EVALUATION SCHEME & SYLLABUS

FOR

B. TECH. THIRD YEAR

ELECTRONICS AND COMMUNICATION ENGINEERING

AS PER

AICTE MODEL CURRICULUM

[Effective from the Session: 2024-25]

B.Tech. V Semester
Electronics and Communication Engineering

S. No.	Course Code	Course Title	Periods			Evaluation Scheme				End Semester		Total	Credits
			L	T	P	CT	TA	Total	PS	TE	PE		
1	IEC-501	Integrated Circuits	3	1	0	30	20	50		100		150	4
2	IEC-502	Microprocessor & Microcontroller	3	1	0	30	20	50		100		150	4
3	IEC-503	Principles of Communication	3	1	0	30	20	50		100		150	4
4	IEC-051–054	Department Elective-I	3	0	0	30	20	50		100		150	3
5	IEC-055-058	Department Elective-II	3	0	0	30	20	50		100		150	3
6	IEC-551	Integrated Circuits Lab	0	0	2				25		25	50	1
7	IEC-552	Microprocessor & Microcontroller Lab	0	0	2				25		25	50	1
8	IEC-553	Communication Engineering Lab I	0	0	2				25		25	50	1
9	IEC-554	Mini Project/Internship **	0	0	2				50			50	1
10		MOOCs (Essential for Hons. Degree)											
		Total										**950**	**22**

**The Mini Project or Internship (4weeks) conducted during summer break after IV Semester and will be assessed during Vth Semester.

Course Code	Course Title
	Department Elective-I
IEC-051	Digital Signal Processing
IEC-052	Industrial Electronics
IEC-053	VLSI Technology
IEC-054	Advance Digital Design using Verilog
	Department Elective-II
IEC-055	Optical Communication
IEC-056	Advance Semiconductor Device
IEC-057	Analog Signal Processing
IEC-058	Designing with ASIC

B.Tech. VI Semester
Electronics and Communication Engineering

S. No.	Course Code	Course Title	Periods			Evaluation Scheme				End Semester		Total	Credits
			L	T	P	CT	TA	Total	PS	TE	PE		
1	IEC-601	Digital Communication	3	1	0	30	20	50		100		150	4
2	IEC-602	Control System	3	1	0	30	20	50		100		150	4
3	IEC-603	Microwave and RADAR Engineering	3	1	0	30	20	50		100		150	4
4	IEC061-IEC065	Department Elective–III	3	0	0	30	20	50		100		150	3
5		Open Elective-I	3	0	0	30	20	50		100		150	3
6	IEC-651	Communication Engineering Lab II	0	0	2				25		25	50	1
7	IEC-652	Control System Lab	0	0	2				25		25	50	1
8	IEC-653	Microwave and Antenna Design Lab	0	0	2				25		25	50	1
9		MOOCs (Essential for Hons. Degree)											
		Total										**900**	**21**

Course Code	**Course Title**
	Department Elective-III
IEC-061	Microcontroller & Embedded System Design
IEC-062	Satellite Communication
IEC-063	Data Communication Networks
IEC-064	Antenna Theory and Design

B.Tech 3rd Year
V Semester
Syllabus

IEC-501	INTEGRATED CIRCUITS	3L:1T:0P	4 Credits

Unit	Topics	Lectures
I	**The 741 IC Op-Amp**: General operational amplifier stages (bias circuit, the input stage, the second stage, the output stage, short circuit protection circuitry), device parameters, DC and AC analysis of input stage, second stage and output stage, gain, frequency response of 741, a simplified model, slew rate, relationship between ft and slew rate.	8
II	**Linear Applications of IC Op-Amps:** Op-Amp based V-I and I-V converters, instrumentation amplifier, generalized impedance converter, simulation of inductors. **Active Analog filters:** Sallen Key second order filter, Designing of second order low pass and high pass Butterworth filter, Introduction to band pass and band stop filter, all pass active filters, KHN Filters. Introduction to design of higher order filters.	8
III	**Frequency Compensation & Nonlinearity:** Frequency Compensation, Compensation of two stage Op-Amps, Slewing in two stage Op-Amp. Nonlinearity of Differential Circuits, Effect of Negative feedback on Nonlinearity. **Non-Linear Applications of IC Op-Amps:** Basic Log–Anti Log amplifiers using diode and BJT, temperature compensated Log-Anti Log amplifiers using diode, peak detectors, sample and hold circuits. Op-amp as a comparator and zero crossing detector, astable multivibrator & monostable multivibrator. Generation of triangular waveforms, analog multipliers and their applications.	4 8
IV	**Digital Integrated Circuit Design:** An overview, CMOS logic gate circuits basic structure, CMOS realization of inverters, AND, OR, NAND and NOR gates. **Latches and Flip flops**: the latch, CMOS implementation of SR flip-flops, a simpler CMOS implementation of the clocked SR flip-flop, CMOS implementation of J-K flip-flops, D flip- flop circuits.	6
V	**Integrated Circuit Timer:** Timer IC 555 pin and functional block diagram, Monostable and Astable multivibrator using the 555 IC. Voltage Controlled Oscillator: VCO IC 566 pin and functional block diagram and applications. **Phase Locked Loop (PLL)**: Basic principle of PLL, block diagram, working, Ex-OR gates and multipliers as phase detectors, applications of PLL.	6

Text Book:

1. Microelectronic Circuits, Sedra and Smith, 7th Edition, Oxford, 2017.
2. Behzad Razavi: Design of Analog CMOS Integrated Circuits, TMH

Reference Books:

1. Gayakwad: Op-Amps and Linear Integrated Circuits, 4th Edition Prentice Hall of India, 2002.
2. Franco, Analog Circuit Design: Discrete & Integrated, TMH, 1st Edition.
3. Salivahnan, Electronics Devices and Circuits, TMH, 3rd Edition, 2015
4. Millman and Halkias: Integrated Electronics, TMH, 2nd Edition, 2010

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Explain complete internal analysis of Op-Amp 741-IC.
2. Examine and design Op-Amp based circuits and basic components of ICs such as various types of filter.
3. Implement the concept of Op-Amp to design Op-Amp based non-linear applications and wave-shaping circuits.
4. Analyse and design basic digital IC circuits using CMOS technology.
5. Describe the functioning of application specific ICs such as 555 timer ,VCO IC 566 and PLL.

IEC-502	MICROPROCESSOR & MICROCONTROLLER	3L:1T:0P	4 Credits

Unit	Topics	Lectures
I	**Introduction to Microprocessor:** Microprocessor architecture and its operations, Memory, Input & output devices, The 8085 MPU- architecture, Pins and signals, Timing Diagrams, Logic devices for interfacing, Memory interfacing, Interfacing output displays, Interfacing input devices, Memory mapped I/O.	8
II	**Basic Programming concepts**:, Flow chart symbols, Data Transfer operations, Arithmetic operations, Logic Operations, Branch operation, Writing assembly language programs, Programming techniques: looping, counting and indexing. Additional data transfer and 16 bit arithmetic instruction, Logic operation: rotate, compare, counter and time delays, 8085 Interrupts.	8
III	**16-bit Microprocessors (8086):** Architecture, Pin Description, Physical address, segmentation, memory organization, Addressing modes. **Peripheral Devices:** 8237 DMA Controller, 8255 programmable peripheral interface, 8253/8254programmable timer/counter, 8259 programmable interrupt controller, 8251 USART and RS232C.	8
IV	**8051 Microcontroller Basics**: Inside the Computer, Microcontrollers and Embedded Processors, Block Diagram of 8051, PSW and Flag Bits, 8051 Register Banks and Stack, Internal Memory Organization of 8051, IO Port Usage in 8051, Types of Special Function Registers and their uses in 8051, Pins Of 8051. Memory Address Decoding, 8031/51 Interfacing With External ROM And RAM. 8051 Addressing Modes.	8
V	**Assembly programming and instruction of 8051:** Introduction to 8051 assembly programming, Assembling and running an 8051 program, Data types and Assembler directives, Arithmetic, logic instructions and programs, Jump, loop and call instructions, IO port programming. Programming 8051 Timers. Serial Port Programming, Interrupts Programming, **Interfacing:** LCD & Keyboard Interfacing, ADC, DAC & Sensor Interfacing, External Memory Interface, Stepper Motor and Waveform generation.	8

