection System: All programs in embedded C.

Syllabus contents required for competitive exams (GATE, UPSC, MPSC etc.)(*if a complete unit is applicable then write only "unit 1/2/.." or write the contents from that unit):***1. NA.**

Text Books:

1. Raj Kamal Embedded systems Architecture, Programming and Design TMH
2. Muhammad Ali Mazidi, Danny Causey, RolinMcKinlay, "PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18", 4th Edition by, Pearson international edition
3. R.J.A. Buhr, D.L. Bailey, "An introduction to real time systems" Prentice Hall International
4. Andrew Sloss, Dominic Symes, Chris Wright, ―ARM System Developer's Guide – Designing and Optimizing System Software‖, ELSEVIER

Reference Books:

1. A. V. Deshmukh, "Microcontrollers: theory and applications", Tata Mc Graw Hill
2. Shibu K V, "Introduction to Embedded System".
3. Microchip's PIC18FXXX Data Sheet
4. Jean J.Labrosse, "Embedded system building blocks", CMP books, 2nd Edition, 1999

E- Books / E- Learning References:

1. NPTEL Course on "Microcontroller & Embedded Systems"
Link of the Course: https://onlinecourses.nptel.ac.in/noc20_ee42/preview

NPTEL LINK :
A. Different types of microcontrollers, Embedded Microcontrollers, Processor Architectures: Harvard V/S Princeton, CISC V/S RISC; microcontrollers memory types; microcontrollers features
http://nptel.ac.in/courses/108102045/
http://nptel.ac.in/courses/108102045/1
http://nptel.ac.in/courses/106108100/5

B. Introduction to PIC microcontrollers, Architecture and pipelining, program memory considerations, Addressing modes, CPU registers, Instruction set, simple operations
http://nptel.ac.in/courses/108102045
http://nptel.ac.in/courses/108102045/3
http://nptel.ac.in/courses/108102045/4

C. Microcontroller 8051- Architecture, Pin Diagram, I/O Ports, Internal RAM and Registers, Interrupts, Addressing Modes, Memory Organization and External Addressing, Instruction Set, Assembly Language Programming
http://nptel.ac.in/courses/108102045
http://nptel.ac.in/courses/106108100/6
http://nptel.ac.in/courses/106108100/7

D. Classification, Processors, Hardware Units, Software Embedded into System, Applications and Products of Embedded Systems, Structural Units in Processor, Memory Devices, I/O Devices, Buses, Interfacing of Processor Memory and I/O Devices
http://nptel.ac.in/courses/108102045/28
http://nptel.ac.in/courses/108102045
http://nptel.ac.in/courses/108102045/
http://nptel.ac.in/courses/108102045/29
http://nptel.ac.in/courses/108102045/30
http://nptel.ac.in/courses/108102045/31
http://nptel.ac.in/courses/108102045/35

Third Year Electronics and Telecommunications (2022 Course)			
Microcontroller & Embedded System Lab (ETMNR502)			
Course Code:	**ETMNR502**	**Credit**	**1**
Contact Hours:	2 Hrs/week	**Type of Course:**	**Practical**
Examination Scheme	Term work 25 Marks		

Pre-requisites:

      1**.** Basic Electronics Engineering
      2. Basics of C Language

Course assessment methods/tools:

Sr. No.	Course assessment methods/tools	External/ Internal	Marks
1.	Term work	Internal	25

Course Objectives : During the course study students will be able to

1	To explain the hardware and software design of Embedded Systems
2	To describe the practical aspects of Microcontrollers in industry

Course Outcomes: On completion of the course, Students will be able to

502.1	Describe the fundamentals of microcontroller and programming.
502.2	Interface various electronic components with microcontrollers
502.3	Explain the features of PIC 18F XXXX
502.4	Describe the programming details in peripheral support
502.5	Develop interfacing models according to applications

List of Experiments: Minimum 3 experiments each from A and B section

  A. PIC Microcontroller: (PIC18F4550)
  1.   To write a program interfacing button, LED, relay and buzzer as follows:

  a. On pressing button1 relay and buzzer is turned ON and LED's start chasing from left to right.
  b. On pressing button2 the relay and buzzer is turned OFF and the LED starts chasing from right to left.
  2.   Interfacing of 16X2 LCD to PIC18FXXXX
  3.   Interfacing 4X4 keypad and displaying key pressed on LCD.
  4.   Generate square wave using timer with interrupt
  5.   Interface analog voltage 0-5V to internal ADC and display value on LCD
  6.   Generation of PWM signal for DC Motor control

Beyond syllabus: Virtual Lab Practicals: Real Time Embedded Systems Lab: Any 3

    1.   DF-Part3: MCU-DAC interfacing and generation of ramp wave

    http://vlabs.iitkgp.ac.in/rtes/exp3/index.html

    2.   DF-Part4: Interfacing of ADC and data transfer by software polling, study of aliasing http://vlabs.iitkgp.ac.in/rtes/exp4/index.html#

    3.   DF-Part5: ADC triggering through timer (On Chip Timer)
    http://vlabs.iitkgp.ac.in/rtes/exp5/index.html

    4.   DF-Part6: Interrupt driven data transfer from ADC
    http://vlabs.iitkgp.ac.in/rtes/exp6/index.html#

    5.   SM-Part1: LCD - MCU interfacing and displaying a string

http://vlabs.iitkgp.ac.in/rtes/exp8/index.html#

6.   SM-Part2 Keyboard-MCU interfacing take a input from keypad and display on LCD http://vlabs.iitkgp.ac.in/rtes/exp9/index.html

Virtual LAB Links: Real Time Embedded Systems Lab

http://vlabs.iitkgp.ac.in/rtes/index.html#

Third Year Electronics and Telecommunications (2022 Course)
VLSI (Minor) ETMNR601

Course Code:	ETMNR601	Credit	3
Contact Hours:	3 Hrs/week (L)	Type of Course:	Lecture
Examination Scheme	End-sem. Examination: 75 Marks		

Pre-requisites:

Basic knowledge of Semiconductor Physics and Basic Electronics Engineering.

Course assessment methods/tools:

Sr. No.	Course assessment methods/tools	External/ Internal	Marks
1.	End Semester Examination	External	75

Course Objectives

1	To explore VHDL and respective digital design methodologies.
2	To overview ASIC issues and understand PLD architectures with advanced features.
3	To realize importance of testability in logic circuit design..
4	To train the students for CMOS circuit designs.

Course Outcomes: Students will be able to

601.1	Design Digital systems using VHDL programming.
601.2	Implement VLSI Design Flow using FPGAs
601.3	Design CMOS based digital circuits.
601.4	Analyze various constraints in design of CMOS based circuits.
601.5	Apply knowledge of testability in design.

Topics covered:

UNIT I: VHDL Design (6 hrs.)

Design Flow, Language constructs, Data objects, Data types, Entity, Architecture & types of modelling, Sequential statements, Concurrent statements, Packages, Sub programs, Attributes, HDL modelling of Combinational, Sequential circuits and FSM. Simulations, Synthesis.

UNIT II: PLD Architectures and applications (6 hrs.)

Design Flow. CPLD Architecture, Features, Specifications, Applications. FPGA Architecture, Features, Specifications, Applications.

UNIT III- Basic MOS Theory (6 hrs.)

MOS transistor theory, MOSFET scaling and small geometry effects, MOSFET capacitances. CMOS inverter, DC characteristics, static load MOS inverter, pull up/pull down ratio, static & dynamic power dissipation, CMOS & NMOS process technology – explanation of different stages in fabrication, body effect.

UNIT IV- Digital CMOS circuits and Issues (6 hrs.)

Stick diagram and design rules, lambda based design rules, switching characteristics & inter connection effects: rise time, fall time delays, noise margin. CMOS logic gate design: NAND, NOR, XOR and XNOR gates, Transistor sizing, combinational MOS logic circuits: pass transistor and transmission gate designs, Pseudo NMOS logic.

UNIT V: VLSI Testing and Analysis (6 hrs.)

Types of fault, Need of Design for Testability (DFT), DFT Guideline, Testability, Fault models, Path sensitizing, Test pattern generation, Sequential circuit test, Built-in Self Test, JTAG & Boundary scan, TAP Controller.

Syllabus contents required for competitive exams (GATE, UPSC, MPSC etc.)(*if complete unit is applicable then write only "unit 1/2/.." or write the contents from that unit):*1. NA.

Text Books:

[T1]	E. Weste, David Money Harris, "CMOS VLSI Design: A Circuit &System Perspective", Pearson Publication.
[T2]	R. Jacob Baker, "CMOS Circuit Design, Layout, and Simulation", 3E, Wiley-IEEE Press
[T3]	Low Power Design Methodologies by J. M. Rabaey, M.Pedram, KAP.

Reference Books:

[R1]	John F. Wakerly, "Digital Design Principles and Practices" , 3E, Prentice Hall
[R2]	M. Morris Mano , "Digital Design", 3E , Pearson.
[R3]	CemUnsalan, Bora Tar, "Digital System Design with FPGA: Implementation Using Verilog and VHDL", McGraw-Hill

E- Books / E- Learning References:

CMOS Digital VLSI Design: CMOS Digital VLSI Design - Course (nptel.ac.

Third Year Electronics and Telecommunications (2022 Course)
VLSI Lab (Minor) ETMNR602

Course Code:	ETMNR602	Credit	1
ConHours:	2 Hrs/week	Type of Course:	Practical
Examination Scheme	Term work 25 Marks		

Pre-requisites:
- Basic knowledge of Semiconductor Physics and Basic Electronics Engineering.

Course assessment methods/tools:

Sr. No.	Course assessment methods/tools	External/ Internal	Marks
1.	Term work	External	25

Course Objectives

1	To explore VHDL and respective digital design methodologies.
2	To overview ASIC issues and understand PLD architectures with advanced features.
3	To realize importance of testability in logic circuit design.
4	To train the students for CMOS circuit designs.

Course Outcomes: Students will be able to

602.1	Design and implement Digital systems VHDL coding.
602.2	Implement VLSI Design Flow using FPGAs.
602.3	Design CMOS based digital circuits by applying CMOS technology specific layout rules.
602.4	Analyze various issues and constraints in design of CMOS based circuits.

List of Experiments:

A. To write VHDL code, simulate with test bench, synthesis, implement on PLD.
    1. 4 bit ALU for add, subtract, AND, NAND, XOR, XNOR, OR, & ALU pass.
    2. Universal shift register with mode selection input for SISO, SIPO, PISO, & PIPO modes.
    3. FIFO memory.
    4. Mod 5 counter
    5. D flip flop
B. To prepare CMOS layout in selected technology, simulate with and without capacitive load, comment on rise, and fall times.
    1. Inverter, NAND, NOR gates
    2. Half Adder
    3.2:1 Multiplexer using transmission gates.
    4. Single bit SRAM cell