Text Books:

1. Ramesh Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", 6th Edition, Penram International Publication (India) Pvt. Ltd.,2013
2. D. V. Hall : Microprocessors Interfacing, TMH 3rd Edition,
3. Mazidi Ali Muhammad, Mazidi Gillispie Janice, and McKinlay Rolin D., "The 8051 Microcontroller and Embedded Systems using Assembly and C", Pearson, 2nd Edition,2006

Reference Books:

1. Kenneth L. Short, "Microprocessors and programmed Logic", 2nd Ed, Pearson Education Inc.,2003
2. Barry B. Brey, "The Intel Microprocessors, 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, PentiumPro Processor, PentiumII, PentiumIII, Pentium IV, Architecture, Programming & Interfacing", Eighth Edition, Pearson Prentice Hall, 2009.
3. Shah Satish, "8051 Microcontrollers MCS 51 Family and its variants", Oxford,2010

Course Outcomes: At the end of this course students will demonstrate the ability to

1. Demonstrate the basic architecture of 8085.
2. Illustrate the programming model of microprocessors & write program using 8085 microprocessor.
3. Demonstrate the basics of 8086 Microprocessor and interface different external Peripheral Devices like timer, USART etc. with Microprocessor (8085/8086).
4. Compare Microprocessors & Microcontrollers, and comprehend the architecture of 8051 microcontroller
5. Illustrate the programming model of 8051 and implement them to design projects on real time problems.

IEC-503	PRINCIPLE OF COMMUNICATION	3L:1T:0P	4 Credits

Unit	Topics	Lectures
I	**Random Variables:** Concept of Probability, Random variables, Statistical averages, Random process, Power Spectral Density & Autocorrelation Function of Random Processes, Gaussian Random Process.	10
II	Overview of Communication system, Communication channels, Need for modulation, Baseband and Pass band signals, Amplitude Modulation: Double sideband with Carrier (DSB-C), Double side band without Carrier DSB-SC, Single Side Band Modulation SSB, Modulators and Demodulators, Vestigial Side Band (VSB), Quadrature Amplitude Modulator, Radio Transmitter and Receiver.	
III	Pulse Modulation, Digital Transmission of Analog Signals: Sampling Theorem and its applications, Pulse Amplitude Modulation (PAM), Pulse Width Modulation, Pulse Position Modulation, Their generation and Demodulation, Digital Representation of Analog Signals Pulse Code Modulation (PCM), PCM System	8
IV	Differential Pulse Code Modulation, Delta Modulation. Adaptive Delta Modulation, Voice Coders, Sources of Noises, Frequency domain representation of Noise, Super position of Noises, Linear filtering of Noises, Mathematical Representation of Noise.	8
V	Noise in Amplitude Modulation: Analysis, Signal to Noise Ratio, Figure of Merit. Noise in Frequency Modulation: Pre-emphasis, De-Emphasis and SNR Improvement, Phase Locked Loops Analog and Digital. Issues in digital transmission: Frequency Division Multiplexing Time Division Multiplexing, T1 Digital System, TDM Hierarchy.	8

Text Book: 1. Herbert Taub and Donald L. Schilling, "Principles of Communication Systems", Tata McGraw Hill. 2. Rishabh Anand, Communication Systems, Khanna Publishing House, Delhi

Reference Books: 1. B.P.Lathi,"ModernDigitalandAnalogcommunicationSystems",3rd Edition, Oxford University Press. 2. Simon Haykin, "Communication Systems", 4th Edition, Wiley India. 3. H.P.Hsu& D. Mitra "Analog and Digital Communications", 2nd Edition, Tata McGraw-Hill.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Understand the fundamentals of communication systems, including modulation techniques, and analyze the functioning of radio transmitters and receivers.
2. Apply pulse modulation techniques and understand the digital transmission of analog signals.
3. Analyze differential pulse code modulation techniques and its effects on communication systems.
4. Evaluate advanced modulation techniques and noise sources, including their frequency domain representation and filtering.
5. Analyze the impact of noise on amplitude and frequency modulation systems, and understand techniques for SNR improvement and phase-locked loops.

IEC-051	DIGITAL SIGNAL PROCESSING	3L:0T:0P	4 Credits

Unit	Topics	Lectures
I	**Introduction to Digital Signal Processing**: Basic elements of digital signal processing, advantages and disadvantages of digital signal processing, Technology used for DSP. **Realization of Digital Systems**: Introduction- basic building blocks to represent a digital system, recursive and non-recursive systems, basic structures of a digital system: Canonic and Non-Canonic structures. **IIR Filter Realization**: Direct form, cascade realization, parallel form realization, Ladder structures- continued fraction expansion of H (z), example of continued fraction, realization of a ladder structure, design examples. **FIR Filter Realization**: Direct, Cascade, FIR Linear Phase Realization and design examples.	8
II	**Infinite Impulse Response Digital (IIR) Filter Design:** Introduction to Filters, Impulse Invariant Transformation, Bi-Linear Transformation, All- Pole Analog Filters: Butterworth and Chebyshev, Design of Digital Butterworth and Chebyshev Filters, Frequency Transformations.	8
III	**Finite Impulse Response Filter (FIR) Design**: Windowing and the Rectangular Window, Gibb's phenomenon, Other Commonly Used Windows (Hamming, Hanning, Bartlett, Blackmann, Kaiser), Examples of Filter Designs Using Windows. **Finite Word length effects in digital filters**: Coefficient quantization error, Quantization noise – truncation and rounding, Limit cycle oscillations-dead band effects.	8
IV	**DFT & FFT**: Definitions, Properties of the DFT, Circular Convolution, Linear Convolution using Circular Convolution, Decimation in Time (DIT) Algorithm, Decimation in Frequency (DIF) Algorithm.	8
V	**Multirate Digital Signal Processing (MDSP)**: Introduction, Decimation, Interpolation, Sampling rate conversion: Single and Multistage, applications of MDSP- Subband Coding of Speech signals, Quadrature mirror filters, Advantages of MDSP.	8

Text Books:

1. John G Prokias, Dimitris G Manolakis, Digital Signal Processing. Pearson , 4th Edition, 2007
2. Johnny R. Johnson, Digital Signal Processing, PHI Learning Pvt Ltd., 2009.
3. S. Salivahanan, A. Vallavaraj, Digital Signal Processing, TMH, 4th Edition 2017.
4. Oppenheim & Schafer, Digital Signal Processing. Pearson Education 2015
5. S.K. Mitra, 'Digital Signal Processing–A Computer Based Approach, TMH, 4th Edition.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Design and describe different types of realizations of digital systems (IIR and FIR) and their utilities.
2. Select design parameters of analog IIR digital filters (Butterworth and Chebyshev filters) and implement various methods such as impulse invariant transformation and bilinear transformation of conversion of analog to digital filters.
3. Design FIR filter using various types of window functions.
4. Define the principle of discrete Fourier transform & its various properties and concept of circular and linear convolution. Also, students will be able to define and implement FFT i.e. a fast computation method of DFT.
5. Define the concept of decimation and interpolation. Also, they will be able to implement it in various practical applications.

IEC-052	INDUSTRIAL ELECTRONICS	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Introduction to Power Switching Devices:** Description of working & constructional features, Switching Characteristics, ratings and Applications of Power Transistor, Power MOSFET, SCR, DIAC, TRIAC, IGBT and MCT.	8
II	**SCR Performance and Applications:** Protection of SCR, SCR Triggering and Commutation Circuits/Methods, Series and Parallel operation of SCR, two transistor model of SCR, , Describe Construction & Working of Opto- Isolators, Opto-TRIAC, Opto-SCR.	8
III	**Power Converter Performance & Applications:** Introduction to Basic Power Converters Architecture - Single Phase, there performance under different types of Loads, Average/RMS output Voltage & Current, Freewheeling Diode, Feedback Diode, State Relay using Opto SCR, SMPS and UPS functioning through Block Diagrams.	8
IV	**Timers & Delay Elements, High Frequency Power Heating, Sensor and Actuators:** RC Base Constant Timers, Timer Circuits using SCR, IC-555, Programmable Timer and their Industrial Applications, Induction Heating and Dielectric Heating System and Their Applications, Sensors, Transducers, and Transmitters for Measurement, Control & Monitoring : Thermoresistive Transducer, Photoconductive Transducers, Pressure Transducers, Flow Transducers, Level Sensors, Speed Sensing, Vibration Transducers, Variable-Frequency Drives, Stepper Motors and Servomotor Drives.	8
V	**Automation and Control:** Data Communications for Industrial Electronics, Telemetry, SCADA & Automation, AC & DC Drives, Voltage & Power Factor Control through Solid State Devices, Soft Switching, Industrial Robots.	8

Text Books:

1. M.H. Rashid, "Power Electronics: Circuits, Devices & Applications", Pearson, 4rd Edition, 2013.
2. P.C.Sen, "Power Electronics", McGraw Hill Education (India) Pvt. Ltd 2nd Ed, 2017
3. V.R. Moorthy, "Power Electronics: Devices, Circuits and Industrial Applications" Oxford University Press, 2007.
4. B. Paul, Industrial Electronic and Control, Prentice Hall of India Private Limited (2004).
5. Ned Mohan, T.M. Undeland and W.P. Robbins, "Power Electronics: Converters, Applications and Design", Wiley India Ltd, 2008.
6. P.S. Bhimbra, "Power Electronics", Khanna Publishers.

Reference Books:

1. Thomas E. Kissell, Industrial Electronics: Applications for Programmable Controllers, Instrumentation and Process Control, and Electrical Machines and Motor Controls, 3rd edition, 2003, Prentice Hall.
2. Chakrabarti & Rai, "Fundamentals of Power Electronics & Drives" Dhanpat Rai & Sons.
3. S.N.Singh, "A Text Book of Power Electronics" Dhanpat Rai &Sons.
4. G.K. Dubey, Power Semiconductor Controlled Drives, Prentice Hall inc. (1989).

Course Outcomes: At the end of this course students will be able to:

1. Describe the characteristics, operation of power switching devices and identify their ratings and applications.
2. Recognize the requirement of SCR Protection and describe the Functioning of SCR.
3. Analyze and design Power Converter based on SCR for various Industrial Applications.
4. Explain High Frequency Heating Systems, Timers, Relevant Sensors & Actuator and their application in industrial setting.
5. Explain and apply Data Communication, Telemetry & SCADA System in industrial applications.

IEC-053	VLSI TECHNOLOGY	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Introduction To IC Technology:** SSI, MSI, LSI, VLSI Integrated Circuits. Crystal Growth and Wafer Preparation: Electronic Grade Silicon, Czochralski Crystal Growth, Silicon Shaping, Processing Considerations. Wafer Cleaning Technology - Basic Concepts, Wet cleaning, Dry cleaning	8
II	**Epitaxy:** Vapor-Phase Epitaxy, Molecular Beam Epitaxy, Silicon on Insulators, Epitaxial Evaluation. **Oxidation:** Growth Kinetics, Thin Oxides, Oxidation Techniques and Systems, Oxides Properties.	8
III	**Lithography:** Optical Lithography, Electron beam lithography, Photo masks, Wet Chemical Etching. **Dielectric and Polysilicon Film Deposition:** Deposition Processes of Polysilicon, Silicon Dioxide, Silicon Nitride.	8
IV	**Diffusion:** Models of diffusion in solids, Fick's 1-Dimensional diffusion equation, Diffusion of Impurities in Silicon and Silicon Dioxide, Diffusion Equations, Diffusion Profiles, Diffusion Furnace, Solid, Liquid and Gaseous Sources, **Ion-Implantation:** Ion-Implantation Technique, Range Theory, Implantation Equipment.	8
V	**Metallization:** Metallization Application, Metallization Choices, Physical Vapor Deposition, Vacuum Deposition, Sputtering Apparatus. **Packaging of VLSI devices**: Package Types, Packaging Design Consideration, VLSI Assembly Technologies, Package Fabrication Technologies, CMOS fabrication steps.	8

Text Books:

1. S. M. Sze, "VLSI Technology", McGraw Hill Publication, 2nd Edition 2017
2. S.K. Ghandhi, "VLSI Fabrication Principles", Willy-India Pvt. Ltd, 2008

Reference Books:

1. J. D. Plummer, M. D. Deal and Peter B. Griffin, "Silicon VLSI Technology: Fundamentals, Practice and Modeling", Pearson Education Publication, 2009
2. Stephen A. Campbell, "Fabrication Engineering at the Micro and Nano scale", Oxford University Press, 2013

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Interpret the basics of crystal growth, wafer preparation and wafer cleaning.
2. Evaluate the process of Epitaxy and oxidation.
3. Differentiate the lithography, etching and deposition process.
4. Analyze the process of diffusion and ion implantation
5. Express the basic process involved in metallization and packaging.

IEC 054	ADVANCED DIGITAL DESIGN USING VERILOG	3L:0T:0P	3 Credits

Unit	Topic	Lectures
I	Introduction to Mixed Logic, Logic Representation and Minimization with cost, Multiple output minimization, Entered Variable K- Map including don't care handling, XOR Pattern Handling.	8
II	Combinational Circuit Design, Multiplexers, Decoders, Encoders, Code Comparators, Adders, Subtractors, Multipliers, Introduction to Verilog, Behavioral and Structural specification of logic circuits, Boolean function implementation using Verilog, Timing Analysis, Hazard Detection and Elimination	8
III	Synchronous Sequential Circuits Design, Mapping Algorithm, Synchronous State Machines, ASM Charts, Asynchronous Sequential Circuit Design, Races, Multi-level minimization and optimization.	8
IV	Factoring, Decomposition, BDD, Ordered BDD, LPDD, Fault Detection and Analysis incombinational and sequential systems, Path Sensitization method, Boolean Difference Method, Initial State Method.	8
V	Study of programmable logic families, PLD, CPLD, FPGA, ASIC, PLA, Architectures,Design of Combinational and sequential circuits using CPLD and FPGA, Design Examples.	8

Text Books:

1. Richard F. Tinder, "Engineering Digital Design", Academic Press.
2. Parag K. Lala, "Digital system Design Using PLDs", PHI India Ltd.
3. Stephen Brown and ZvonkoVranesiv, "Fundamental of Digital Logic with Verilog Design", Tata McGraw Hill.

Reference Books:

1. John Williams, "Digital VLSI Design with Verilog", Springer Publication..
2. Samuel C. Lee, "Digital Circuit and Logic Design", PHI India Ltd.
3. Alexander Miczo, "Digital Logic Testing and Simulation",Wiley Interscience.

COURSE OUTCOME: After completion of the course student will be able to

1. Describe mixed logic circuits and their implementation.
2. Implement combinational circuits using mixed logic and Verilog.
3. Design sequential circuits using mixed logic and Verilog with mapping of Algorithm.
4. Understand faults and its elimination in sequential and combinational circuits.
5. Understand the working of programmable logic families.

IEC-055	OPTICAL COMMUNICATION	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Introduction to Optical Communication:** Optical Spectral Band with Operating Windows, General Communication System, Optical Communication System with its advantages. **Optical Fiber Waveguides:** Ray Theory of Transmission with TIR, Acceptance Angle, Numerical Aperture and Skew Rays, Electromagnetic Mode Theory for Optical Propagation, Modes in a Planar Guide, Phase and Group Velocity, Phase Shift with Total Internal Reflection, Evanescent Field, Goos-Haenchen Shift, Cylindrical Fiber Modes, Mode Coupling, Step Index fibers Vs Graded Index fibers, Single Mode Fibers- Cut off wavelength, MFD & Spot Size.	08
II	**Signal Loss in Optical Fibers:** Attenuation, Material Absorption Losses (Intrinsic and Extrinsic absorption), types of Linear and Non-Linear Scattering Losses, Fiber Bending Losses, Kerr Effect. **Dispersion:** Introduction with its types: Chromatic / Intramodal Dispersion (Material and Waveguide Dispersion), Intermodal dispersion (for MSI and MGI fibers), Overall (Total) Fiber Dispersion in Multimode and Singe Mode Fiber, Dispersion Modified Single Mode Fibers, Polarization & Fiber Birefringence.	08
III	**Optical Sources: LEDs-**Introduction to LEDs & Materials used for fabrication, LED Power and Efficiency, LED Structures, LED Characteristics, Modulation Bandwidth. **Laser Diodes-**Introduction, Optical Feedback & Laser Oscillations, Resonant Frequencies, Laser Modes, and Threshold Condition for Laser Oscillation, Laser Diode Rate Equations, Semiconductor injection Laser- Efficiency, Laser Single Mode operation, Reliability of LED & ILD.	08
IV	**Power Launching in Fiber:** Source to Fiber Power Launching and Coupling Techniques, Power Launching Vs Wavelength, Equilibrium Numerical Aperture. **Photo Detectors:** Introduction, Physical Principles of Photodiodes: The PIN Photo Detector, Avalanche Photodiodes, Temperature Effect on Avalanche Gain, Detector Response Time, Photo Detector Noise: Noise Sources, Signal to Noise Ratio, Comparison of Photo Detectors, Fundamental Receiver Operation with Digital Signal Transmission.	08
V	**Digital Receiver Performance:** Probability of Error / BER, Receiver Sensitivity & The Quantum Limit, Error Control Techniques, Eye Diagram Pattern Features, Coherent Detection: Homodyne Detection and Heterodyne Detection, Digital links: Point to Point Links, Power Penalties, Multichannel & Multiplexing Transmission Techniques, basic concept of Free Space Optics (FSO) based Communication System.	08

Text Book:

1. John M. Senior, "Optical Fiber Communications", Pearson, 3rd Edition, 2010.
2. Gerd Keiser, "Optical Fiber Communications", McGraw Hill, 5th Edition, 2013.
3. Govind P. Agrawal, "Fiber Optic Communication Systems", John Wiley, 3rd Edition, 2004.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Define and explain the basic concepts and theory of optical communication.
2. Describe the signal losses with their computation and dispersion mechanism occurring inside the optical fiber cable.
3. Differentiate the optical sources used in optical communication with their comparative study.
4. Identify different optical components on receiver side; assemble them to solve real world problems related to optical communication systems.

Evaluate the performance of an optical receiver to get idea about power budget and ultimately be an engineer with adequate knowledge in optical domain.

IEC-056	ADVANCE SEMICONDUCTOR DEVICES	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Physics and Properties of Semiconductors:** Introduction, Crystal Structure, Energy Bands and Energy Gap, Carrier Concentration at Thermal Equilibrium, Carrier-Transport Phenomena. Phonon, Optical, and Thermal Properties, Heterojunctions and Nanostructures, Basic Equations and Examples. *p-n* Junctions, Introduction, Depletion Region, Current-Voltage Characteristics, Junction Breakdown, Transient Behavior and Noise, Terminal Functions, Heterojunctions. Metal-Semiconductor Contacts, Metal-Insulator - Semiconductor Capacitors.	8
II	**Bipolar Transistors:** Static Characteristics, Microwave Characteristics, Related Device Structures, Heterojunction Bipolar Transistor. **MOSFETs:** Basic Device Characteristics, Nonuniform Doping and Buried-Channel Device, Device Scaling and Short-Channel Effects, MOSFET Structures, Circuit Applications, Nonvolatile Memory Devices, Single-Electron Transistor. JFETs, MESFETs, and MODFETs	8
III	**Tunnel Devices:** Tunnel Diode, Related Tunnel Devices, Resonant-Tunneling Diode. **IMPATT Diodes:** Static Characteristics, Dynamic Characteristics, Power and Efficiency, Noise Behavior, Device Design and Performance, BARITT Diode, TUNNETT Diode.	8
IV	Transferred-Electron and Real-Space-Transfer Devices Thyristors and Power Devices **Photonic Devices and Sensors:** Radioative Transitions, Light-Emitting Diode (LED), Laser Physics, Laser Operating Characteristics, Specialty Lasers.	8
V	**Photodetectors and Solar Cells:** Photoconductor, Photodiodes, Avalanche Photodiode, Phototransistor, Charge-Coupled Device (CCD), Metal-emiconductor-Metal Photodetector, Quantum-Well Infrared Photodetector, Solar Cell. Sensors: Thermal Sensors, Mechanical Sensors, Magnetic Sensors, Chemical Sensors.	8

Text Book:

1. S. M. Sze, Kwok K. NG, "Physics of Semiconductor Devices", 3rd edition, Wiley Publication, 2015
2. Jacob Millman, Christos C. Halkias, Satyabrata Jit, Electronic Devices and Circuits. Publisher: TMH, 4th edition 2015.
3. Ben G. Streetman & S K Banerjee, Solid State Electronic Devices, Pearson 7th Edition, 2015
4. Pierret, Robert F., Semiconductor device fundamentals. 2nd Edition, Pearson Education India, 2015.

Course Outcomes: At the end of this course students will able to

1. Explain the behavior of BJT and MOSFET in DC biasing and as CE amplifier circuit.
2. Describe the Tunnel diode and IMPATT diode.
3. Explain the basics of Light-Emitting Diode (LED) and evaluate the performance of Photoconductor and photodiode.
4. Distinguish the performance of Photoconductor, photodiode, Phototransistor, Charge-Coupled Device
5. Analyze the functioning of Metal-Semiconductor-Metal Photodetector.

IEC-057	ANALOG SIGNAL PROCESSING	3L : 0T : 0P	3 Credits

Unit	Topics	Lectures
I	Introduction to domains and the analogue/digital trade off, Introduction to current conveyor, current feedback amplifier. Analog signal filtering: introduction to bilinear transfer functions and active realizations. Second-order filter realization, filter design parameters (Q and ω_0), frequency response, Three op-amp biquad, effect of finite gain of op-amp over filters, Sallen-Key biquad.	8
II	Ideal low-pass filter, Buttreworth and Chebyshev magnitude response, pole locations, low-pass filter specifications, comparison of Maximally flat and Equal ripple responses.	8
III	Delay equalization: equalization procedures, equalization with first-order and second order modules, strategies for equalization design. Definition of Bode sensitivity.	8
IV	The General Impedance Convertor (GIC), optimal design of the GIC, realization of simple ladders, Gorski-Popiel's Embedding Technique, Bruton's FDNR technique, Creating negative components.	8
V	Elementary transconductor building blocks, resistors, integrators, amplifiers, summers, Gyrator, First and second order filters, Higher order filters	**8**

Text Book:

1. R. Schaumann and M.E. Valkenberg, "Design of Analog Circuits", Oxford University Press

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Describe and apply fundamentals of signal processing in analog domain and its associated concepts like OTA and current conveyor.
2. Introduction of filter and its designing parameters
3. Solve problems and design higher order filters like Butterworth and Chebyshev.
4. Understand and explain the reasons for delay in filter designing and its procedure to equalize.
5. Understand the principles of the inductor simulation like general impedance convertor (GIC), optimal design of the GIC, Gorski-Popiel's Embedding Technique, Bruton's FDNR technique which are used for placing equivalent inductor on integrated circuits.

IEC 058	DESIGNING WITH ASICS	L:3	T: 0	P: 0	CREDITS : 3

Course Objective: Students undergoing this course are expected to:

1. Demonstrate in-depth knowledge in ASIC Design flow, ASICs Design styles and issues.
2. ASICs Design Techniques. ASIC construction.
3. Analyze the characteristics and performance of ASICs and judge independently the best suited device for conducting research in ASIC design.
4. Solve problems of Design issues, simulation and Testing of ASICs.
5. Apply appropriate techniques, resources and tools to engineering activities for appropriate solution to develop ASICs

Syllabus:

Unit	Topics	Lectures
I	Types of ASICs -Standard Cell-Gate Arrays, PLD's, Structured Gate Array .ASIC Design Flow	**8**
II	CMOS modeled as Transistor and , Capacitor ,CMOS Design rules – Lamda Based Design Rule, Mead Conway ,Design of Combinational Logic Cell, ,Data Path cell Library architecture.	
III	ASIC Library Design- Transistors as Resistors, Logical Effort , Transistor Parasitic Capacitance, Drive Strength calculation ,Logical effort - Library cell design programmable ASIC design software: Design system – logic synthesis – half gate ASIC.	**8**
IV	Low level design entry: Schematic entry – low level design languages – PLA tools – EDIF .Problems with Boolean function implementation based on ACTEL & Xilinx FPGA in detail with an example	**8**
V	An overview of VHDL and verilog. Logic synthesis in verilog and & VHDL simulation. Implementation of combinational and sequential circuits	**8**

Text / References:

1. J.S. Smith, "Application specific Integrated Circuits", Pearson Education, 2008
2. Wayne Wolf, "FPGA-Based System Design", Prentice Hall PTR, 2009.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1 Demonstrate VLSI tool-flow and appreciate FPGA architecture.

2 Understand the issues involved in ASIC design, including technology choice, design management, tool-flow, verification, debug and test, as well as the impact of technology scaling on ASIC design.

3 understand the algorithms used for ASIC construction

4 Understand the basics of System on Chip, On chip communication architectures like AMBA, AXI and utilizing Platform based design.

5 Demonstrate and appreciate high performance algorithms available for ASICs

IEC-551	INTEGRATED CIRCUITS LAB	0L:0T:2P	1 Credit

SUGGESTIVE LIST OF EXPERIMENTS:

1. Design the following using Op-Amp: ***(Through Virtual Lab Link 1)***
   a) A unity gain amplifier.
   b) An inverting amplifier with a gain of "A".
   c) A non-inverting amplifier with a gain of "A"
2. Study and design Log and antilog amplifiers.
3. Voltage to current and current to voltage convertors.
4. Second order filters using operational amplifier for: ***(Through Virtual Lab Link 1)***
   a) Low pass filter of cutoff frequency 1 KHz.
   b) High pass filter of frequency 12 KHz.
5. Realization of Band pass filter with unit gain of pass band from 1 KHz to 12 KHz.
6. Study and design voltage comparator and zero crossing detectors.
7. Function generator using operational amplifier (sine, triangular & square wave).
8. Design and construct astable multivibrator using IC 555 and
   a) Plot the output waveform
   b) Measure the frequency of oscillation ***(Through Virtual Lab Link 2)***
9. Design and construct a monostable multivibrator using IC 555 and
   a) Plot the output waveform
   b) Measure the time delay ***(Through Virtual Lab Link 2)***
10. Implement Schmitt Trigger Circuit using IC 555. ***(Through Virtual Lab Link 2)***
11. Implement voltage-controlled oscillator using IC566 and plot the waveform. ***(Through Virtual Lab Link 2)***
12. Study and design ramp generator using IC 566.

Virtual Lab Link:

1. http://vlabs.iitkgp.ernet.in/be/exp17/index.html
2. http://hecoep.vlabs.ac.in/Experiment8/Theory.html?domain=ElectronicsandCommunications&lab=Hybrid%20Electronics%20Lab

Available on: http://www.vlab.co.in/broad-area-electronics-and-communications

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Design different non-linear applications of operational amplifiers such as log, antilog amplifiers and voltage comparators.
2. Explain and design different linear applications of operational amplifiers such as filters.
3. Demonstrate the function of waveforms generator using op-Amp.
4. Construct multivibrator and oscillator circuits using IC555 and IC566 and perform measurements of frequency and time.
5. Design and practically demonstrate the applications based on IC555 and IC566.

IEC-552	MICROPROCESSOR & MICROCONTROLLER LAB	0L:0T:2P	1 Credit

SUGGESTIVE LIST OF EXPERIMENTS:

1. Write a program using 8085 Microprocessor for Decimal, Hexadecimal addition and subtraction of two Numbers. ***(Through Virtual Lab Link)***
2. Write a program using 8085 Microprocessor for addition and subtraction of two BCD numbers. ***(Through Virtual Lab Link)***
3. To perform multiplication and division of two 8 bit numbers using 8085. ***(Through Virtual Lab Link)***
4. To find the largest and smallest number in an array of data using 8085 instruction set.
5. To write a program using 8086 to arrange an array of data in ascending and descending order. ***(Through Virtual Lab Link)***
6. To convert given Hexadecimal number into its equivalent ASCII number and vice versa using 8086 instruction set.
7. To convert given Hexadecimal number into its equivalent BCD number and vice versa using 8086 instruction set.
8. To interface 8253 programmable interval timer and verify the operation of 8253 in six different modes.
9. To write a program to initiate 8251 and to check the transmission and reception of character.
10. Serial communication between two 8085 through RS-232 C port.
11. Write a program of Flashing LED connected to port 1 of the 8051 Micro Controller
12. Write a program to generate 10 kHz square wave using 8051.
13. Write a program to show the use of INT0 and INT1 of 8051.
14. Write a program for temperature & to display on intelligent LCD display.

Virtual Lab Link: http://vlabs.iitb.ac.in/vlabs-dev/labs_local/microprocessor/labs/explist.php

Available on: http://www.vlab.co.in/broad-area-electronics-and-communications

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Use techniques, skills, modern engineering tools, instrumentation and software/hardware appropriately to list and demonstrate arithmetic and logical operations on 8 bit data using microprocessor 8085.
2. Examine 8085 & 8086 microprocessor and its interfacing with peripheral devices.
3. State various conversion techniques using 8085 & 8086 and generate waveforms using 8085.
4. Implement programming concept of 8051 Microcontroller.
5. Design concepts to Interface peripheral devices with Microcontroller so as to design Microcontroller based projects.

IEC-553	COMMUNICATION LAB1	0L:0T:2P	1 Credit

SUGGESTIVE LIST OF EXPERIMENTS:

1. To study DSB/ SSB amplitude modulation & determine its modulation factor & power in side bands.
2. To study amplitude demodulation by linear diode detector.
3. To study frequency modulation and determine its modulation factor.
4. To study PLL 565 as frequency demodulator.
5. To study sampling and reconstruction of Pulse Amplitude modulation system.
6. To study the Sensitivity, Selectivity, and Fidelity characteristics of super heterodyne receiver.
7. To study Pulse Amplitude Modulation.

a) using switching method

b) by sample and hold circuit

8. To demodulate the obtained PAM signal by 2nd order LPF.
9. To study Pulse Width Modulation and Pulse Position Modulation.
10. To study Pulse code modulation and demodulation technique.
11. To study Delta modulation and demodulation technique.
12. Design and implement an FM radio receiver in 88-108 MHz

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Create and visualize various discrete/digital signals using MATLAB/Scilab.
2. Implement and test the basic operations of Signal processing.
3. Examine and analyse the spectral parameters of window functions.
4. Design IIR and FIR filters for band pass, band stop, low pass and high pass filters.
5. Design the signal processing algorithms using MATLAB/Scilab.

B.Tech 3rd Year
VI Semester
Syllabus

IEC-601	DIGITAL COMMUNICATION	3L:1T:0P	4 Credits

Unit	Topics	Lectures
I	**Digital Communication Basics:** Introduction to Digital communication systems, PSD of Line Coding schemes, Pulse shaping, Scrambling, Eye diagram, Gram-Schmidt orthogonalization scheme.	8
II	**Digital Modulation:** Modulation and Demodulation of Digital modulation schemes-ASK, FSK, PSK, DPSK, QPSK. Constellation diagram, Introduction to M-ary communication.	8
III	**Digital Receiver:** Optimum threshold detection, Concept of Matched Filters, BER analysis of BASK, BFSK, BPSK, Introduction of Spread spectrum communication (DS-SS, FH-SS).	8
IV	**Digital Passband Transmission**: Geometric Interpretation of Signals, Response of Bank of Correlators to Noisy Input, Coherent Detection of Signals in Noise, Correlation Receivers,	8
V	**Information Theory:** Measure of information-information, entropy, mutual information, mutual entropy, Source encoding (Shannon-Fano, Huffman), Shannon's channel capacity theorem, Introduction to error correction and detection, Linear block codes, Cyclic codes (systematic, non-systematic), Convolution coding and Viterbi decoding.	8

Text Books:

1. B.P. Lathi, "Modern Digital and Analog communication Systems", 4th Edition, Oxford University Press.
2. John G. Proakis, "Digital Communications", 5th Edition, TMH.
3. H. Taub, D L Schilling, Gautam Saha, "Principles of Communication", 4th Edition, TMH.
4. Singh & Sapray, Communication Systems, 3th Edition, TMH.

Reference Books:

1. Simon Haykin, "Communication Systems", 5th Edition, Wiley India.
2. (Schaum's Outline Series) H P HSU & D Mitra, "Analog and Digital Communications", TMH, 3rd Edition.

Course Outcomes: At the end of this course students will demonstrate the ability:

1. To formulate basic statistics involved in communication theory.
2. To demonstrate the concepts involved in digital communication.
3. To explain the concepts of digital modulation schemes.
4. To analyze the performance of digital communication systems.
5. To apply the concept of information theory and coding in digital systems.

IEC-602	Control System	3L:1T:0P	4 Credits

Unit	Topics	Lectures
I	**Introduction to Control Systems:** Basic Components of a control system, Feedback and its effect, types of feedback control systems. Block diagrams Reduction and signal flow graphs, Modeling of Physical systems: electrical networks, mechanical systems elements, free body diagram, analogous Systems, sensors and encoders in control systems, modeling of armature controlled and field controlled DC servomotor.	8
II	**State-Variable Analysis:** Introduction, vector matrix representation of state equation, state transition matrix, state-transition equation, relationship between state equations and high-order differential equations, relationship between state equations and transfer functions, Decomposition of transfer functions, Controllability and observability, Eigen Value and Eigen Vector, Diagonalization.	8
III	**Time domain Analysis of Control Systems:** Time response of continuous data systems, typical test signals for the time response of control systems, unit step response and time-domain specifications, time response of a first order system, transient response of a prototype second order system, Steady-State error, Static and dynamic error coefficients, error analysis for different types of systems.	8
IV	**Stability of Linear Control Systems:** Bounded-input bounded-output stability continuous data systems, zero-input and asymptotic stability of continuous data systems, Routh Hurwitz criterion, Root-Locus Technique: Introduction, Properties of the Root Loci, Design aspects of the Root Loci.	8
V	**Frequency Domain Analysis:** Resonant peak and Resonant frequency, Bandwidth of the prototype Second order system, effects of adding a zero to the forward path, effects of adding a pole to the forward path, polar plot, Nyquist stability criterion, stability analysis with the Bode plot, relative stability: gain margin and phase margin.	8

Text Book:

1. I. J. Nagrath & M. Gopal, "Control System Engineering", 6th Ed. New Age International Publishers, 2018
2. B.C. Kuo & Farid Golnaraghi, "Automatic Control Systems", 9th Edition, John Wiley India, 2008

Reference Books:

1. (Schaums Outlines Series) Joseph J. Distefano III, Allen R. Stubberud, Ivan J. Williams, "Control Systems", 3rd Edition, TMH, Special Indian Edition, 2010.
2. A. Anand Kumar, "Control Systems", Second Edition, PHI Learning private limited, 2014.
3. William A. Wolovich, "Automatic Control Systems", Oxford University Press, 2011.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Describe the basics of control systems along with different types of feedback and its effect. Additionally they will also be able to explain the techniques such as block diagrams reduction, signal flow graph and modelling of various physical systems along with modelling of DC servomotor.
2. Explain the concept of state variables for the representation of LTI system.
3. Interpret the time domain response analysis for various types of inputs along with the time domain specifications.
4. Distinguish the concepts of absolute and relative stability for continuous data systems along with different methods.
5. Interpret the concept of frequency domain response analysis and their specifications.

IEC-603	Microwave and RADAR Engineering	3L:1T:0L	4 Credits

Course Objectives:

1. An understanding of microwave waveguides,
2. An understanding of passive & active devices, tubes and network analysis.
3. An ability to design microwave matching networks.
4. An ability to perform microwave measurements.
5. An understanding of RADARs and its applications.

Pre-requisite: Engineering Mathematics, Engineering Electromagnetics.

Units	Topics	Lectures
Unit 1	**Wave Guide:** Rectangular Wave guide and Circular Wave guide – Solutions of Wave equations, TE and TM modes in rectangular waveguides, Cutoff frequency, propagation constant, phase velocity, group velocity, characteristic wave impedance, waveguide wavelength, degenerate mode, Dominant Mode TE_{10}, Power transmission, Excitation of modes in waveguide, Wave guide Cavities.	**8 L**
Unit 2	**Passive microwave devices:** Microwave Junctions and Couplers, Scattering Matrix, Passive microwave devices: Microwave Hybrid Circuits, Terminations, Attenuators, Phase Shifters, Microwave Propagation in ferrites, Faraday Rotation, Isolators, Circulators. S parameter analysis of all components.	**8 L**
Unit 3	**Microwave tubes :** Microwave Tubes: Limitation of Conventional Active Devices at Microwave frequency, Two Cavity Klystron, Reflex Klystron, Magnetron, Traveling Wave Tube, Backward Wave Oscillators: Their Schematic, Principle of Operation, Performance Characteristic and their applications.	**8 L**
Unit 4	**Microwave Measurements:** Measurement of Insertion Loss, Frequency, Cavity Q, Dielectric Constant, Scattering Parameters, Noise Factors, Return Loss, Impendence; VSWR Metering and Measurement, High Power Measurement; Power Meters, Microwave Amplifiers.	**8 L**
Unit 5	**Introduction to RADAR systems:** RADAR Block diagram, RADAR Range equation, Probability of detection of false alarm, Integration of RADAR pulses, RADAR cross section of targets, MTI RADAR, CW RADAR.	**8 L**

Text Books:

1. Samuel Y. Liao, "Microwave Devices & Circuits", 3rd Edition, Prentice Hall of India Publication, 1995.
2. David M. Pozar, "Microwave Engineering," Fourth Edition, Wiley, 2017.
3. M.I. Skolnik, "Introduction to Radar Engineering ", 3rd Edition, Tata McGraw Hill Publication, 2001.

Reference Books:

1. A Das and S.K. Das, "Microwave Engineering", 1st Edition, Tata McGraw Hill Publication, 2000.
2. S Vasuki, D Margaret Helena, R Rajeswari, "Microwave Engineering", McGraw Hill Publication 2015.
3. Robert E. Collin, "Foundations for Microwave Engineering", Second Edition, Wiley, 2017.

MOOC / NPTEL Lectures Link:

https://archive.nptel.ac.in/courses/108/103/108103141/#
https://youtu.be/2SxSBMum4gc
https://youtu.be/-9QIUsu0s-U
https://youtu.be/JlQB0yZw2as
https://onlinecourses.nptel.ac.in/noc23_ee36/preview

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Analyze various parameters and characteristics of the transmission line and waveguide and also use of wave guide component as per applications.
2. Describe, analyze and design simple microwave circuits and devices e g couplers, Attenuators, Phase Shifter and Isolators. Student will also understand the microwave propagation in ferrites.
3. Analyze the difference between the conventional tubes and the microwave tubes for the transmission of the EM waves.
4. Acquire knowledge about the handling and measurement of microwave equipment.
5. Differentiate different Radars, find applications and use of its supporting systems.

KEC-061	MICROCONTROLLER & EMBEDDED SYSTEMS DESIGN	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Advanced concepts in 8051 architecture:** Review of 8051 architecture, concept of synchronous serial communication, SPI and I2C communication protocols, study of SPI port on 89LP 51RD2, study of SAR ADC/DAC MCP3304 / MCP 33, interfacing concepts for SPI based ADC/DAC, study of watchdog timer, study of PCA timer in different modes like capture mode, PWM generation mode, High speed output toggle mode Embedded 'C' programming for the above peripherals **Introduction, AVR Family architecture**, Register File, The ALU. Memory access and Instruction execution. I/O memory. EEPROM. I/O ports. Timers. Interrupt Structure	8
II	**MSP430x5x Microcontroller:** series block diagram, address space, on-chip peripherals (analog and digital), and Register sets. Instruction set, instruction formats, and various addressing modes of 16-bit microcontroller; Sample embedded system on MSP430 microcontroller. Memory Mapped Peripherals, programming System registers, I/O pin multiplexing, pull up/down registers, GPIO control. Interrupts and interrupt programming.	8
III	**Peripheral Devices:** Watch dog timer, system clocks, Timer & Real Time Clock (RTC), PWM control, timing generation and measurements. Analog interfacing and data acquisition ADC and Comparator in MSP430, data transfer using DMA.	8
IV	**Serial communication** basics, Synchronous/Asynchronous interfaces (like UART, USB, SPI, and I2C). UART protocol, I2C protocol, SPI protocol. Implementing and programming UART, I2C, SPI interface using MSP430, Interfacing external devices.	8
V	**Internet of Things (IoT)**: overview and architecture, Overview of wireless sensor networks and design examples. Various wireless connectivity: NFC, ZigBee, Bluetooth, Bluetooth Low Energy, Wi-Fi. Adding Wi-Fi capability to the Microcontroller, Embedded Wi-Fi, User APIs for Wireless and Networking applications, Building IoT applications using CC3100 user API for connecting sensors.	8

Text Books:

1. Mazidi Ali Muhammad, Mazidi Gillispie Janice, and Mc Kinlay Rolin D "The 8051 Microcontroller and Embedded Systems using Assembly and C", Pearson Publication,2006
2. John H Davies, "MSP430 Microcontroller Basics" Newnes Publication,2008

Reference Books:

1. TI MSP430x5xx and MSP430x6xx Family User's Guide , Revised 2018.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Explain the advance concept of 8051 architectures and AVR family architecture and compare them for different applications.
2. To demonstrate the basics of MSP430x5x Microcontroller
3. To execute the I/O interfacing and peripheral devices associated with Microcontroller SoC (system on chip).
4. Evaluate the data transfer information through serial & parallel ports and implement its interfacing with MSP430.
5. Demonstrate the basics of IoT, WSN and its application sectors and design IoT based projects using MSP430 microcontroller.

IEC-062	SATELLITE COMMUNICATION	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Introduction to Satellite Communication:** History, Overview of Satellite Communication, Types of Satellite, Types of Orbit, Satellite services, Advantages & Applications of Satellite communication, Satellite Life phases, Space Debris, Introduction to Geo-synchronous and Geo-stationary satellites.	8
II	**Orbital Mechanics:** Orbital Mechanics, Kepler's Three laws of Planetary Motion, Developing the Equations of the orbit, Look Angle Determination, Earth Stations, Orbital Perturbations, Orbital effects in Communication system performance.	8
III	**Satellite Sub-systems:** Seven segments of Satellite communication, Attitude and Orbit control systems, Telemetry, Tracking and command control system, Power supply system. **Satellite Link Design:** Basic transmission theory, System noise temperature and G/T ratio, Design of down link and uplink, Design of satellite links for specified C/N.	8
IV	**Introduction to Various Satellite Systems:** VSAT**,** Direct broadcast satellite television and radio, Satellite navigation and the Global positioning systems, GPS position location principle, GPS receivers and codes, Satellite Signal Acquisition, GPS navigation Message, GPS Signal Levels, Timing Accuracy, GPS Receiver Operation.	8
V	**Launchers & Advanced Technologies:** Mechanism of Satellite launching, Launch Vehicles, Advanced launching tech like Space X, Intelligent Testing, Control and Decision making for Space, Inter Satellite Link. **Indian Satellite Systems:** History and Overview of Indian Satellite System, Achievements, GSLV, PSLV, Advanced Technology Vehicle.	8

Text Books:

1. B.Pratt, A.Bostian, "Satellite Communications", Wiley India, 2nd Edition,2006.
2. D. Roddy, "Satellite Communications", TMH, 4th Edition, 2001.
3. Digital Satellite Communications/ Tri T. Ha./ McGraw-Hill, 2nd Edition
4. D.C. Agrawal, Satellite communication, Khanna Publishers; 7th Edition.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Define and list the benefits of satellite communication**.**
2. Demonstrate orbital mechanics principles of satellite communication systems and solve problems related to it.
3. Describe a satellite link and identify ways to improve the link performance.
4. Classify new technologies of satellite communication systems as per given specifications.
5. Examine advanced technologies of satellite launching and describe the Indian satellite system.

IEC-063	DATA COMMUNICATION NETWORKS	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Introduction to Networks & Data Communications:** Goals and Applications of Networks ,The Internet, Protocols & Standards, Layered Tasks, OSI reference Model, TCP / IP, Addressing, Line Coding Review.	8
II	**Physical Layer**: Transmission Media- Guided and unguided, Network Topology Design, **Data Link Layer**: Error detection and Correction, Framing, Flow and Error Control Protocols, Noiseless Channel and Noisy Channel Protocol, HDLC, Point-to-Point Protocol	8
III	**Multiple Access:** RANDOH, CDMA, CSMA/CD, CSMA/CA, Controlled Access, Channelization Wired LANs: IEEE Standards, Standard Ethernet, Fast Ethernet, Gigabit Ethernet, Wireless LAN IEEE 802.11, Bluetooth IEEE 802.16.	8
IV	**Network Layer:** Design Issues. Routing Algorithms. Congestion control Algorithms. Internetworking –TCP/IP, IP Packet, IPv4 and IPv6 Protocols, IPV4 Addresses, Connecting Devices, Virtual LAN IPV6 Addresses.	8
V	**Transport Layer Protocol:** UDP and TCP, ATM, Cryptography, Network Security**,** Session Layer-Design issues. **Application Layer:** File Transfer, Electronic mail, HTTP, WWW, SMTP, Cryptography, Network Security.	8

Text Books:

1. B. A. Forouzan, "Data Communications and Networking", 5th Edition, TMH, 2017.

Reference Books:

1. S. Tanenbaum, "Computer Networks", 4th Edition, Pearson, 2013.
2. W. Stallings, "Data and Computer Communication", 8th Edition, Pearson, 2007.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Identify the issues and challenges in the architecture of a network.
2. Analyze the services and features of various protocol layers in data layer.
3. Demonstrate the knowledge of multiple access to design a access technique for a particular application.
4. Realize protocols at different layers of a network hierarchy.
5. Recognize security issues in a network and various application of application layer.

IEC064	Antenna Theory and Design	3L:0T:0L	3 Credits

Course Objectives:

1. Understand basic terminology and concepts of antennas.
2. To attain knowledge on the basic parameters those are considered in the antenna design process and the analysis while designing that.
3. Analyze the electric and magnetic field emission from various basic antennas and mathematical Formulation of the analysis.
4. To have knowledge on antenna operation and types as well as their usage in real time filed. Aware of the wave spectrum and respective band based antenna usage.
5. To understand the various methods involved in the measurement of antenna parameters.

Pre-requisite: Engineering Mathematics, Electromagnetic Field Theory

Unit 1	**Antennas Basics:** Introduction, Basic Antenna Parameters, Patterns, Beam Area (or Beam Solid Angle) Ω_A, Radiation Intensity, Beam Efficiency, Directivity D and Gain G, Directivity and Resolution, Antenna Apertures, Effective Height, The Radio Communication Link, Fields from Oscillating Dipole, Antenna Field Zones, Shape Impedance Considerations, Linear, Elliptical and Circular Polarization, Poynting Vector for Elliptically and Circularly Polarized Waves, The polarization Ellipse and the Poincare Sphere, Signal to Noise Ratio (SNR), Antenna Temperature, Antenna Impedance, Front-to-Back Ratio, Antenna Theorems.	**8 L**
Unit 2	**Point Sources and Antenna Arrays:** Point Source, Power Patterns, Power Theorem and its Application to an Isotropic Source, Radiation Intensity, Field Patterns, Phase Patterns, Arrays of Two Isotropic Point Sources, Non-isotropic but Similar Point Sources and the Principle of Pattern Multiplication, Pattern Synthesis by Pattern Multiplication, Linear Arrays of n-Isotropic Point Sources of Equal Amplitude and Spacing, Linear Broadside Arrays with Non-uniform Amplitude Distributions, Linear Arrays with Non-uniform Amplitude Distributions, Continuous Arrays, Huygens's Principle.	**8 L**
Unit 3	**Electric Dipoles and Arrays of Dipole:** Short Electric Dipole, The Fields of a Short Dipole, Radiation Resistance of Short Electric Dipole, Thin Linear Antenna, Radiation Resistance of λ/2 Antenna, Array of Two Driven λ/2 Elements: Broadside Case and End-Fire Case, Horizontal Antennas Above a Plane Ground, Vertical Antennas Above a Plane Ground, Yagi-Uda Antenna Design, Long- Wire Antennas, Folded Dipole Antennas.	**8 L**
Unit 4	**Practical Antenna Design**: Criteria for an Antenna Design, Antenna for Low Frequencies, Marconi Antenna, Hertz Antenna, Radio Direction Finding, Loop Antenna, Antenna for Medium Frequencies, Long Wire or Harmonic Antenna, Travelling Wave Antenna, Antenna for High Frequencies, Rhombic Antenna, Log-periodic Antenna, Helical Antenna, Parabolic Reflector, Horn Antenna, Lens Antenna, Slot Antenna, Smart Antennas and Techniques, 5G Massive MIMO Antenna.	**8 L**
Unit 5	**Antenna Measurements:** Introduction, Concepts - Reciprocity, Near and Far Fields, Coordinate System, Measurement of Different Antenna Parameters: Directional Pattern, Gain, Phase, Polarization, Impedance, Efficiency, and Current Distribution. Large millimeter and submillimeter antennas, Electrically small antennas.	**8 L**

Text Books:

1. Kraus, John D., Ronald J. Marhefka, and Ahmad S. Khan. Antennas and wave propagation. Tata McGraw-Hill Education, 2006.
2. Balanis, Constantine A. Antenna theory: analysis and design. John Wiley & sons, 2016.
3. Prasad, K. D. "Antenna and wave propagation." (No Title) (2003).

Reference Books:

4. Raju, G. S. N. Antennas and wave propagation. Pearson Education India, 2006.

NPTEL Lectures Link:

1. https://www.digimat.in/nptel/courses/video/108101092/L01.html
2. https://www.digimat.in/nptel/courses/video/108101092/L02.html
3. https://www.digimat.in/nptel/courses/video/108101092/L03.html
4. https://youtu.be/wKL6WsEOl00
5. https://youtu.be/fAg0mrwLH9Y

Course Outcomes (COs): After completion of this course student will be able to:

1. Be aware of antenna parameter considerations.
2. Analyze the antenna and evaluate fields under various conditions and formulate the electric as well as magnetic fields equation sets for far-field and near-field conditions.
3. Understand the array system of different antennas and field analysis under application of different currents to the individual antenna elements.
4. Appraise the design issues, and apply the concept to design some practical antennas.
5. Design and prepare a set-up for antenna parameter measurement for testing the effectiveness of designed antenna.

IEC-651	DIGITAL COMMUNICATION LAB	0L:0T:2P	1 Credit

SUGGESTIVE LIST OF EXPERIMENTS:

Part A

1. To study Eye diagram patterns of various digital pulses.
2. To study the inter symbol interference.
3. To study generation of Unipolar RZ & NRZ Line Coding.
4. To study generation of Polar RZ & NRZ Line Coding.
5. To study generation of Bipolar RZ & NRZ Line Coding.
6. Implementation and analysis of BASK modulation and demodulation
7. Implementation and analysis of BFSK modulation and demodulation
8. Implementation and analysis of BPSK modulation and demodulation. *(Through Virtual Lab)*
9. Implementation and analysis of QPSK modulation and demodulation. *(Through Virtual Lab)*
10. To simulate M-ary Phase shift keying technique using MATLAB.
11. To study generation and detection of DPSK using MATLAB.
12. Implementation and analysis of Delta modulation and demodulation.
13. Implementation and analysis of DSSS Modulation, Demodulation & BER measurement.
14. Implementation and analysis of FHSS Modulation, Demodulation & BER measurement.
15. To study encoding and decoding of Linear Block Codes
16. To study the working of Convolution encoder.

Part **B**

1. To study simple dipole λ 2 antenna and to calculate beam-width, front / back ratio, and gain of the antenna. 10.
2. To study folded dipole antenna and to calculate beam-width, front / back ratio, and gain of the antenna.
3. To study λ 2 phase array end-fire antenna and to calculate beam-width, front / back ratio, and gain of the antenna.
4. To study broadside array antenna and to calculate beam-width, front / back ratio, and gain of the antenna.

Virtual Lab Link: https://vlab.amrita.edu/?sub=1&brch=201

Course Outcomes: At the end of this course students will demonstrate the ability:

1. To formulate basic concepts of pulse shaping in digital communication.
2. To identify different line coding techniques and demonstrate the concepts.
3. To design equipments related to digital modulation and demodulation schemes.
4. To analyze the performance of various digital communication systems and evaluate the key parameters.
5. To conceptualize error detection & correction using different coding schemes in digital communication.

IEC-652	CONTROL SYSTEM LAB	0L:0T:2P	1 Credit

SUGGESTIVE LIST OF EXPERIMENTS:

1. Introduction to MATLAB Control System Toolbox.
2. Determine transpose, inverse values of given matrix.
3. Plot the pole-zero configuration in s-plane for the given transfer function.
4. Determine the transfer function for given closed loop system in block diagram representation.
5. Create the state space model of a linear continuous system.
6. Determine the State Space representations of the given transfer function.
7. Determine the time response of the given system subjected to any arbitrary input.
8. Plot unit step response of given transfer function and find delay time, rise time, peak time, peak overshoot and settling time.
9. Determine the steady state errors of a given transfer function.
10. Plot root locus of given transfer function, locate closed loop poles for different values of k.
11. Plot bode plot of given transfer function. Also determine gain and phase margins.
12. Plot Nyquist plot for given transfer function. Also determine the relative stability by measuring gain and phase margin.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Classify different tools in MATLAB along with the basic matrix operations used in MATLAB.
2. Evaluate the poles and zeros on s-plane along with transfer function of a given system.
3. Construct state space model of a linear continuous system.
4. Evaluate the various specifications of time domain response of a given system.
5. Appraise the steady state error of a given transfer function.
6. Examine the relative stability of a given transfer function using various methods such as root locus, Bode plot and Nyquist plot.

IEC-653C	Microwave and Antenna Design Lab	0L:0T:2P	1 Credit

SUGGESTIVE LIST OF EXPERIMENTS:

1. To study microwave test bench.
2. To study the characteristics of reflex klystron tube and to determine its electronic tuning range.
3. To determine the frequency and wavelength in a rectangular waveguide working on TE01 mode.
4. To study measurement of reflection coefficient and standing wave ratio using double minima method.
5. (a) To study isolation and coupling coefficient of a magic Tee.
   (b) To measure coupling coefficient, Insertion loss & Directivity of a Directional coupler.
6. To study V-I characteristic of Gunn diode.
7. To measure an unknown impedance with Smith chart.
8. (a) To measure attenuation and insertion loss of a fixed and variable attenuator.
   (b) To measure isolation and insertion loss of a three port Circulators/Isolator.
9. Study of Attenuator (Fixed and Variable type).
10. To Study working of Doppler radar, and measure the velocity of the object moving in the Radar range.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Describe working on microwave testing bench.
2. Practically demonstrate the Characteristics of Reflex klystron using Microwave bench setup.
3. Demonstrate the performance of the Gunn diode using Microwave bench setup.
4. Perform measurement of Frequency, attenuation, VSWR, Impedance of microwave passive device using Klystron Bench Setup.
5. Interpret the basics of Smith chart for solution of transmission line problems and impedance matching.